Chapter 9: Welcome to the Coral Zone:

Big Sur, the Life of Frogs and the Oranges of Hieronymus Bosch

The newspaper proclaims a victory for protecting habitat for the red-legged frog, the namesake celebrated (or notorious, depending on which version you are reading) jumping frog of Mark Twain, which also means that of the San Francisco Garter snake (which eats the red-legged frog). The red-legged frog was once endemic to California. It exemplified "frogness" in the state. But as far back as the Gold Rush, its habitat was increasingly taken over by development, and its water resources reduced. The frog can estivate (basically "hibernate" during the summer: the driest months) but like other frogs needs water to survive and for its tadpoles to develop through the winter.

But it may have been overharvesting, not habitat destruction that led to its slide into rarity during the Gold Rush days.

> "…Well, I'm only a stranger here, and I an't got no frog; but if I had a frog, I'd bet you." And then Smiley says, "That's all right—that's all right—if you'll hold my box a minute, I'll go and get you a frog…Smiley he went to the swamp and slopped around in the mud for a long time, and finally he ketched a frog…[i]"

Well, old Smiley would have to slop around way longer than that to find a red-legged frog, nowadays. But it wasn't catching frogs for jumping contests that caused its decline. In the late eighteen hundreds frog's legs were considered a delicacy and were so overharvested that bullfrogs (which exemplify frogness only for the East) were brought in to replace the declining red-legged species, further threatening them by taking over their habitat.

When I was a child, and my pet bullfrog died my father proposed that we dissect it. When I expressed concerned about the life of the frog and the dignity of it being dismantled rather than properly buried, he retorted, “Don’t worry, they’re taking over the world.” I gleefully accepted his proposition.

The newspaper article went on to talk about how corrupt officials had doctored reports to show the habitat range of the red-legged frog to be much less than what actually existed at the behest of agricultural and development interests, essentially filling the belly of habitat protection legislation with “quail shot.” The picture of the frog in the article didn’t look like it had red legs. But then, just like weighed down frogs and phony statistics about frog habitat, sometimes there is more to frogs than meets the eye.

I fold the paper and tuck it under my arm as my name is called. I approach the car rental desk and mention to the reservation clerk that I forgot my reservation number but had reserved a subcompact. I was told the name of the car over the phone, but for some reason, all I can think of now is "Topo Gigio." No, that's the name of the mouse puppet on the Ed Sullivan Show. Rather than reveal my stupidity, I let the clerk figure out what model it is. She looks me up and down for an uncomfortably long time, then says: "I think you need something a little…sportier." Perhaps they are out of Topo Gigios. I walk out to the parking lot where a small white convertible is waiting. When I get in, I notice that it has one of those scented, cardboard pendants hanging from the rear-view mirror. It is in the shape of an orange, but the fragrance it gives off bears little resemblance to that or any other fruit. I smile at the prospect of having to “freshen” the air in a convertible. Air is funny that way.

Junipero Serra Freeway (a.k.a, 280) is named after a priest. A huge statue of him overlooks the freeway with an accusing finger outstretched (either that or he is giving driving directions to Half Moon Bay). I suppose it’s appropriate, since the highway

parallels God's country: the San Andreas fault. I am meeting a friend who works for CERN in Switzerland (Conseil Européen pour la Recherche Nucléaire), the world's largest physics lab, which is where the World Wide Web was invented: they think big.

She is a visiting scientist to Stanford's own physics research lab, albeit a smaller one called SLAC (Stanford Linear Accelerator). She insists that there is something in the water here because Americans could not possibly be stupid enough to build a nuclear accelerator across the San Andreas Fault. I want to see for myself. On the left is golden, serpentine grassland, on the right, deep green of the chaparral and oak forests, and then redwood forests on the farthest ridges. Through my two-dimensional lens of traveling down the freeway, it seems like untrammeled wildernesses on either side.

San Andreas Lake shimmers bejeweled in the middle of the fault. A blanket of tiny white pearls beading its surface rises, becoming an enormous flock of gulls in the air. Another five minutes or so I cross the bridge under which the main accelerator building runs, swerving as I crane my neck to see where it ends. The main building looks like it runs to within about a half mile of the main fault. Although it doesn't cross the fault itself, as with anything built here it is bound to get shaken, and indeed it was during the Loma Prieta Earthquake in nineteen eighty-nine, something which, nearly twenty years later is still fresh in people's mind at SLAC.[ii]

Hmm. San Andreas Lake is used for drinking water. Perhaps it is seagull guano that affected the thinking of the fine folks at Stanford and the Department of Energy, allowing them to come up with this as the site for such a powerful LINAC. They could have been much more pragmatic. If they had run it along El Camino Real, then the street racers could have been pitted against positrons and electrons instead of each other. Maybe they would have discovered a new particle, the NASCARino, or its antimatter equivalent, the antiNASCARino, or perhaps just a new kind of relativistic car part.

One of the objectives of the meeting was to find out more about how photons and electrons network in quantum electrodynamics (QED). I had read Feynman's lectures on QED and the arrows, and it all marginally made sense, at least while reading it.[iii] Sort of the way life insurance policies make sense while the insurance agent is reading it to you, but then immediately after they stop and you try reading it yourself, it makes no sense at all. In QED, photons are converted to electrons (or positrons), electrons (or positrons) are converted to photons, photons are converted to photons and electrons are converted to electrons. Some have interpreted this as photons being exchanged by electrically charged particles (positrons and electrons), as being the cause of all matter. These exchanges or transformations happen wherever there are charged particles. Feynman indicated (through his famous arrow diagrams) a cascading network of interactions of photons and electrons. So, then what happens?

I take Pagemill Road to El Camino Real and make a left at the mission bell. Standing beneath it is a panhandler, holding up a sign: "Will program Visual BASIC for food." Ah, if only he knew Object-Oriented C.

I am running early so decide to stop in Palo Alto to see if I can find a store that sells *epazote*, a distinctive herb used in Mexican cooking. It has a strong, almost lemony flavor and scent to it, a little like cilantro, but not quite. I use this for cooking legumes and have been working on a kind of fusion that takes advantage of some of the sophisticated overtones of Central Mexican cuisine. Epazote comes from the Aztec words 'epatl' and 'tzotl' meaning "smelly animal." With any luck my dinner guests will not have that come to mind while they are eating it.

Downtown Palo Alto is divided into four color-coded parking zones: Purple, Coral, Lime and Blue. The idea is that you can park in any zone for two hours and can come and go during those two hours to the same color, but after that you must repark into a

different color zone and cannot return to your original color until after five o'clock, or the next day. This could provide an interesting network problem for shoppers. Trying to combine an all-day shopping trip with relocations every two hours, one would cluster shopping sites and color zones by proximity. Of course, this does not account for there being no spaces in any parking lots, which seems to be my more immediate problem.

As far as I can tell, the "permit" dangling from my rear-view mirror is only valid in the "Orange Zone," which doesn't exist. If I had a quantum car, then this would not be a problem, because I could park in one zone and my car would have a probability of appearing in all color zones at once. I could park as far away as I wanted, then still get into my car right outside the store. Or, I could get four quantum parking violations at once, but then, if I pay with quantum checks, I could have the money in my bank account, in my wallet, and at the parking violations bureau all at the same time.

Since I have no idea where I am going anyway, I eventually I find a space in the Coral Zone and just try walking down University Avenue. No luck. I will need to do more than just a random walk to find smelly animal here. But there is another kind of smelly animal at Stanford, one I would rather not get hold of.

As I fetch my car from the Coral Zone, cross El Camino Real again and enter the Stanford Campus, an announcement on the radio warns anyone visiting Stanford to keep an eye out for "cats" (mountain lions have been spotted prowling around. . . I have never smelled one.). We are not meeting at the SLAC itself, but on the main campus. Of course, parking anywhere near where we are supposed to meet is a problem, but it's a beautiful day, "cats" notwithstanding, and I don't mind a bit of a walk. To hell with it: if I get eaten, then Thrify will just have to come pick up their car themselves. As I walk toward the meeting location, scrub jays flit gaily amongst the palms, oaks, eucalyptus and redwoods. I pass a huge eucalyptus tree, and a pungent odor rises to my nostrils, I pull a leaf off and

crush it under my nose. My great aunt Bernice who lives in Walnut Creek would say that eucalyptus smells like a wet cat (she doesn't think this is a good thing). One thing about mountain lions is that if they are around, you can be sure they have smelled you, but you probably have not smelled them.

As I pass through Jordan Quad, I take a turn and suddenly remember a conference I was at on color management here a few years ago, including some of the best minds in color science, such as R.W.G. Hunt, Roy Berns, and some other Stanford faculty, a fairly distinguished bunch. Somehow, I had the notion in my head that attending this would answer the question of ages: how do we reconcile the differences between the CIE Lu'v' and CIE La*b* color models (the ways colors are created on your display screen and on your color printer respectively. CIE is the Commission Internationale de l'Eclairage) to accurately predict color images from computers. After several days at the conference, it became apparent that the problem was much more complex than say, figuring out the best location to build a linear accelerator.

The problem is, while the SLAC might be linear, predicting color output from computers is not. Complexity and the messy world of human perception would once again foil us from finding the perfect answer. There is a non-linear relationship between the way color looks on the computer screen and the way color appears on the printed page. *Non-linearity* is a fancy, scientific way of saying that (like the weather) it doesn't behave predictably. There are also a number of variables, such as the viewing conditions, color acuity of the observer (how well you can distinguish one color form another), surround contrast and color, something called *metamerism* (in which something is one color in daylight and a different color in artificial light), the kinds of dyes, pigments and paper used, or the dye, and color backlight used in displays…you get the idea.

Those user-friendly controls you seem to have when color is in its computer state in Photoshop are all but lost as it is turned into light. Color is only perfect when it doesn't exist; which as we now know, it indeed does not, neither in the computer, nor in the environment, it is a survival mechanism in our brains (and the brains of most other creatures that see) to help us sort out the patterns in Nature: to find food and avoid being eaten, to beguile a potential mate or be beguiled, to be able to navigate Nature's art gallery and be pleased or reviled at the patterns we find there.

As I pass by the clock tower, I realize that I am too far north. I intended to go through Tressider Union and across the Plaza. I turn right at the library and go around to the Plaza side of the bookstore in case she is waiting outside. She has already gotten a table in the Bookstore Café.

After catching up, I pose the all-important question: "so where does one find epazote in this town?" She remarks that I should try to the farmer's market on Gilman Street. I then asked her sarcastically what color parking zone was that. She quickly responded: "well, lime or coral, of course!"

This somehow transmogrified into a discussion of quantum physics, which apparently has its own color-coded parking zones. It is called quantum chromodynamics and has to do with how we classify the interactions between quarks and gluons, those funny little things that make up hadrons that form subatomic particles, like protons and neutrons. Quarks have colors red, green and blue while anti-quarks have anti-red (cyan), anti-green (magenta) and anti-blue (yellow). Combining a quark with its anti-quark results in white (or no color). Combining red, green and blue quarks or red, green and blue anti-quarks likewise ends up as white or colorless.

The color coral is not among the gamut of interactions characterizing chromodynamics. It is a pinkish orange color, the color of polished coral, the kind used

in the old jewelry my great aunt wears while serving tea and complaining about the smell of eucalyptus trees. In a computer its hex value is FF7F50, on the Web it would be slightly more reddish at FF7755, in print (CMYK) it would be C0.000/M0.502/Y0.686/ K0.000, on the computer screen (RGB) it would be R255/G127/B80, its Pantone number is 1777…

According to Maerz and Paul, the term "Coral" for a color dates to 1513,[iv] three years after Garci Rodríguez de Montalvo published the novel Las Sergas de Esplandián, in which the mythical Island of California is first mentioned:

> …Know that on the right hand from the Indies exists an island called California very close to Earthly Paradise; and it was populated by black women, without any man existing there, because they lived in the way of the Amazons. They had beautiful and robust bodies and were brave and very strong. Their island was the strongest of the World, with its cliffs and rocky shores. Their weapons were golden and so were the harnesses of the wild beasts that they were accustomed to domesticate and ride, because there was no other metal in the island than gold…

For many years after Las Islas Californias was discovered in 1539 (originally by Francisco de Ulloa, sent by Cortez up the Gulf of California along the Baja Peninsula), there was an assumption that if one sailed far enough that one could go around the California Isles and possibly find a northern passage back to Spain. Well, it turned out California was only an island metaphorically, and the Spanish never found the gold, or the Amazons, or the northern passage, or color-coded parking zones, but arguably, paradise.

Like coral, gold (hex value: FFD700, Web: FFDD00, CMYK: C0.000/M0.157/Y1.000/K0.000, RGB: R255/G215/B0…), is not a color of interactions in quantum chromodynamics. There are no "hues," only primary colors, anti-primaries (secondary colors), and white. Oh, and by the way, these colors, don't exist either, and you can't see them. The decision to use the term "color" was a way to get our minds around quark-gluon interactions. It has nothing to do with what we perceive as color in reality. It was quite a while into the discussion with my scientist friend that I figured this out. The word "quark" is from Joyce's *Finnegan's Wake* and was coined by physicist Murray Gell-Mann (who was seeking a word to represent the sound a sub-atomic duck makes). He also came up with the notion of "color" to describe quarks, Gell-Mann, being a colorful character himself.

The problem with quantum chromodynamics, as my CERN friend relates (in a rapid, caffeine-induced staccato), is although it is likely that it explains gluon-quark interaction, it cannot be proven analytically. It is too complex or non-linear, meaning, she explains, "You cannot solve the problem by perturbation expansion of interaction strength, because you are dealing with strong interactions. So, a lattice QCD theory must be used. The problem is that you need to solve a twenty-one-million-dimension integral using Monte Carlo, which means MONDO computing power."

"Huh?" I feel like I was just run over by a physics lingo freight locomotive. She may as well be speaking in Tamyen. After several attempts to get a more humane explanation I try to steer the discussion to a different topic.

"Why do you think we do not have the ability to sense quantum physics, even though it explains everything in the Universe, and particularly is fundamental to the behavior of light?" I ask.

"Well…, light is electromagnetic…" She begins slowly, as if deeply puzzled at my question, then speeds up again "…which is not part of the strong force compared to quark-gluon interaction."

"I'm sorry," I explain, "that's not what I mean. I mean, how come we see, touch smell, hear a mechanical world, when it is supposedly a quantum world?"

"Oh, I get it (she reels back in her chair at the realization that I am unwittingly conflating the discussion of quarks with a discussion about light), this has nothing to do with the strong force, per se. You mean electro-MAG-netism. Well, and this is only my opinion, we DO sense a quantum world, we just don't notice it. It's like asking a fish, how it feels to be wet. The problem is how our senses evolved to interface with the environment. Vision is a perfect example, it developed to sense photons, not light waves. Vision turns photons into electrons, which is a quantum electrodynamic phenomenon, not a mechanical one. As a matter of fact, photons are not only how we see, but are the glue by which all matter is held together, that covers smell, touch, taste, hearing… Without the dynamic quantum interactions of photons and electrons, reality would melt away, obviously making it impossible to hear, smell, taste of touch anything either!"

She is half-chuckling and looking at me like I am an idiot. The expression on my face must be indicating that she has lost me somewhere between QCD and QED.

"Think of it this way," she continues. "Think of photons as money and electrons as people. An economic system only exists because there is something to exchange. Money is a virtual entity, an idea that represents something, but is not a real thing in itself. Money being exchanged back and forth is the glue that holds an economic system together. If all of a sudden there is no money, that kind of system would have no need to exist and would fall apart."

It occurs to me that this is a little like lateral gene transfer in bacteria, instead of photons they exchange genes. I mention this and she says "lateral gene wha…?"

"Never mind," I retort.

She interrupts my train of thought, "So where did you park?"

"Over on the other side of Jordan Quad."

She asks me whether she could catch a ride back to SLAC. "Sure, I respond, as long as you don't mind a bit of a walk." We had both been pumping espressos as we ate so the walk back to the car is pretty brisk. As we head out to Sandhill Road, we talk a bit more about the problems of light and reality.

She begins. "Color is actually just energy levels: quanta, if you will. Since you can't have a wave and a particle at the same time, what differentiates one color from another, say lime and coral." She smiles broadly." is the energy those photons have. So, your eyes have sensors that are tweaked by photons at one energy level while others are affected by photons at another. So, seeing is all about the quantum world, not the mechanical world."

We pull into the Loop Road, and she says she needs to be at Building Twenty-Eight, so I turn at the PEP Ring Road and stop. As she gets out of the car, she tells me to wait, that she has something for me. The stark buildings seem to concentrate the intense sunlight and prevent the breeze from carrying it away, making it feel much hotter than it really is, as well as much brighter. I am so saturated in heat and light that color seems to fade to intense pastels: it hurts to keep my eyes open.

She soon shows up with what looks like a carton of copier paper. As she approaches the car I get out and notice that it is filled with oranges. She tells me that she picked them this morning from her own tree, instructs me to take some and apologizes that she doesn't have a box or bag for me to put them in. I unload about a dozen oranges from the box

and place them on the passenger seat. "Thanks," I exclaim as she rushes back into the building crying out "Let's do this again soon, call me next week."

I come to the intersection at Sandhill Road again and make a right to head back to the office. The whole idea of light and color as a psychophysical phenomenon (something that our brain creates from something in the environment but does not accurately represent it) becomes an obsession. I look at the pile of oranges in the passenger seat. They glow like golden cannonballs, like perfect blazing planets, like suns. Then I look around me and think about what it would be like if the only metal available to build things was gold, everything would shine like these oranges under the intense autumn, California sun.

As I drive down University Avenue and get to the intersection of Bryant Street, I cannot make up my mind whether I should turn and head back to work or continue straight and head back to anti-work. Like a photon, I could do either, but unlike one, cannot do both. I look at the clock in the car. As I slow down a car horn startles me and I continue on, going back to anti-work. The person in the car behind me unwittingly was the catalyst for my decision. I call in and tell my staff that my meeting is running longer than expected and that I would not be back today. It's Friday afternoon anyway, I keep reminding myself.

I continue down University Avenue and keep turning the ideas of color and light as paradigms of perception rather than portals to reality over and over in my mind. The humanist/analyst question arises again. Photons are a paradox, a trickster. How can these masters of the Universe, the things that hold all of matter together, and allow us to perceive it through the senses, be in two places at once, or behave like a wave or a particle, or… Hummingbird may have stolen the light, but Coyote has made it so that we can never fully understand it, so that we are fish trying to explain what it is like to be wet.

Then once color is created in our heads, it is further affected by meaning. Since it is a survival mechanism, we use it to classify what we see, determine whether something tastes good (ripeness), whether something is hot or cold, wet or dry, fresh or moldy, near or far, we can detect emotion, illness or injury in others, classify plants and animals, it is an analytical tool for understanding the environment and navigating it successfully.

As we gaze into the looking glass of the computer display, our models and scientific visualizations can hopelessly entangle the emotional and rational side of our minds with color, a Gordian Knot in which science and art undergo a perpetual interplay, a dance, as it were. The outcome of scientific inquiry using computer visualization techniques can exhibit beauty, which transcends its usefulness, and the creator or programmer may even feel tinged with guilt that she or he is indulging the aesthetic experiences, rather than using them purely to better analyze data. As we harvest data and mine it for the gold it contains, it is a virtual realm of pure color and light. The question "what does it look like?" ricochets through our consciousness until we find or create a way to look at it, whatever form and color it might be. We want to be stimulated by color and light: soothed and stroked by beauty.

But what is beauty, and can we only see it? What about the other senses? It is more than sensation, more than aesthetics, it is information: the symmetry and structure which resonates throughout the Universe: the explicate form found in such things as the spiral, the structure of which is replicated in galaxies, the movement of planets about the Sun, the circulation of water in the oceans, hurricanes, tornados, flushing the toilet, the pattern of hair on my head, a sunflower, seashells, microscopic plants and a DNA molecule. It is the patterns of color and light we perceive in the course of our lives. In the words of David Bohm, the implicate order emerges in the form of beauty, symmetry, and the seemingly coincidental or synchronistic nature of thoughts, words and actions in the environment.[v]

Perhaps this implicate order is found in the non-linear realm underlying color and light, or the chromodynamic interactions of quarks. Perhaps it is in an elusive, fundamental force of beauty. We do not have access to this implicate order, it is beyond our control or understanding. Perhaps it is something we cannot analyze, we can only "feel" it emotionally; like color, it only happens within us.

One of the things that network science does for us is help reveal patterns, it eschews ideas of randomness and chaos. Nature happens in patterns, albeit complex ones. If these patterns are many faceted and evolving, they may be so complex that the processes underlying them are not obvious, they simply follow the rules until their beauty is revealed to our waiting eyes.

Chaos implies randomness, something complexity theory indicates doesn't exist. Even the roulette wheel, the exemplar of random number generators (Monte Carlo Method was named after the city, known for its casinos and roulette wheels), functions through a chain of interactions and forces that are, perhaps emergent, perhaps too complex to model accurately, but not random. Monte Carlo textbooks call modeling randomness "simulating random variables."

Perhaps the implicate order is the complexity exhibited in the Universe, a spiral of increasing complexity, the knowable receding away like the background noise from the Big Bang. When the Big Bang happened, things were very simple. But as the Universe spiraled outward and cooled it became increasingly complex as more species of atoms came into being and could form molecules, which could then interact in increasingly complex ways over time, eventually leading to living systems. The process of the Universe is to increase in complexity through the sheer numbers of molecules and energy available for them to interact, come apart and recombine in seemingly infinite ways. Everything we know resonates from increasing complexity of Nature. We are a result of

this process. The unknowable complexity of Nature, its implicate order created us, allowed us to emerge. As we focus in on a small piece of knowledge to impose order, we then stand back and look at the relationships that knowledge has with the rest of the Universe, complexity rules.

The subtle mutations which take place in organisms through successive generations, the formation of mountains, the interplay of beings, the networks of thought, clouds, the currents of the air and sea, the structure of the Universe all result in exquisite beauty, but have no basis in the kind of organized construction we attribute to, say, the creation of a painting. Yet, the creative force underlying the complexity of the Universe has resulted in artists making art.

Indeed, one might go as far as to say that as art imitates life, its goal is to attain beauty, to extract an essence from the patterns, order, and relationships which have arisen together and resonated from complexity. To "walk in beauty", as the Navajo call the order in one's life reflecting the order of the Universe. The integration of living things into the ebb and flow of Nature, into the collective intelligence of place, then becomes the foundation of beauty. From the interrelationship among organelles in a cell, to the organisms that work together within ourselves to allow life, to the way we integrate ourselves into the life of the world. This is the network, nodes interconnected through the network of life culminating in the patterns of beauty. The biosphere is a network. Every living thing takes its cues from the other living thing with which it shares the world. Data take the forms of sounds, chemicals, colors, which pervade our existence.

The dichotomy we have imposed on separating aesthetics from analysis is in my estimation a grave mistake. Beauty is the culmination of everything, it is the "purpose" (creative process) of why we are here: a byproduct of a survival instinct that helps us

procreate and get enough to eat, it has taken on a life of its own, bigger than just surviving.

I came to this realization through a dream I had many years ago when I was going through a painful divorce and reassessment of my career. I was running down a hallway at the computer graphics lab at the university where I worked. As I came to the wall at the end of the hallway, I broke through it and found myself flying through space toward, what at first appeared to be the Sun. I soon realized that it was a silicon wafer, covered with microprocessors. I became angry at the sight of it trying to imitate the Sun, thinking it could provide light. So, I accelerated my flight toward it, tucked my head down and dashed through it causing it to shatter into tiny fragments, spreading out across the Universe, filling it with stars. The drama of this event was a catalyst for me to redefine my understanding of perception. There is no objectivity without subjectivity, no rationality without emotion, no science without creativity. Such pluralities have been contrived: falsely created. The most important things happen through the interplay amongst them. Without recognizing this interplay, we cannot know which domain we are in. We only know light because of darkness, we only know cold because of heat, or in the case of a fish, we can only know wetness if we can know dryness. This interplay is part of the process that culminates in beauty.

The distinctions between analog and binary, virtual and manifest, art and science become blurred as our collective, Postmodern mind expands enough to encompass more than a single point of view. We have no choice but to embrace technology as an extension of the human mind and body, and no matter how precise our instruments, we will have no inherent objectivity with which to view either the Universe, or ourselves.

We are tuned to assimilate rhythms, commonality of form, and consistencies that exist without having access to their underlying function and structure. This is perhaps at the

root of point of view and why beauty cannot be defined in objective terms, "we just know it when we see it." It may also be the bond we have to the implicate order. Beauty may be the attachment we have to the unknowable, both in ourselves, and the rest of Nature.

The poetry of the cycles of seasons, days, the influence of all things on all other things is apparent in our everyday experience, yet the nature of these relationships cannot be easily defined. When we turn our gaze toward the implicate to try to see it, our eyes shift around to the pieces of it, but we can no longer see the whole and it vanishes. We are always part of the experiment we conduct on the parts, but it is the whole that experiments on us.

For example, as we turn our gaze from the relationship frogs have with the Universe to dissect them and figure out how they work, we have precluded ourselves from understanding their true nature, only the fragments and functions we extract and lay in the stainless-steel pan. When it was alive, we were an integral part of its "frogness" a part of the environment in which it lived.

We are part of the experiment Nature conducts on frogs, and even our dissection of the frog in its pickled, allopoietic state is part of Nature's experimentation on us. We have surgically removed the subject of study from that which defines it, but we are still part of that definition. A frog is nothing without the environment that necessitates its form and function. Its existence is no longer an autopoietic part of the Universe as it lies eviscerated in a stainless-steel pan. It has become a tool, an extension of ourselves and our perception, its "frogness" has evaporated away. We can know more about "frogness" when we watch it live its life. Perhaps we need to watch it for a day, a lifetime, or perhaps ten thousand years. As we watch it, both its connections to the Universe and ours enfold into our understanding like the healthy roots of an oak tree reaching into the intelligent earth to

possibly draw in information on the influences and interactions it has in the world through the mycelial network conveniently laid at its feet.

Whether a pickled frog or a computer workstation, we revel in the insight our tools give us. For sound and light, when the oscilloscope was invented in 1897, it dramatically altered our perception of waves, because we could now see energy waves, and came to understand their similarities and differences to physical waves we see in an earthquake or the ocean. The squiggly lines we observe on an oscilloscope are a representation of waves, not the waves themselves.

When I did engineering work, I felt blind without an oscilloscope. Meters, loggers and counters were too barren as compared to the richness and nuance of observing and manipulating waves displayed on the oscilloscope, a real-time portal to the invisible realm of waves. Is that nerdy, or what? Similarly, we can use light and color of the computer display to represent the networks in which we participate and which are a part of us. It is turning the idea of the oscilloscope on ourselves, a portal into our unseen threads, influences, attachments and interactions. We may be seeing something closer to truth than what we see in the mirror, beyond waves, beyond dissection. But is this a portal to the implicate order of the Universe? It is what Joseph Fourier had in mind when he indicated that like a frog, every wave can be dissected into a set of simpler waves?

Laws of the mechanical, logical Universe were devised by scientists who were trying to prove the existence of God. This is no doubt, why they ended seeming more like laws instead of theories. Over the past three hundred years we have been teaching the absoluteness of the mechanical Universe with absolute conviction. But the twentieth century has proven that the mechanical Universe is largely a construct, a perception, a way of simplistically calculating the function and dimension of something much grander and more elusive than the laws indicate.

We can use laws of mechanical physics to predict the trajectory of a spacecraft, but as with the frog, we cannot describe the true nature of the Universe by taking it apart and looking at the parts. We must somehow see the structure of its behavior overall: the process of the Universe, in order to see its "Universeness." That is what quantum physics tries to do, to look at the process of the Universe and see how it applies to all of it. This has been very difficult, because for quantum physics to be a law of physics, there must be a sense of absoluteness to it, something many aspects of quantum physics have yet to possess, but then there are no other absolute laws in other branches of science either. All scientific truths are subject to revision based on new evidence. But like quantum electrodynamics and quantum chromodynamics, this may just have to do with a lack of sophisticated enough tools.

Similarly, as we try to characterize the living realm, we discover that we cannot know it very well by taking it apart. As a whole it is too complex to understand by looking at and trying to assemble the parts we extracted. What we can do, however, is to create tools for observing Nature through only its interactions, through the implicate order of how energy and information percolate through these networks and affect the way it behaves, lives and dies, how it changes over time, what its connections are, and how they form and break. As with quantum mechanics, with networks, we need to improve and innovate on ways to detect and model things we cannot actually see.

When I later pose some of these questions to my friend, she remarks that the purpose and function of science is based on what is not known. There is no point exploring things we know about, that's no fun. Curiosity may have killed the cat, but it saved us. Science honors this salvation by perpetuating this process. Also, all science is based on the patterns and connections we cannot readily see, which is why they call it discovery which literally means to "take away the cover," to pry open the can and see what's inside. The

computer is the can opener to most twenty-first century science. Without it we would be dancing around the important questions of science and never get to the business of understanding them. So perhaps we have created this tool to be the portal to the implicate order, a way to see the unseeable.

In part one we talked about how many of the things we thought were in the explicate order turned out to be part of the patterns of networks. What we need to do now is harness the power of computers and scientific visualization to allow this secret beauty to emerge in light, emerge in ways to change our thinking, to redefine our place, our perception, so we can walk in beauty. The challenge is to use our quantum perception, which is paradoxically tuned to the material world through photons, to connect to the invisible, perhaps implicate processes underlying the materiality of driving down University Avenue toward the Bayshore Freeway.

But this brings up another question. If network science is the implicate order we are looking for, is there then an implicate order underneath networks? If we can perceive it, isn't it part of the explicate order now? Doesn't it need an implicate order underneath it in order to exist? Perhaps it is the electrical world we have created within the computer that now becomes the implicate order. It is no less enigmatic than the paradox of waves and particles. This world contains information we have created but cannot understand in its binary state. It exists in a parallel universe beyond our senses, yet we control it and use it as a tool.

This makes accurately defining it an elusive exercise. In the computer everything is a "particle." broken down into binary digits, which race around in strings through the machine weaving files from data blocks: bits and pieces of numbers sprinkled onto the roulette-wheel-hard drive, seemingly at random. It must be translated to color, sound, or power for us to detect, know and use it. The transition between these states (at least for

color) is what gives rise to the mental questioning of how we define "digital." We can create laws for defining what comes out of a computer and how we translate it, but the chaos of the world will not allow this *deus IN machina* to give confidence in the results. The boundary of the precise rule-bound world of the computer must always be shattered for the computer to be useful. How do we reconcile the disparity between the machine, and the useful outcome of such binary tools? It quickly becomes a circularity, a koan, to quote Winston Churchill: "…a riddle wrapped in a mystery inside an enigma." When it is suggested that the world rests on the back of a turtle, the scientist asks: so, on what does that turtle stand? To which the correct answer is: the back of another turtle. But then as we ask what THAT turtle stands on, we are told authoritatively, that it is turtles all the way down…

As I head out of Palo Alto, the Diablo range looms wraithlike, a faded, golden phantom rising across the Bay: a torchlight guiding me toward the Bay and the Bayshore Freeway. As I get to the entrance ramp, I feel as if I have entered a Mobius' strip, with ants of thought running around in figure eights at a dizzying pace in my brain. I realize that I need to "reboot," so I head south.

The Bayshore Freeway curves east toward San Jose and forms a pencil-line down the middle of Santa Clara Valley, which is squeezed between the San Andreas and Hayward faults: a narrow corridor of once rich farmland. Gone are the fruit trees that gave rise to local names like Orchard Road and Pruneridge Avenue. Growing code and silicon has largely supplanted plums, apricots, cherries, and pears in the Valley. High-tech billboards and corporate offices come to an abrupt end, replaced by rural grazing land occasionally dotted with condominium complexes rising pueblo-like from the parched hillsides.

A half an hour or so out of San Jose, and time has reversed. Garlic and olives are the technologies here. And the only start-ups are tractors readying to till the fields for another season. But what is on my mind is a bit further off. Ever since remembering that Marilyn Monroe postcard, I had been obsessed with artichokes. I decide to turn off 101 onto 156 near Prunedale and head through Castroville to the coast.

It is Joachin Rodrigo's birthday, and Concierto de Aranjuez blasts merrily from the radio. In the music of Spain, resonates the music of the world. You can hear passages sounding like the Kora music of Gambia and others from the French Renaissance, yet others sound like Fado from Portugal or the rustic village music of Anacapri.

As I near the coast, the highway is bounded by endless fields of artichokes. These ragged thistle-bushes with their enormous buds seem alien among the more conventional fare of strawberries and cauliflower. I stop at a farm stand and pickup a small crate of large artichokes, enough for dinner guests and a large crate of the smallest buds so I can blanch and freeze the hearts. Artichokes require unusual growing conditions, neither too cold nor too warm year-round, which is why the coast with its moderate climate is ideal. Artichokes should never be allowed to flower and go to seed, since the seeds produce a noxious, invasive weed called artichoke thistle, which can take over habitat of native plants. I'm doing my part by eating as many artichokes as I can.

Along coastal route one, I make side excursions through Monterey and Carmel. On the way into Monterey, I pass a Volkswagen Bus parked along the road and think of my college friend. I eat two oranges. Monterey is a kind of eco-Coney Island. The shrunken boutiques, restaurant chain-gangs and purveyors of gewgaw along Cannery Row can't keep the sea otters, and elephant seals away from the piers. One cannery remains. The sound of Incan pipe buskers reverberates off its walls, with organ-like tones overwhelming the incongruous mixture of kitsch and wildlife: turning it into a blithe

carnival of California ostentatiousness buoyed by depression grit. Not the streets of Monterey Steinbeck remembered.

In Carmel, a gas station becomes a catch-basin for paparazzi to reign down. Where else do they charge admission to drive through private neighborhoods like Pebble Beach and elect movie stars as mayor. Clint has stopped in for a fill-up. Tastefulness is not one of the prime attributes for survival along the Artichoke Coast. Junipero Serra died for our sins here of a rattlesnake bite in 1784. He should have paid more attention to where he stepped. There is no salvation here for the careless…

But beneath this fragile veil of humanity lies an eternal life force, which bursts through yes, even money. It has a hypnotic, cleansing effect on even the most cluttered of minds. It is a kind of light, elusive in the fog, yet eternal, unforgettable, glowing from within the Earth, seeping into your shoes and filling the empty spaces within the soul: glistening off the cactus groves, reflecting up into the sullen boughs of the Monterey cypress, and scintillating within pure cobalt waters as prehistoric giant pelicans and ravens glide overhead, casting their shadows against the kelp forest canopy.

Then Big Sur rises camel-like out of the sea. Golden, grass-caped peaks meet in cañons filled with the same redwoods for three thousand years. They tower over primeval fern groves drinking thirstily from the fog, which stalks up the river, just as beauty stalks up rivers of the heart. That reminds me, Esalen Institute is here too. Like Google it was started by a pair of Stanford grads and became the heart of local culture. Henry Miller, Jack Kerouac, Hunter Thompson and a litany of stayers and passers-through, posers and wannabes, genius scientists and misanthropic artists from the four corners of literary and pop culture have made this place home for a week or a lifetime.

But how many of these folks really understood its beauty, its underlying vital life force? Perhaps Henry Miller is among the few. He lived and breathed Big Sur, to some

extent defined its culture, defined our perception of it[vi] There is something pure and penetrating about the light here. Just as the life force seems to blossom from the Earth, so does the intense sunlight somehow penetrate everything to illuminate a higher truth.

On one of the hairpin curves, the slowly dwindling, cannonball pile of oranges collapses and oranges cascade to the floor, leaving a simple two-dimensional array of oranges covering the passenger seat, with the remainder rumbling back and forth on the floor. The afternoon sun illuminates the higher truth of this Cartesian array of oranges, something akin to Miller's observation of the "preternaturally real" oranges in Bosch's painting "The Millennium." How appropriate, as we grapple with a new paradigm in science at the inception of a new millennium, that scenes from Bosch's painting are Xerox-copied into my mind. In Miller's words: Bosch "saw through the phenomenal world, rendering it transparent, and thus revealed its pristine aspect."[vii] Yes, that is what we need to do, we need to render the phenomenal world transparent to see the pristine, untainted connections underneath. We need to connect what we experience in our lives to these networks in ways that we see through experience into the realm of connections, the realm of Nature.

Although he was cynical about the future, Miller used the metanarrative of paradise to describe his life in wilds of Big Sur. I believe that it is the mingling between this incredible, “hallucinating” light and terrific ruggedness that creates this perception. In Big Sur California might as well be an island, it is so singular, so disconnected: like a dream. Yes, it is still paradise here: all the other senses are assailed here as intensely as vision. Arid hillsides drip with desert blooms, but their perfume is overwhelmed by the sweet smell of the Pacific. At the water's cutting-edge, at its “cliffs and rocky shores,” sea lions: oboes of the sea, play their obbligato to the sentinel oak and cypress trees: watching,

seemingly forever… How different from the gentle rolling hickory forests of the east; how un-New York. They've never even heard of Howard Johnson's here.

But up in the mountains, Ventana Wilderness has been left to the cougars and condors. The tentative success of the condor captive breeding program has enabled them to grace the skies here, hopefully forever more. When you see one of these huge Ice Age birds, it is hard to believe you are not seeing the Wind-God in a dream. Compared to the relative paucity and hopefully emerging condor population are cougars. There are more of them here than anywhere else in the country. Perhaps the cougar's success can be part of the condors. There must be a sufficient deer population to sustain the cougars. This might also be able to keep the condors flying. They arise together. Part of the primeval character here: a land that is ever changing. Winter landslides and a lack of trail markers see to it that the reach of humanity is limited, perhaps allowing more room for everything else.

But like Lao Tzu's vessel, in which it is the space within that makes it useful, perhaps the most spectacular thing about Big Sur is not just the mountains, but the spaces between, the steep, wild cañons peering out thoughtfully onto the sea, filled with primeval redwoods guarding narrow creeks bounded by an understory of enormous ferns: a world apart from the dry, chaparral of its peaks. These are the circulatory system of Big Sur. Ancient redwood sentinels guard its precious creeks for the eons. All this, in the extreme southern part of their range: the sea, the fog, the fern, the creek, the sequoia everlasting are one. They are as inseparable as heart and mind. I am haunted by trees.

I make my return along the coast, wading through the astounding dawn light. My supply of oranges is nearly gone. As I approach the 156 Exit on Route 1, I deliberately miss it in favor of the coast. Behind Moss Landing the Elkhorn Slough winds its way to the sea. Shore birds of every description feed among the grasses. As in San Francisco Bay,

the remnants of a once active sea salt drying operation can be seen. In this case supplying the canneries of Monterey. The Moss Landing Power Plant watches over the dark waters, which reveal the entrance to the great underwater Monterey Cañon, comparable in size to the Grand Canyon hidden beneath the blue Pacific.

Rather than take Route 17 at Santa Cruz, another popular way to get back to the land of silicon, I decide to continue along the coast up to Pescadero. Huge waves are breaking across the wide sand beaches, dotted with surfers. I stop at the bakery, where they are just taking the last fresh loaves of artichoke sourdough bread out of the oven. I can smell them when I pull into the parking lot. Once I buy them, I have to leave the loaves exposed to cool on the car seat so the bags will not fill with beads of moisture. The fresh odor of sourdough fills my senses, even as the moving convertible plies the cool damp air of the redwoods along Pescadero Road. They sit on top of the last few oranges, heating them up to release a faint fragrance of oranges, I am supposing what they had in mind when they hung the little air freshener from the rear-view mirror. I should buy a bottle of local Chardonnay.

I head back through Sky Londa, LaHonda and Los Altos and stop at the Chinese bakery in Mountain View. Even though I have already consumed nearly all of one of the loaves of bread (deciding that it always tastes best fresh from the oven), some lotus bean moon cakes will be needed for dessert. It is comforting to remember that the Ohlones, original inhabitants of the area, did not consider gluttony to be a bad thing. As I sip Bo Nay tea and eat lotus bean moon cakes, I decide that perhaps it is turtles all the way down after all.

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[i] Twain, M. 1867. *The Celebrated Frog of Calaveras County and Other Sketches*. New York: C.H. Webb.

[ii] Ruland, R.E. 1989. A Summary Of Ground Motion Effects At SLAC Resulting From The Oct 17th 1989 Earthquake. Stanford: Stanford Linear Accelerator Center.

[iii] Feynman, R. 1985. *QED: The Strange Theory of Light and Matter*. Princeton: Princeton University Press.

[iv] Maerz, A. and M. Paul, 1930. Dictionary of Color. New York: McGraw Hill.

[v] Bohm, D. 1980. *Wholeness and the Implicate Order* London: Routledge.

[vi] Miller, H. 1957. *Big Sur and the Oranges of Hieronymous Bosch*. New York: New Directions Publishing Corporation.

[vii] ibid. 23.