

**“YOU WERE A STAR ONCE, WEREN’T
YOU?”**

**NONLINEAR STEPS INTO THE RE-ENCHANTMENT
OF SCIENCE EDUCATION**

by

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ABSTRACT

This thesis opens rather than closes the black box, evokes rather than answers questions, and invites rather than leads. It invites the reader to imagine how science education could be, if defrosted from a disenchanting spell of the mechanistic worldview.

The modern “Machine” has collapsed the entire world into static, sterile, and meaningless kingdom of plain passive matter, bringing the human race into a state far from ecological, political, social, educational, and spiritual equilibriums. According to the science of complexity, a state-far-from-equilibrium is the edge of chaos, the dynamic space of possibilities, from which a new world might be born.

Departing from rigid certainties of modernity and entering the eclectic and vague bricollage of postmodern visions, we do not know yet which possibility might actualize and what kind of world might leap into existence. Will it be a technological paradise, the world of sophisticated scientific and technical rationality? Perhaps. Will it be a ruined, dead world where humanity committed ecological or military suicide? There exists a real omnipotent danger of this scenario. Or... will we eventually invent a better world that evolves not only along technological and virtual dimensions but also along our inner spiritual dimensions? Will it be a re-enchanted world where meaning, purpose, values, beauty, freedom, wisdom, divinity, compassion, awe, mystery, creativity, and the ultimate unity of everything--all qualities “stolen” by modernity--are restored? New developments in science open a space for such possibilities.

State-of-the-art science provides us not only with technological miracles, but also with a conceptual framework for re-enchancement of our worldview and of education, respectively. In this manuscript I synthesize and articulate insights emerging from leading edge developments in science in a language accessible to individuals without science background. While attending to the voices of contemporary scientists, philosophers, and educators, such as Illia Prigogine, Isabelle Stengers, David Bohm, David Griffin, Gregory Bateson, Rupert Sheldrake, Alfred North Whitehead, Frijof Capra, Bill Doll, David Orr, Jack Miller, c and Ken Wilber, I identify re-enchancing dimensions within new scientific visions, conceptualize holonomic inquiry for exploring these dimensions, and discuss possibilities for re-imagining school science curriculum by moving it deeper and deeper into the re-enchanted world, step by step, nonlinearly. The deeper is the re-enchancement, the more radically it will change the rationale, purpose, structure, content, skills, and metaphoric language of science education.

I brought my visions of re-enchanted science curriculum to pedagogical practice, when teaching an elementary science education course. The reoccurring leitmotif throughout the entire manuscript, a soap opera “Days of Physical Science in an Elementary Schools Course,” is the narrative describing and analyzing my attempts. The conclusion of my

thesis is open-ended and as such, inconclusive. How could it be otherwise in the re-enchanted, creative, ever-evolving, and ever-becoming world?

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... we, who are not afraid of taking a false step--
fools, from the common point of view--
still keep enchantment in our faces
through all the disillusioned crowd
we are driven towards the distance
by a glimmering of something,
away from the daily grind,
the calculation of everyday living,
from pale skeptics and pink schemers,
transforming the world with your reflections
but the inevitability of disappointments
makes us to see too clearly... On all sides
everything suddenly takes shape,
all unknown to us till now
the world appears before us, unhazed; unmisted,
no longer radiant with something priceless,
but with all this truthfulness unmasked as deceit.
But what is gone-- was no deception
you see, it is not the knowledge of the serpent,
it is not the doubtful honor of experience,
but the ability to be enchanted by the world
that reveals to us the world as it really is
suppose someone with illusions in his eyes
flashes past, pursuing some distant gleam,
then it doesn't seem to us that he is blind--
it seems to us that we ourselves are blind¹

¹ Russian poet Eugeny Eutushenko, a poem remembered.

**ON THE THRESHOLD:
THE BUTTERFLY STRETCHES HER WINGS**

*Butterfly, butterfly,
Oh where are you butterfly fluttering through the wind?²
(the 5th grade student)*

*We face new horizons at this privileged moment
in the history of science, and it is our hope that we have
been able to communicate this conviction to our readers.³
(Ilia Prigogine)*

*Researchers in many different fields are joining together to present startling and thought-
provoking perceptions of reality which teachers can no longer afford to ignore.⁴
(Alistair Martin-Smith)*

I am enchanted by butterflies. To me, they symbolize fragile beauty, mystery, poetry, and freedom of expression. I imagine how wonderful their world must be.

Have you ridden a wind before?⁵

As a beautiful butterfly, pulsing and breathing, the new vision of reality stretches its wings, emerging today from the mechanistic cocoon of a modern worldview. Interesting time. I have not traveled any spaceships to near or distant stars, and I did not crawl through wormholes from one parallel universe to another. As far as I remember, I have never left the Earth, but...my entire world is changing. Nothing is the same anymore. As a piece of clay in a child's hands, all familiar and taken for granted attributes of a physical reality--matter, energy, time, space, as well as the entire universe--are gradually transforming into something drastically different from what they seemed before.

"We must begin where we are," writes William Doll, the author of

² Cited in Leggo, 1997.

³ Prigogine, 1996: 189.

⁴ Martin-Smith, 1995: 35.

⁵ L'Engle, 1978.

*A Postmodern Perspective on Curriculum.*⁶ At this moment I am at the threshold and this is where I begin. Behind me lies the straight-angled cold mechanistic kingdom where I resided and taught science for many years. In front of me shimmers an exciting world where I am yet to live and yet to teach. Avant-garde science unfolds into the 21st century as a powerful and fantastic force. Perspectives from even the nearest future make my mind boil. However, philosophical applications of new scientific insights are even more fascinating. As Nobel Prize winner, Illia Prigogine notes, contemporary “science started a new dialogue with nature.”⁷

While not yet organized into a coherent worldview, this new dialogue opens the door for re-enchantment, which means departing from a mechanistic, fragmented, meaningless, sterile, spiritless, static, and as such disenchanted world toward something (or someone?) living, feeling, dynamic, complex, interrelated, creative, and ever-evolving. As Suzan Gablik writes, re-enchantment is “in the air.”⁸ This ether of re-enchantment is saturated with possibilities for re-thinking human nature, place, and role, as well as human relationship with the world, from dispassionate and manipulative to respectful, caring, appreciative, and deeply connected. In light of this, the significance of re-enchantment is difficult to overestimate: disastrous consequences of our “objective” detachment from the rest of the world are well known. I agree with Thomas Moore who states that modern ecological, political, social, psychological, economical, educational, and spiritual problems grow out of our loss of enchantment.⁹

⁶ Doll, 1993.

⁷ Prigogine & Stengers, 1984.

⁸ Gablik, 1991.

⁹ Moore, 1996.

But...the re-enchantment is “in the air”... It began to penetrate various dimensions of our life, inviting us to re-invent ourselves and the world we live in, as Morris Berman indicated in *The Reenchantment of the World*, David Griffin in *The Reenchantment of Science*, Thomas Moore in *The Re-enchantment of Everyday Life*,¹⁰ and Suzan Gablik in *The Reenchantment of Art*.¹¹ According to Gablik, the challenging and important task is to speed up the diffusion of re-enchantment throughout all levels and endeavors of society. “If there is a new agenda, a new vision emerging within our society, how might one help put it into practice?”¹²

The idea of re-enchantment¹³ deeply resonates with my individual and professional identity. I am in the midst of a personal paradigm shift as an experiencing being and as a science teacher. The emerging interrelated, organic, mysterious world portrayed by contemporary science truly and deeply fascinates me. For some inexplicable reason, I have a strong sense of déjà-vu. It seems to me, I have known this new world for a long, long time. Today, I experience an exciting moment of “Aha!” “Quantum Leap!” that relates to my thinking about reality in general and science education in particular.

I am enchanted with the opportunity to contribute to the overall process of the re-enchantment of the world from the dimension of science education that currently remains chained to a mechanistic worldview. My thesis is a conceptual-philosophical essay attempting to (re) imagine elements of school science curriculum and pedagogy on the

¹⁰ Moore, 1996.

¹¹ Berman, 1986; Griffin, 1988; Gablik, 1991. There are others who write about reenchantment of the world and of science. Among them Ken Wilber, 1998; Isabelle Stengers and Illia Prigogine, in Stengers, 1997.

¹² Gablik, 1991: 164.

¹³ I write “re-enchantment” rather than “reenchantment” to indicate that currently, we are simply changing the direction of our enchantment. Many authors refer to the so-called modern epoch as time of disenchantment. In *We Have Never Been Modern*, Bruno Latour (1995) argued that we have never been modern since we have never been truly disenchanted. Modernity is rather enchantment with disenchantment. It is enchantment with possibilities to separate nature from culture and to reduce the whole world “out-there” to manageable fragmented pieces.

grounds of a new conceptual framework offered by contemporary developments in science.

The detailed structure of a possible curriculum is beyond the scope of my thesis. To express my intentions, I will borrow the words of William Doll: "I will speak about curricular possibilities in terms of vision."¹⁴ Visions, imaginations, or as Martin Heidegger puts it, "searching for horizons," have power to (re) create our reality.¹⁵

The changes in science education I propose are dramatic, risky, and at times difficult to articulate or to accept. "It is not particularly easy to see the beginning of something that is being shaped by a truly different awareness,"¹⁶ writes Suzan Gablik.

Although these ideas have started to move through our culture very quickly, the challenge still remains for all of us to translate them into our own activities and practices. Obviously, the kind of change I have been signaling here is so major that we will encounter much resistance to even recognizing it.¹⁷

I experienced this challenge first hand while attempting to translate my new visions into pedagogical practice. As I finished teaching a teacher education course, entitled "Physical Science in Elementary Schools," memories of internal struggles, excitement, tears, happiness, desperation, and hope are still fresh. According to philosopher Alfred North Whitehead, "...the true method of discovery is like the flight of an airplane. It starts from the ground of particular; it makes flight in the thin air of imaginative generalization; and it again lands for renewed observation rendered acute by rational interpretation."¹⁸ My landing from the air of imaginative generalization was not

¹⁴ Doll, 1993.

¹⁵ Heidegger, 1962.

¹⁶ Gablik, 1991: 164. The different awareness Gablik refers to is the holistic awareness of being deeply unified with the rest of the world.

¹⁷ Gablik, 1991: 165.

¹⁸ Whitehead cited in Griffin, 1993:166.

always smooth. Freefall without a rope.¹⁹ Lots of bruises. But...I am not the first and not the last. Many others were crushed in their quest for flight. However, some strange irresistible power, which is apparently embedded into the human nature, pushes us to continue the quest, no matter what.

I hope this thesis will result in an emergence of a new order of complexity out of the chaotic, fuzzy interplay of my experiences, memories, thoughts, feelings, intuitions, intentions, and imaginations. The data I use include my experiences as a resident of the enchanted land of childhood, a chemistry and physical science instructor in a Russian community college,²⁰ the instructor of a science education course in the elementary teacher education program,²¹ the director of the youth science video club "Gaia",²² a mother of an unfolding young life, a poet, and simply as a Being who, as Martin Heidegger writes, is thrown into this phenomenal world without preliminary negotiations.

Why did I find it important to explore my own experiences? I think that in order to propose and to practice dramatic re-enchanting changes in science education and therefore in students' worldviews, I must interpret, understand, internalize, accept, and adopt these changes myself. Otherwise, my thesis will remain an artificial construct collecting dust on the library shelves.

My own experiences, however, are inevitably interwoven and entangled with others' experiences as well as with experiences of the rest of the universe. According to

¹⁹ Johnna Haskell conceptualizes a freefall pedagogy as a space of open possibilities and radical transformations. In Haskell, 2000.

²⁰ *Minutes of teaching mechanistic science* is my story of teaching physical chemistry in the community college. At that time, the mechanistic science was the only science I knew.

²¹ I taught this course for three successive years. A *soap opera* "Days of Physical Science in Elementary Schools Course," that reappears throughout the entire manuscript, is the story of my attempts to apply my emerging visions into pedagogical practice. See an appendix for the overview of this course.

²² I organized this club with the purpose for exploring possibilities for informal teaching and learning re-enchanting science. The science video club gave me a priceless opportunity to be connected with young people not as a teacher or researcher, but as one of them.

understandings that have emerged from the new developments in science, there is no way I can “objectively” cut myself off from the world. In this sense, the entire world is my “research sample.” *I am the World. I am a Cosmos.* This is the main idea of a *holonomic inquiry*, which I attempt to conceptualize as my research methodology.

I spiraled (structured) my thesis into circlelets (steps) toward the deeper and deeper re-enchantment of visions of reality and of science education, respectively. This will permit my audience, which I hope to extend to teachers, to stop at the level of their comfort. Grounded on new insights in science, the nonlinear steps into re-enchantment that I propose, spiral down along the following progression:

- ⊖ A modest re-enchantment of the science of complexity:

*Self-organization, creativity, ambiguity,
and interconnectedness are embedded in Nature.*

- ⊖ The deeper re-enchantment of a holonomic paradigm:

Our reality is an unbroken holographic wholeness.

- ⊖ Even deeper re-enchantment of postmodern organicism:

*The world is an experiencing, feeling, and imaginative
organism, comprised of organisms throughout its totality.*

- ⊖ The radical re-enchantment of the spiritual “no-no”:

New developments in science invite Spirit.

- ⊖ The extreme re-enchantment of a “plain” magic:

Cutting edge science legitimizes laws of magicality.²³

While writing this manuscript, I was surprised how much it has written itself²⁴ and how far I am now from what I initially intended.

²³ The term coined by Ahsen, 1965.

²⁴ Poet Carl Leggo has made a similar observation. I discuss this later.

*I intended an ode,
but it turned out a sonnet,
I intended an ode:
It began a la mode,
but Rose crossed the road,
in her new Sunday bonnet,
I intended an ode,
but it turned out a sonnet²⁵*

Initially, I limited my study to applications of contemporary physics for school science curriculum, but soon realized that it would be insufficient for my re-enchanting purposes. I was “forced” to look at a broader picture that included insights from new developments in biology, neuroscience, ecology, astrophysics, chemistry, and quantum theory. Poems from my favorite poets, as well as my own, “incorporated” themselves throughout my entire essay. They kept jumping into my writing without any special invitation, making me increasingly aware of the power of poetic intuition and of the deep narrative nature of scientific knowledge. I wrote about science and education, but I was unable to do so without poetry! Excerpts from children's science fiction, written by my daughter's favorite authors, situated themselves quite comfortably within this essay as well. Eventually, my story “wrote itself” into an eclectic mixture of science, poetry, and philosophy. Before I begin, once again I wish to stress my intentions, and for this purpose I will borrow words from Illia Prigogine’s *The End of Certainty: Time, Chaos, and Laws of Nature*:

*The world, our world, tries ceaselessly to extend frontiers of the knowable
and the valuable, to transcend the givenness of things,
to imagine a new and better world.²⁶*

We must begin where we are, and now is time to begin...

²⁵ Austin Dobson, cited in Splitter, 1997: 10.

²⁶ Peter Scott, cited in Prigogine, 1996: 185.

*Of course,
this is how it must begin:
imagining the world.
Standing on any green hill
at the mercy of all blue rivers,
(re) inventing the colours of sky
and three perfect ravens...²⁷*

²⁷ Rasberry, 1997: 10.

TIME TO BEGIN...

I only know that I write my poems with a keen ear for what they are saying to me, teaching me, and so I cannot pretend that I am controlling everything that happens in my poems.²⁸
(Carl Leggo)

Where do we go to listen to the music that has not yet been heard? There is a place in our body to which we can turn and listen. If we go in there and become quiet, we can start to bring music up.²⁹
(Stephen Nachmanovitch)

The moonlight tonight is especially mysterious. Everything is saturated with this magic soft light: air, grass, waves on the sea... Clouds rush swiftly through the lunar media and there is no way to catch their intricate, constantly changing shapes. Don't even try. These enigmatic entities cast eerie shadows on the moon but for a fleeting moment, then vanish, hurrying somewhere herded by a rancher, the stormy wind. But... lunar light! My God! Shiny milk from heaven! Pour it into your palms and drink this elixir, this pure enchantment. Have you ever tasted lunar light? If not, just open your window as wide as you can and invite this madness of moonlight into your room, along with the rest of the night darkened world, with its clouds, winds, oceans, and mountains!

*The body of the mountain hesitates before my window:
"How can one enter if one is the mountain,
if one is tall, with boulders and stone,
a piece of Earth, altered by the sky?"³⁰*

The entire
world
is invited
into my story

²⁸ Leggo, 1997: 83.

²⁹ Nachmanovitch, 1990: 159.

³⁰ Jules Superville, cited in Bachelard, 1964: 66.

which is about
to begin

Beginning. There is magic³¹ in every Beginning! This magic is hidden somewhere inside or behind an empty computer screen that apparently holds nothing but the convenient electronic features of a word-processing program. This magic is concealed within the infinity of quantum probability waves that are patiently waiting for the occasion to materialize from pure potentiality into reality.³² This magic resides somewhere inside of me in a chaotic mixture of thoughts, memories, intentions, images, feelings, and emotions.

This subtle inner mixture is not material. It is not visible, not touchable. However, it contains “something” which is about to organize itself into the virtual words on the computer screen and from there onto printed paper. This “something” is about to jump into existence from the constructions of my consciousness, from the depth of my unconsciousness, from possibilities offered by the universe, at the crossroad of play and intention, at the fusion point of my body, mind, and soul.³³

The only thing I really need to do is to begin, and then...the “evolving organism takes on a momentum and identity of its own. We conduct a dialogue with the living work in progress.”³⁴ According to academic and poet Carl Leggo³⁵, we write our stories as much as they write themselves; therefore, our stories and we write the world together.

³¹From the dictionary, magic is “the art which claims or is believed to produce effects by the assistance of supernatural beings or by mastery of secret forces of nature.” I understand magic as mystery, intrigue, the unexplainable, as something that is, but according to commonsense, is not supposed to be, and vice versa.

³² According to the widely accepted Copenhagen interpretation of quantum mechanics (1924), our reality exists in the form of nonmaterial quantum probability waves until the act of observation actualizes them into material existence. See Davis, 1986.

³³ Nachmanovitch, 1990.

³⁴ Nachmanovitch, 1990: 107.

³⁵ Leggo, 1997.

Although I definitely have some ideas about what I am going to write, the outcome of the collaboration between my story, me, and the rest of the universe (s) is not completely predictable. How could it be otherwise if the quantum uncertainty principle states that nothing is entirely predictable in this world anyhow.³⁶ In every knowing there is always an element of the unknown, in every expectation there is always an element of the unexpected, and in every prediction there is always an element of the unpredictable. For this reason, the only way to become acquainted with my not-yet-born story is to begin.

*It is time to Begin.
It is really Time.
The night is mysterious and dark.
The hard rain lashes persistently and loudly.
A tumult of ocean waves.
Leafy fountains.
A majestic rhapsody of a stormy wind.
The Universe, a crescendo bursting through my window.
Yes, it is Time to Begin.
What could be a better moment
for boiling my magic solution?!
All the ingredients are ready,
ready for me to put in the cauldron:
the dry frogs of disappointments,
spider webs of doubts,
a sweet syrup of success,
acid vinegar of confusion,
dust from all read books and papers,
pieces of memory,
garnishes of poetry and music,
segments of conversations,
a bag, heavy with thoughts,
yellow rose petals of dreams,
the cold ice of reason and logic,
a spicy flavor of love,
salt of my tears, loneliness, and melancholy,
several spoons of happiness,
a powder of wonder and desires,
handfuls of soil from not traveled grounds,
and also,*

³⁶ Heisenberg's Uncertainty Principle is described in Davis, 1986; Johnes, 1982. See p.108 of this manuscript for details.

*a little of everything:
surprises of unexpected meetings,
the eye expression of a homeless old woman,
a smile of my child,
lunar light,
crying rains,
and many, many other useful things...
I shall boil this eclectic mixture
for hours and hours,
until...*

Until... the “something” hopefully crystallizes from the wave circlets in my magic solution, which at the same time could be the spirals of a hermeneutic search for meaning, which at the same time could be the spirals of spinning galaxies, which at the same time could be infinite quantum leaps, which at the same time could be circular holographic patterns.³⁷

In my essay I explore these magic circlets, which are not spreading out from any particular source of disturbance as normal circular waves do. To the contrary, they are funneling down toward the alchemists’ philosopher’s stone; which at the same time could be the nucleus of an atom; which at the same time could be the very heart of the galaxy; which at the same time could be my own pulsing hear; which at the same time could be the omega³⁸ point of meaning; which at the same time could be a new order of complexity, which at the same time could be a newborn re-enchanted world.

*So, it is Time.
Fearing the worst, yet hoping for the best,
balancing the past into the future
astride the subtle rope of the edge of chaos,
knowing that the dark night conceals the inevitability of the new day,
opening the door onto unknown horizons,
I Begin.*

³⁷ The holographic resonance patterns have a circular form. I describe holograms in more details in the chapter *A Holonomic Paradigm as a Step into Deeper Re-Enchantment*.

³⁸ Omega point is the point of ultimate destination.

A SWINGING PENDULUM OF ENCANTMENTS

*A Philosopher, strolling with a Lady in the moonlight...
taught the new cosmology to his apt pupil...
"You have made the Universe so large," said she,
"that I know not where I am, or what will become of me...
I protest it is dreadful."*

*But the Philosopher was one of those delighted with the
freedom of new space, whose imagination expanded with the
vast. "Dreadful, Madame...I think it is very pleasant; when the
Heavens were a little blue Arch, stuck with Stars, I thought the
Universe was too straight and close,
and I was almost stifled for want of Air;
but now it is enlarged...
I begin to breathe with more freedom and think the Universe
to be incomparably more magnificent than it was before."³⁹*

³⁹ Heyneman, 1993: 11.

We Have Never Been Disenchanted

Pendulums are strange creatures. They like to swing backward and forward, to and fro, pro and con. What makes a pendulum want to swing back? Is it the law of harmonious movement or a nostalgic desire to return into the past? Do not we humans, just like pendulums, often want to swing back into the space-moments of our past? But there is no way for us to re-construct what is gone forever. Only an ideal pendulum, free from friction, comes back exactly to the same point. Ideal pendulums, however, exist only in the abstract mathematical universe. In real life as we experience it, there is no such thing as an ideal pendulum. It never comes back to the same position. The universe is never the same and never repeatable. Even if you try to return to the same point of your existence, you will come to it on a different turn of the spiral that includes your new experiences and those of the universe. Each time a pendulum swings back, it inevitably swings *back to the future*. This is how the new story of Western civilization unfolds. Today its pendulum swings back to the future, from the modern enchantment with disenchantment into the vision of reality that resembles and transcends the ancient, interrelated, living, feeling, and mysterious macrocosm. As Rupert Sheldrake writes, the emerging understanding of Nature “gives an even stronger sense of her spontaneous life and creativity than the stable, repetitive world of Greek, medieval, and Renaissance philosophy. All nature is evolutionary. The cosmos is like a great developing organism, and evolutionary creativity is inherent in nature herself.”⁴⁰

⁴⁰ Sheldrake, 1990: 75.

Up, up to the galaxies, down, down to the mysteries of atomic and subatomic lands and here, in between, in this amazing phenomenal world, moments happen as huge as a swallow of water when dying of thirst, as significant as the collapse of a star from which a new solar system is born, and as far reaching as the birth of the human race. These are the moments of great transformations when a new world jumps into existence, and in this dizzying quantum leap, new meaning is born. As Thomas Berry expressed, these are moments of grace, grand moments of revolutionary change.⁴¹

The current moment in the evolution of Western civilization, the beginning of a new millennium, could definitely qualify as a moment of grace. It is a moment when the so-called modern epoch⁴², after several centuries of existence, as the dragon in the alchemist's crucible, is about to "consume itself" and dissolve into the river of history. It is a moment when the new postmodern⁴³ world is about to leap into being. The shimmering silhouette of this new world is still obscure. It is not clear yet what this postmodern world is all about; however, the rumor being spread by leading edge science is that the emerging world is going to be re-enchanted!⁴⁴

Enchantment...it sounds so wonderful! I agree with Steve Bowles who writes: "Whenever I hear the word *enchantment* my mind immediately flies back to my childhood days out of the window."⁴⁵ In my imagination, the word *enchantment* is winged, alive, and beautiful, just as a butterfly riding the wind. I am enchanted with enchantment and, therefore, salute the emerging (re) enchanted world.

⁴¹ In Heyneman, 1993.

⁴² A modern epoch or modernity is time in the history of Western civilization that corresponds to a "mechanistic" "quantitative," "scientific," or "disenchanted" worldview.

⁴³ I do not wish to go into the detailed discussion what actually the term "postmodern" means. There are no clear definitions anyhow. I use the word "postmodern" to express emergence of a new coil of the spiral that embraces and transcends visions of the epoch called "modernity."

⁴⁴ Griffin, 1988; Berman, 1986; Stengers, 1997.

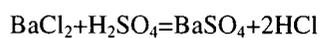
⁴⁵ Bowles, 1996: 15.

What is an exact meaning of the word “enchantment”? According to the dictionary, enchantment is “magic, delight, fascination.” To be enchanted means to be under a spell, to be charmed, irresistibly attracted to something. At some intuitive level, though, I feel that “enchantment” holds a wider spectrum of meaning than the one offered by the dictionary. To elaborate, I shall conduct a brief exploration of my own enchanted experiences.

(Self) Phenomenology of Being Enchanted

I feel enchanted when:

*holding the hand of my daughter
sinking in an ocean of night stars
flying in an airplane
listening to a beautiful melody
looking at impressionists' drawings
solving an intricate mathematical problem
reading a wonderful poem
revisiting magical childhood lands
admiring a modest spring flower
teaching something I love
writing when inspired
absorbing a symphony of fresh scents after a rain
performing scientific experiments :*



*(add two clear liquids and you will see white
snow appearing from nowhere)
dreaming about the future
being struck by a flash of memory
riding ocean waves
seeing the unbelievable
captured by sorrow
listening to a deep spooky forest
looking at a dancing fire
being in love*

The list of enchanting/enchanted events may continue and continue *ad infinitum*.

While writing this, I surprised myself with the obvious abundance of such moments. Up,

up to the sky, down, down to the mysteries of a subatomic universe and here, in the middle, in this beautiful phenomenal world, everything is saturated with the ether of enchantment. According to my (anti) scientific conclusion, enchantment is the natural human state to be. What do I experience when feeling enchanted?

*I feel
a warm wave flowing over my body which,
while becoming lighter and lighter,
gradually loses its material essence, transforming itself into a wave
that merges and resonates
with
the waves of the ocean,
the waves of my child's laugh,
the beauty of a mathematical formula,
the sounds of a dark haunted night,
the rhythms of winds and raindrops..*

*I feel
losing track of thoughts, of questions:
Where am I? When am I? Who am I? Am I? I?
As a butterfly flies out from her cocoon,
my soul flies out from my separate "self,"
swirling in a timeless and spaceless tango of oneness
with the subject of my enchantment.
I and whatever I feel enchanted with:
a picture, my work, or the spooky "under-bed" monsters of my childhood
are evolving into a single living and breathing organism,
unified by spiritual "gravity" ...
Nothing else exists nor matters during an enchanted moment.
I am consumed.*

Concluding my (self) phenomenological inquiry, I feel even further away from a crisp and clear definition of *enchantment*. What is *enchantment*? It is magic, mystery, game, laughter, tears, fears, happiness, music, sorrow, spell, ecstasy, poetry, awe, love, chemistry, obsession... It is forgetting yourself. It is an immediate and breathtaking experience of oneness with the subject of our enchantment.

Eureka!

After my brief enchanting exploration, I think I can now formulate the first (anti) scientific law of enchantment:

The heavier spiritual gravity, the lighter my ego.

Lora, 13 years old, a member of the science video club "Gaia":

Once I went to the forest with my parents. I thought this forest was enchanted. Why? It seemed to be alive. It had a mood. Very gloomy mood...The forest was not inviting...

Yana, my daughter, 14 years old:

How would I define enchantment? Well...can we actually define it? Enchantment is "The". It simply is. You know it and you feel it without any particular definitions.

I saw the drop of morning dew caught in the spider web.

It was enchantment in its own right.

No definitions necessary.

The Starting Point of Swinging: As Above so Below

*There is nothing new on the earth
for a person who lives long and experiences much.
In my years of youthful wandering
I have seen crystallized people⁴⁶
(Goethe, Faust)*

One to one with the mysteries of nature, the alchemist in his lab was cleansing an especially rare substance, a dragon's blood. It is not so easy, you know, even if you have all the necessary scientific ingredients in your crucible, such as colored earth, exotic triangular pebbles, a variety of hair and feathers, corals, dust from mummies, and other quite useful substances. From the alchemist's lab report:

⁴⁶ Cited in Elkins, 1999: 30.

The dragon is the blackness that remains at the bottom of the vessel when everything else has been boiled away, and the last thickened water around was its tail, so that the two could be coagulated together into something new.⁴⁷

The alchemist cleansed dragon's blood in the crucible, chemically and magically married sulphur and quicksilver (mercury), and crystallized anew the human soul, while dissolving, purifying, and crystallizing chemical substances. Alchemy was the royal art of recovering a "noble" human nature.⁴⁸ The world of the alchemist was comprised of *materia prima*:

It can be found anywhere in the world, if people only had eyes to see it. Travelers will trip over it thinking it was a stone dislodged on the roadway. Farmers would plow it up, taking it to be a stubborn root. Fishermen would sit down next to it and fish the whole day through, without even recognizing what was inches from their feet. The *materia prima* could be the commonest lump of clay, or the most ordinary nondescript pebble.⁴⁹

The *materia prima* was original Chaos, from everything came. It was many things and had many names. It was cold, silent, and strangely semi-real. "It is nothing (yet), and everything (in potentia), it is all things that wait to exist."⁵⁰ The alchemist's universe, "made of" this obscure *materia prima*, was small, cozy and alive: the disk of the Earth in the center of the universe, under the starry walnut of heaven. The Earth, an ever-pregnant female, gives birth to all plants and creatures. Heaven, a male, arranges day and night, lights up the stars, and creates rains and rainbows.⁵¹

Everything in this universe had a special meaning and was interconnected into a living unity: heavens, humans, and chemical substances in the alchemists' crucibles. The

⁴⁷ Elkins, 1999: 49.

⁴⁸ Burekhard, 1960.

⁴⁹ Ibid: 71.

⁵⁰ Ibid: 85.

⁵¹ Ibid.

soul of a mercurial individual was intimately linked to the planet Mercury and to its namesake chemical element “mercury.” The universe (macrocosm) and each human being (microcosm) reciprocally reflected each other. “*As above so below*” was the adage written in the alchemists’ “bible,” the Emerald Table.⁵²

As the ocean manifested itself through each tiny drop of its water, the intellect of each human being was understood as part of an indivisible Divine Intellect, Universal Mind, Spirit, the One, Undivided Unity. Matter and Spirit as the two hands of God were not separated, but complemented and interpenetrated with each other. Alchemist’s matter was considered automatically alive because it was “saturated” with living Spirit.

As the Russian doll “Matreshka” comprises identical but smaller dolls, ancient reality was organized into hierarchical levels or nests with different “percentages” of matter and spirit. “Each senior level ‘envelops’ or ‘enfolds’ its junior levels--a series of nests within nests within nests of Being--so that every thing and event in the world is interwoven with every other, and all are ultimately enveloped and enfolded by Spirit, by God, By Goddess...”⁵³ Within such a hierarchical structure, everything contains everything. All in all. *Omnia omnibus*.⁵⁴

This was the essence of the Great Chain of Being,⁵⁵ a matterspirit continuum, “a rich tapestry of interwoven levels, reaching from matter to body to soul to spirit.”⁵⁶ The vision of reality via the Great Chain of Being was central to a *perennial* philosophy that “has been the dominant official philosophy of the larger part of civilized humankind

⁵² Ibid.

⁵³ Wilber, 1998: 7.

⁵⁴ Elkins, 1999: 46.

⁵⁵ The term suggested by Arthur Loveloy. In Wilber, 1998.

⁵⁶ Wilber, 1998: 6.

throughout most of its history.”⁵⁷ The perennial philosophy assumed a deep unity between all entities in the world, which were unique appearances of a huge single organism, a living mysterious Cosmos. The idea that the world was alive throughout all its totality was taken for granted.

Pointing out the universality of such a view, Ken Wilber writes: “it is either the single greatest intellectual error ever to appear in humankind's history--an error so colossal and widespread as to literally stagger the mind--or it is the single most accurate reflection of reality yet to appear.”⁵⁸

The perennial philosophy was the philosophy of organicism. I will borrow the definition of the term *organic* from poet Carl Leggo: “The word *organic* means: *derived from living organisms or having an organization similar in its complexity to that of living things*. The word *organic* is related to the living, ecology, the mystical and spiritual, the world of interconnectedness.”⁵⁹ In this light, organicism is enchantment.

The alchemist was enchanted with his organic universe, and this was perhaps the basis for his alchemical ethic. All transmutations and manipulations of elements were permitted only if the goal of the experiments was to improve human nature or to help those in need.

All the alchemist's work, prayer, and efforts were directed toward this goal: to awaken the dormant powers of nature, to reconcile her dynamic conflicts, and to assist at the birth of a new and higher consciousness. Through the hermaphrodite, lay the path beyond good and evil toward liberation from contending dualities...this was the coming together of earth and heaven, the completion of the circle of perfection.⁶⁰

⁵⁷ Ibid: 7.

⁵⁸ Wilber, 1998: 7.

⁵⁹ Leggo, 1999: 119.

⁶⁰ Rozak, cited in Neutropia, 1994: 250.

To help the poor was the motivation behind the alchemist's search for the magical “philosopher’s stone,” which turns base metals into gold. A little luck, a lot of patience, cooperation from mysterious natural forces, and (who knows?) maybe you will become the happy owner of this marvelous stone. If this happened, the stone would bring to you more than just gold. It would show you the way when lost, it would convert sadness into joy, it would protect you from disease and disappointment, and it would lead you from darkness into light.⁶¹

The alchemist's obsession with a miraculous philosopher’s stone as a means to help others is understandable. Medieval science, even mixed with real magic, did not give contemporaries relief from “debilitating work in the fields, from uncured pain, and from chronic hunger. The majority of people were uneducated and their overall life span was about thirty years of age.”⁶² Alchemy did not find its philosopher’s stone. But modern mechanistic science, which sprang onto the stage in the seventeenth century, did. This philosopher’s stone was *the Machine!*

Modern Enchantment with Disenchantment

*...the world appears before us, unhazed, unmisted
no longer radiant with something priceless.⁶³
(Eugeniy Eutushenko)*

What is it out there, beyond the horizon? Forced by an irresistible inherent power, like a butterfly drawn to a flame, humanity is constantly driven towards the unknown. While growing up, human civilization looks at the world through different windows, or

⁶¹ Burckhard, 1960.

⁶² Kaku, 1998.

⁶³ From the poem remembered.

filters, which Thomas Kuhn named paradigms.⁶⁴ A paradigm, or worldview, is a set of beliefs, rules, concepts, and assumptions that determines our way of thinking about the world and consequently, influences our way of living. People make sense of their scientific findings and their everyday experiences by filtering them through an accepted worldview, however impermanent. Time goes by and the scientific community finds more and more anomalies, which do not fit the accepted paradigm. These anomalies and exceptions accumulate until...Boom! Scientific revolution occurs. A different window into a different world suddenly opens and through this new window a wider panorama is seen, new things become visible and old things are understood in different ways. This is what happened in the seventeenth century: Western people glanced through the new window and...oh, my...instead of an enchanted living and breathing Cosmos, they saw a lifeless Machine. It was the beginning of a new epoch called modernity.

In 1599 educated people in Western Europe believed themselves living in the centre of a finite cosmos, at the mercy of supernatural forces beyond their control, and certainly continually menaced by Satan and all his allies. By 1700, educated people in Western Europe for the most part believed themselves living in an infinite universe on a tiny planet in (elliptical) orbit around the sun, no longer menaced by Satan, and confident that powers over the natural world lay within their grasp.⁶⁵

Who opened the new window?

...Everything started from Copernicus. Of course, perhaps this is not how everything really started. Maybe it started from the shimmering light of a vanishing star, or from the song of the spring wind, or from someone's dream, or from something else, but it materialized in the Copernicus heliocentric theory, according to which the earth

⁶⁴ Kuhn, 1970.

⁶⁵ Easlea, 1980: 30.

was not the center of the universe, but a little planet circling around the sun. This innocent suggestion, taken today for granted, triggered the birth of mechanistic science.

Voices from the crowd:

- The Earth is not the center of the universe? It is quite disappointing!*
- What nonsense! Just look at the sky and you will see the opposite!*

Johannies Kepler:

-Copernicus was right. The earth is revolving around the sun. Also, mathematical calculations indicate that the universe works like a celestial machine linked to a clockwork. We need to replace the word "soul" (anima) with the word "force" (vis) in reference to planets. The universe is a machine!⁶⁶

Galileo Galileo:

-Observations through the telescope proved that the earth is not the center of the universe. The movement of celestial bodies can be calculated through mathematical laws!

Church:

-It is heresy!

Francis Bacon:

-We can discover the secrets of nature through the use of scientific method [experiment, conclusions, generalizations, and more experiments to test these conclusions]. The scientific method can tame and control nature!

"The new man of science must not think that the 'inquisition' of nature is in any part interdicted or forbidden'. Nature must be 'bound into the universe' and made a 'slave', put 'on constraint' and 'molded' by the mechanical arts. The 'searchers and the spies of nature' are to discover her plots and secrets'.⁶⁷

Rene Descartes:

-Scientists need to separate fact from fancy and truth from falsehood! Real scientific knowledge seeks clarity, objectivity, and distinctiveness. Beginning from simple objects, step by step, we can obtain knowledge of the most complex. The universe is a machine, and it can be perfectly understood through analyzing its parts, which are machines as

⁶⁶ Heyneman, 1993: 11.

⁶⁷ Hardy, 1987: 133.

well. The universe is reducible to parts! "Give me matter and motion and I shall construct a universe!"⁶⁸

"And I have been greatly helped by considering machines. The only difference I can see between machines and natural objects is that the working machines are mostly carried out by apparatus large enough to be readily perceptible by the senses (as is required to make their manufacture possible), whereas natural processes almost always depend on parts so small that they utterly elude our senses."⁶⁹

Isaac Newton:

It is amazing and fascinating! All the endless diversity, chaos, and mysteries of Nature can be uncovered and organized into concepts. All universal motion can be predicted and calculated mathematically! The world obeys mechanical laws! All universal phenomena can be understood rationally! Earthly and heavenly objects are governed by the same laws of mathematics! The universe is a static mechanistic system which God once placed into motion.

The 28th day of April 1686, the day when Isaac Newton presented his *Principia* to the Royal Society of London, can be perhaps considered the official birth date of mechanistic science, the science of objectivity, measurement, reduction, and quantification.⁷⁰ This event manifested a significant turn in human thought, the realization that the natural world can be understood and manipulated through the laws of mathematics and the logic of causality. It was the beginning of enchantment with disenchantment that resulted in new understanding of the nature and purpose of science. The goal of science changed to controlling and dominating natural resources from the pursuit of the glory of Nature, Spirit, and the human soul. "The process of mechanizing the world picture removed the controls over environmental exploitation that were an

⁶⁸ Descartes, cited in Birch, 1988: 70.

⁶⁹ Descartes, cited in Kirk, 1993: 2.

⁷⁰ Doll, 1989: 243.

inherent part of the organic view that nature was alive, sensitive, and responsive to human action.”⁷¹

Mechanistic science brought spectacular results to society, both positive and negative. Machines, railroads, factories were rushed into the human world. Advances in science brought relief from exhausting labor, helped to “lift people out of wretched poverty and ignorance, enrich their lives, empower them with knowledge, open their eyes to new worlds, and eventually unleash complex forces which would topple the feudal dynasties, fiefdoms, and empires of Europe.”⁷²

Splendid, brilliant success.

Due to the overwhelming accomplishments, by the end of the nineteenth century no doubt remained that “objective” scientific knowledge, constructed block by block by mechanistic science, was the only true way of understanding the world. Such opinion penetrated all levels of Western society, giving birth to industrial- mechanistic- technological-materialistic-quantitative modern culture. This culture speaks to us today through a bombardment of commercials and looks at us through the windows of soulless rectangular boxes-buildings, storefronts, residential houses, offices, and factories. This culture established,

...a belief in the scientific method as the only valid approach to knowledge; the view of the universe as a mechanical system composed of elementary material building blocks, the view of life in society as a competitive struggle for existence; and the belief in unlimited material progress to be achieved through economic and technological growth.⁷³

Huxley:

The whole of modern thought is steeped in science;

⁷¹ Hardy, 1987: 103.

⁷² Kaku, 1997: 4.

⁷³ Capra, cited in Hardy, 1987: 172.

it has had made its way into the works of our best poets...⁷⁴

*Mechanistic science
and modern materialistic society
shook their hands and lived happily ever after,
approaching closer and closer
the technological paradise...*

The end.

Actually, it is not. This technological fairy tale does not have a happy ending. The problem is that mechanistic science is guilty of an enormous offence--the disenchantment of the world. To see the criminal record, let's open the personal file of mechanistic science.

Personal File of Mechanistic Science

Name: *Modern-Classic-Newtonian-Mechanistic-Materialistic-Disenchanted Science.*

Date of birth: *Seventeenth century.*

Fathers: *Copernicus, Galileo, Descartes, Bacon, Newton, and others.*

Goal in life: *Using, mastering, taming, and controlling Nature for anthropocentric purposes.*

Religion: *Mechanicism.*

Modern people have an ultimate faith that scientific knowledge, technology, and machinery give "panacea for the world's ills."⁷⁵

Moral values: *None.*

Motto: *Every effect has its own cause!*

View of Reality: *There exists a reality "out-there".*

⁷⁴ Huxley, cited in Hardy, 1987: 160.

⁷⁵ Quinn, 1997: 259.

Reality exists independent of the observer; this is why it can and should be explored objectively.

Ideals: *Perfect Machine, Ultimate Particle, and Pure Object.*⁷⁶

A Machine is Perfect if nothing ever goes awry or wrong. The universe is an example of such a machine. All movements of its parts are regular, predictable, static, and controllable. There is no place for spontaneity. Since the world is a machine, it can be reduced and disassembled into small parts. By studying its small parts, we can obtain legitimate knowledge about the whole. Therefore, to find explanations for the world, we must discover an Ultimate Particle, the building block of everything. The key to knowledge regarding the complex is reduction.

Approach to knowing: *Measurement, Quantity, Detachment, Reasoning.*

Measurement and quantity are the only viable avenues for constructing knowledge about the world. True scientific knowledge has to be analytical, rational, distinct, and, therefore, reproducible by others. The validity of knowledge has to be demonstrated by tests of objectivity, evidence, reasoning, and the quoting of authorities. Inner, qualitative knowledge is subjective, untestable, irrational, and, therefore, nonscientific.

Mode of thinking: *Dualistic.*

By treating everything as a machine which can be reduced into smaller isolated fragments, mechanistic science has difficulty explaining how our material mechanical bodies and our material mechanical brains produce qualities as ephemeral as emotions, desires, and intentions. Or, how such ephemeral entities as our fantasies and intentions can influence and change the physical world?

⁷⁶ Griffin, 1988.

The apparent fact is that mind and body seem to interact; that is, the mind seems to be affected by the body and seems to affect it in return. The inference is that the human body is composed by things that are devoid of experience. The resulting problem is: How is it understandable that these two totally unlike things appear to interact? How can the impenetrably spatial relate to the nonspatial, the nontemporal to the temporal, the mechanistically caused to the purposively acting, the idealess to the idea filled, the purely factual to the value-laden, the externally locomotive to the internally becoming?⁷⁷

In respect to this problem, modern science took a dualistic approach: the body is a machine, completely explainable scientifically and mind is the Great Exception, the Ghost in the Machine. The modern dualistic mode of thinking separates mind and body, spirit and matter, interior and exterior, subjective and objective, observer and observable, human and nature. Modern dualism approaches the world from the position of “either/or” logic.

Plans for the future: *Construction of a technological paradise.*

Marital status: *Divorced from “the Beautiful” (arts) and “the Good” (ethics and morals).*⁷⁸

Once upon a time, in pre-modern cultures, science (the True), arts (the Beautiful), and morals (the Good) were undifferentiated. Though this fusion looked attractive, there was a downside. According to Ken Wilber, such an undifferentiated mixture was not conducive to the development of science. Church morals put science between the restricting walls of what it could or could not do. Galileo had to renounce his theory that “the sun went around the Earth, and that was the end of the discussion.”⁷⁹ Healthy growth is the result of many stages of differentiation and integration. A single cell divides itself into millions of other cells, giving birth to a complex organism. All these cells are

⁷⁷ Griffin, 1988: 17.

⁷⁸ “The True”, “the God”, and “the Beautiful” are Kant’s concepts, adopted by Wilber (1998).

⁷⁹ Wilber, 1998: 12.

differentiated, but at the same time they are integrated into a single and whole organism. If for some reason differentiation or integration does not occur, the organism becomes ill. Its growth is arrested, or it becomes cancerous.

At first the process of differentiation between the three cultural value spheres, “the True,” “the Good,” and “the Beautiful”, was a process of healthy growth. Modern science, separated from any restrictions, was free to explore the world. This democracy of dissociation was one of the reasons for the splendid mechanistic success. Problems occurred quickly, however. The process of differentiation went too far into dissociation, complete separation, alienation, a disaster.

The growth became a cancer. As the value spheres began to dissociate, this allowed a powerful and aggressive science to begin to invade and dominate the other spheres, crowding art and morals out of any serious consideration in approaching “reality.” Science became scientism--scientific materialism and scientific imperialism--which soon become the dominant “official” worldview of modernity.⁸⁰

Science conquered the pedestal. The realms of arts and morals were pronounced “not scientific” and therefore delusional. The Great Chain of Being was collapsed under a heavy materialistic press. Perennial levels of matter-spirit realities were flattened into plain, dead, and dull matter. Spirit was filtered out. Beauty lost its value as a legitimate avenue for knowing the world.

Language: *Fluent in “it”-language.*

Each of the cultural spheres, “the Beautiful”, “the Good”, and “the True” has its own native tongue, writes Ken Wilber.⁸¹ “The expressive-aesthetic sphere is described in “I” since aesthetic judgment and artistic self-expression operate in the subjective, “I” domain. Morals and ethics use “we” language since that is the domain of collective

⁸⁰ Wilber, 1998: 12.

⁸¹ Ibid.

interactions and negotiations about norms, rules, and justice. The “objective” truth of science is spoken in “it”-language. What language would you use to describe objects or mechanistic systems, if not the impersonal, abstract, monological, sterile, and prosaic language of “its”?

The scientific worldview was of a universe composed entirely of objective processes, all described not in I-language or we-language, but merely in it-language, with no consciousness, no interiors, no value, no meaning, no depth and no Divinity.⁸²

Personality: *Strong leadership traits.*

Claims to tell the truth, the whole truth, and nothing but the truth regarding reality. Expresses a low tolerance for anything “nonscientific.” Despite overwhelming anecdotal evidences of psychic paranormal phenomena (holistic healing, telepathy, clairvoyance, psychokinesis, near death experiences), modern science rejects these experiences on the basis that there are no rationally explicable causes for such events.

Address: *“Flatland of its” in the mechanistic universe.*

Mechanistic science removed the interior dimensions from the Cosmos, such as “morals, artistic expression, introspection, spirituality, contemplative awareness, meaning, value and intentionality,” therefore collapsing a rich, multidimensional world into a “monochromic flatland of its.”⁸³

*everything is perfect in the flatland of "its"; everything is arranged in a proper order:
all things are*

objectified

classified

labeled

dissected

separated

measured

shelved

⁸² Wilber, 1998: 56.

⁸³ Ibid.

all events are

*proscribed
precalculated
predetermined
prerecorded
predicted*

no surprises!

the flatland of "its" is very clean:

*unnecessary
emotions
feelings
confusions
mysteries
magic
poetry*

*all this non-scientific delusional crap
(which only increases chaos and entropy)⁸⁴*

*is mapped
scrubbed
swiped away
tossed into the garbage
forgotten*

who are the lucky ones who inhabit this perfect land?

*perfect citizens: body-machines
with brain-processors of bits and bytes
minds wandering somewhere else
body-machines
who worship machines
drive machines
live with machines
live for machines
depend on machines
produce new machines*

*the universe of multiplying machines
the flatland of "its"
is an Infinite Perfect Machine!*

⁸⁴ Entropy [S] is a thermodynamic function, which increases with increasing disorder in the state of the system.

Criminal Offence: *Disenchanted the entire world.*

*It would be a static, predictable world
but we would not be here to make predictions.⁸⁵
(Illia Prigogine)*

The crime of disenchantment is heavy: mechanistic science killed the living world. It dissected perennial connections under the sharp knife of mathematical logic and reduced the world's complexities into manageable mechanistic fragments-- "its." Processed through a mechanistic filter, the whole universe was cleansed of "impurities" such as purpose, creativity, values, divinity, and meaning. The sterile mechanistic world became "...a dull affair, soundless, scentless, colourless; merely a hurrying material, endlessly, meaninglessly."⁸⁶ All phenomena were collapsed to movements of and collisions between mindless particles.

The world as a whole was thus disenchanted. This disenchanted view means that experience plays no real role not only in a "natural world," but in the world as a whole. Hence, no role exists in the universe for purposes, values, ideals, possibilities, and qualities, and there is no freedom, creativity, temporality, or divinity. There are no norms, not even truth, and everything is ultimately meaningless.⁸⁷

As Isabelle Stengers writes, the disenchanted deterministic world is "deaf and dumb to whatever is outside," totally foreseeable, automatic, and non-temporal.⁸⁸ The elimination of temporality, according to Illia Prigogine, is disenchantment because there cannot be novelty, spontaneity, and creativity in the time-reversible world that does not know the difference between the past, present, and future.⁸⁹

⁸⁵ Prigogine, 1996: 55.

⁸⁶ Whitehead, cited in Heyneman, 1993: 23.

⁸⁷ Griffin, 1988: 3.

⁸⁸ Stengers, 1997: 35.

⁸⁹ From Prigogine's and Stenger's chapter *The Reenchantment of the World*, in Stengers, 1997.

In the disenchanting world, all wondrous ancient stars, elements, mountains, rivers, and rains became nothing but manifestations of dead matter obeying mathematical laws. Human beings with their feelings and emotions, realities and dreams, sorrows and happiness were dismissed from the status of being microcosms, into machine-like collections of mindless elementary particles.

Science presents our belief that man is a product of causes which had no provision of the end they were achieving; that of his origin, his growth, his hopes, and fears, his loves and beliefs, are but the outcome of accidental collocations of atoms.⁹⁰

“The more the universe seems comprehensible, the more it also seems pointless,” admits physicist Steven Weinberg in his book, *The First Three Minutes*.⁹¹ This is how the story goes: there was a high price to pay for modern enchantment with disenchantment. The entire world, including human life in it, lost its meaning.

(Self) Phenomenology of Meaning

*I have seen many people die because life for them was not worth living. From these I conclude that the question of life's meaning is the most urgent question of all.*⁹²
(Albert Camus)

What does *meaning*, mean? Dictionaries define it as: *what is intended to be expressed or indicated, the end or purpose of something, interpretation, significance*. We cannot interpret or estimate the significance of something without some point of reference, without a background, without a context. Therefore, meaning is context dependent. Using an example from Ken Wilber, the word *bark*, means something entirely

⁹⁰ Bertrand Russell, cited in Griffin, 1988: 7.

⁹¹ Griffin, 1988: 5.

⁹² Camus, cited in Lloyd, 1999:1.

different in the phrases *the bark of a dog* and *the bark of a tree*.⁹³ We cannot understand the meaning of the word *bark* without knowing the sentence.

In searching for meaning, we look for connective associations, relationships between the pattern and the whole fabric. The pattern can be meaningless if its purpose is not understood. It can be boring and dead as a detail in tasteless wallpaper if it does not evolve.

In my groping for clarity about what I meant by meaning
I eventually began to understand that in order for our lives to have
a meaning, the pattern in which we participate must also be alive.⁹⁴

How can a pattern be alive? To explain that, Martha Heyman uses a *dance* metaphor. During a dance, you know your movements at every point of spacetime in relation to the theme of dance performance, which is also evolving and moving. The pattern and the whole constantly co-evolve together.

How do I experience *meaning*? Of course, this depends on how significant such meaning is for me. For instance, I have been trying to solve a problem for a long time, but without any particular success. Suddenly, “aha”! A light went on! Meaning jumped into existence! A quantum leap. A paradigm shift. My body feels it as a “flush” of warmth and as the lightness of joy.

I can detect the birth of meaning when I teach a class. The expressions in students' eyes, plus their body language tell me when and if meaning is born. I cannot describe what I see or hear or smell that gives me an indication of newborn meaning. I know it

⁹³ Wilber, 1998: 123.

⁹⁴ Heyman, 1993: 47.

intuitively. As Brent Davis writes, this internal, *enacted* meaning is unformulated and unseen, as a part of the iceberg hidden under the water.⁹⁵

Musician Nachmanovitch experiences bells ringing in his belly when meaning is born.⁹⁶ While writing this essay, I started to listen to myself more attentively than before. I feel the birth of meaning not in my stomach area, but somewhere closer to my heart. Could that indicate some kind of a gender difference? (Recollect the fabled cross-cultural saying that the soul of a man lies in his stomach.) Just joking. In any case, the metaphor of ringing bells that signal the birth of meaning, works for me.

I think about meaning as a harmonious resonance between the pattern and the whole, between our inner and outer worlds. We feel the ringing bells of this resonance inside us. We understand meaning and respond to it with our entire essence, with interfused mind, body, and soul. The more significant meaning is to us, the more powerful the explosion of emotions. Meaning can kill and meaning can heal. The meaning of *I do not love you* can make our heart stop. The meaning of a simple *hello* can sometimes make our flesh flush. Depending on the meaning of meaning, bells inside of me ring a triumphant sonata or a dark requiem. Humans structure their lives around meaning. Meaning is needed as much as food or air.⁹⁷ The human search for meaning in life is “an urge in human nature as basic and organic as any instinct or biological drive.”⁹⁸

When there is no meaning, the internal bells remain silent...

⁹⁵ Davis, 1994.

⁹⁶ Nachmanovitch, 1990.

⁹⁷ Heyneman, 1993.

⁹⁸ Assagioli cited in Whitmore, 1986: 43.

A soap opera “Days of the Physical Science in Elementary Schools Course”

From Geraldine’s reflective journal:

Why am I placed in this world? I have been pondering this question for quite some time now. Still, I have no answer. Am I just mere matter to occupy space in time? Or do I have some other purpose to achieve?

Disaster of Disenchantment

*Pain and panic,
the world is tilting,
swirling on its axis, out of control,
spinning off away from the sun into the dark.⁹⁹
(Madeleine L'Engle)*

What is the meaning, the identity of humans in the mechanistic universe? We have driver license numbers, social insurance numbers, student numbers, passport numbers, credit card numbers, and bank account numbers that show how much we are “worth”. All these numbers determine our identity in the mechanistic quantitative universe. Within a materialistic culture, a human being is just a walking, talking collection of mindless particles, a numerical unit in a crowd, “the mass overage”:

...modern mass man is a numerical reduction to the average mean, with no connection to higher states of consciousness, being, or reality via a chain: this is “value free.” From the contemporary perspective, the modern person has been “set free” by science, technology, and exclusive reason, and has presumably seen through the miasma of atavistic superstitions, like the values of integrity, dignity, quality, and sacrality, to which he was, like Prometheus, bound” before the liberating advent of modern thought.¹⁰⁰

⁹⁹ L'Engle, 1978: 200.

Madeleine L'Engle is my adolescent daughter’s favorite fiction writer. I am convinced that fictional stories provide an excellent context for teaching and learning science.

¹⁰⁰ Quinn, 1997: 254.

Ken Wilber writes that mechanistic science created airplanes, telephones, rockets, the global economy, advanced medicine, and computers, but at the same time it created a colossal spiritual or “value vacuum” which resulted in:

...the collapse of compassion to serotonin, joy to dopamine, cultural values to modes of techno-economic production, moral wisdom to technical steering problems, or contemplation to brain waves.¹⁰¹

Modern science caused “collapse of quality to quantity, value to veneer, interior to exterior, depth to surface, dignity to disaster.”¹⁰² The ideal of value in the quantitative materialistic culture is money and the grand objective is 100%. Of what? Of everything that can increase the material level of living--the more the better. Period. No matter what. No matter what price. If the price paid is manipulation and destruction of nature, who cares. Natural resources exist to be consumed and manipulated.

Today, however, it is increasingly understood that this kind of mentality is lethal. Disenchanted mass culture has neither qualitative connections with, nor moral obligations toward, the rest of the world. As a result, modern industry and consumerism are about to terminate the Cenozoic era in the geological history of the Earth, which means the annihilation of human civilization. It seems that the modern machine drove humanity in the wrong direction down a one-way street with a dead end.

As Quinn states, hand in hand with the growing danger of ecological disaster, the internal crisis of individuals belonging to industrial civilization grows exponentially.¹⁰³ This crisis is manifested in increased violence, depression, mass neurosis, skepticism, hopelessness, and nihilism, which is “rather an amorphous, spontaneous, and direct

¹⁰¹ Wilber, 1998: 177.

¹⁰² Ibid.

¹⁰³ Quinn, 1997.

response of despair and surrender to the confusion of an exclusively mechanistic, materialistic, secular world.”¹⁰⁴ Psychologist Carl Jung described the “schizophrenic” modern culture as chaotically disoriented.¹⁰⁵ The nihilism of modern Western culture, which is rapidly becoming global, is a reflection of the meaninglessness and emptiness of human life in the materialistic universe of shopping malls and markets...

*I myself do not know my own face,
I have forgotten it in the midst of the market crowd*¹⁰⁶

Inner bells remain silent in a world where commercials are loud!

...Once upon an ancient time, the human identity was written in the sky because human life had a cosmic meaning. Who knows, maybe such an intuitive and, from the modern perspective, naïve vision was an echo of universal memory, a deep memory, older than the Big Bang...

This is the issue of duality, with which we still struggle today--the sense of being strangers in a strange world, of alienation, of yearning for something which would make life on earth meaningful, a greater context than the common-sense world, a reality once known and forgotten.¹⁰⁷

Modernity cut off the whole grand context of human life, and life itself became no longer a multifaceted, multicolored, and multidimensional firework of interwoven inner and outer. It turned into a mechanical device temporarily “on” today and irreversibly “off” tomorrow. In the mechanistic universe life is going nowhere and this is a terrible loss and the disaster of modern disenchantment...Life going nowhere... Technological civilization is lost within the jungles of mechanistic simplicity.

¹⁰⁴ Quinn, 1997: 269.

¹⁰⁵ Ibid.

¹⁰⁶ Kanze Motokiyo Zeami cited in Heyneman, 1993: 147.

¹⁰⁷ Hardy, 1987: 111.

*I woke to find myself in a dark wood,
where the right road was wholly lost and gone...
how I got into it I cannot say,
because I was so heavy and full of sleep
when first I stumbled from the narrow way*

*life goin' nowhere
somebody help me
staying' alive, staying' alive.¹⁰⁸*

The door to eternal happiness is not found within building blocks of promised technological paradise. The modern mechanistic construct is shaky because its mechanistic foundation is shallow and superficial. This construct is slowly but inevitably crashing. Is there any chance for salvation?

*Somebody help me
Staying' alive, staying' alive.*

Hey, people, what shall we do?

Voices from the crowd:

Science brought us to this disaster, science needs then to fix it! We know science can do it! We have ultimate faith! We believe in salvation via science! We need to give science a chance!

Salvation via science? Hmm...If there is a chance, it has to be a new science. Mechanistic science with its disenchanting and manipulative attitude toward the world will not do. The good news is that a new science is already here. Its powerful sprouts pierce through the rusty body of modernity. The seeds of these sprouts were planted a hundred years ago when quantum mechanics came into play.

Paradigms in science are shifting; the stage is set for the change.¹⁰⁹

¹⁰⁸ Dante Alighieri, *The Divine Comedy*. Cited in Hardy, 1987: 144.

¹⁰⁹ Broud & Anderson, 1998: 13.

The Dark Thing that Eats the Stars?

"It was a star," Mrs. Whatsit said sadly.
"A star giving up its life in a battle with the Dark Thing.
It won, oh, yes, my children, it won."¹¹⁰
(Madeleine L'Engle)

A new science was born a hundred years ago from the quantum revolution that later ignited computer and biomolecular revolutions.¹¹¹ These three revolutions are changing our world, dramatically and rapidly. Michael Kaku writes in *Visions How Science Will Revolutionize the Twenty-first Century*:

By the end of the twentieth century, science had reached the end of an era, unlocking the secrets of the atom, unraveling the molecule of life, and creating electronic computers. With these three fundamental discoveries, triggered by the quantum revolution, the DNA revolution, and the computer revolution, the basic laws of matter, life, and computation were, in the main finally solved. This epic phase in science is now drawing to the close; one era is ending and another only beginning.¹¹²

According to visions of contemporary prominent scientists, synthesized by Kaku, the new era in the development of science is already "unfolding before our eyes." Twenty-first century science based on a synergy between quantum, computer, and biomolecular revolutions will give humans the ability to produce new unimaginable forms of matter, nanomachines as small as molecules, computers with now-unheard-of properties, superconductors, ever-more powerful lasers, and new sources of energy as exotic as antimatter. The human genome will be decoded by the year 2005. It will provide an "owner's" manual for a human being, revolutionizing medicine. Advanced

¹¹⁰ L'Engle, 1978: 87.

¹¹¹ Kaku, 1998.

¹¹² Ibid: 4.

knowledge of cell development will enable humans to “invent” new organisms. Entire organs will be grown in a laboratory.¹¹³

According to a TV *Discovery* program I watched recently, we perhaps will be able to modify ourselves dramatically, in order to live in various conditions on various planets. As Wilson writes, currently, we are taking our first steps into “volitional evolution”--a species deciding what to do about its own heredity. That will present the most profound intellectual and ethical choices humanity has ever faced.¹¹⁴ Science of the twenty-first century and beyond is expected to bring wealth to nations, an abundance of cheap food, smart houses, slave-robots, 3-D holographic television, and powerful sources of communication. “The Internet will wire up the entire planet and evolve into a membrane consisting of millions of computer networks creating an “intelligent planet.” The Internet will be able to speak with the wisdom of the human race.”¹¹⁵ An exciting time to live, isn't it?

We are getting closer to reaching the stars! Quoting scientists, Kaku writes that today we are a Type 0 civilization which takes its first clumsy steps into the cosmos and produces energy mostly from coal and oil.¹¹⁶ By the twenty-second century we may evolve into a Type I civilization that might reach nearby stars. Such a civilization will be able to modify the weather, mine the ocean, and to use energy from the center of the earth. A Type I civilization will be forced to become a planetary civilization because its huge energy needs will require global cooperation to “harness and manage resources on such a gigantic scale.” A Type II civilization will master stellar energy. “Their energy

¹¹³ The human cornea is already grown in Canada (from TV Discovery program).

¹¹⁴ Wilson, 1999: 299.

¹¹⁵ Kaku, 1998: 15.

¹¹⁶ Ibid.

needs will be so great that they will have exhausted planetary sources and must use their sun to drive their machines.”¹¹⁷ Perhaps we can reach Type II status in 800 years or so. Type III civilization will exhaust the sun and will look for energy in its galaxy. We may reach this status in 10,000 years!

What a breathtakingly fantastic prospective! Stars! Wouldn't it be wonderful to finally reach the stars, to meet them, to say “hello”! Wouldn't it be appealing to get out from our wilderness and to develop a Type III civilization! It is truly exciting, but... while applauding such a grandiose scenario, I feel a strange discomfort caused by the unscientific question:

*how will our lovely blue planet Earth feel and look when
all her planetary sources are exhausted?*

Having a Masters degree in mechanistic science, I know that both my planet and I are ultimately meaningless things, completely separated from one another. But...still... somewhere ...in the midst of mindless particles which comprise my physical form, I feel pain, thinking:

*how will our lovely blue planet Earth feel and look when
all her planetary sources are exhausted?*

Under the influence of this unnecessary emotion, another unscientific question comes to mind. Who are we? What is the meaning of our rushing toward the stars? Do we want to meet them so as to eat them? I imagine Type I to III civilizations being something like a huge, rapidly growing spider, a Dark Thing eating the stars. It crawls from one star to another and to another and to another, exhausting their resources to satisfy its enormous energy appetite. Moving along this monstrous food chain, the Dark

¹¹⁷ Kaku, 1998.

Thing leaves garbage in its wake and an arid desert of exhausted planets and stars. No regrets and no remorse since the entire universe exists to be utilized, mastered, and manipulated: "It won, oh, yes, my children, it won."¹¹⁸

These are the words of Mike Kaku who interviewed one hundred and fifty (!) scientists:

...in front of us lies a new ocean, the ocean of endless scientific possibilities and applications, giving us the potential to manipulate and mould the forces of Nature to our wishes. For most of human history, we could only watch, like bystanders, the beautiful dance of Nature. But today, we are on the cusp of an epoch-making transition, from being passive observers of Nature to being active choreographers of Nature.¹¹⁹

Wait.... Are we really speaking about the new science that will supposedly save the world? If so, then why does this new science sound suspiciously similar to the mechanistic one with its arrogant attitude toward Nature? What is different? Only the power of capabilities and the scale of activities. The essence is the same: to mould and manipulate!

What modern man has to offer extraterrestrial space is colonization (e.g., mining), and orbiting industries, to say nothing of orbiting particle-beam weapons of unfathomable destructive capability. These are seen as large achievements, the high points of technology and machinery.¹²⁰

In this scenario, our global (galactic?) technological civilization may survive ecological Armageddon, but at the cost of exploited and destroyed planets and stars. The Internet would become the Central Intelligence, a planetary wisdom of such a civilization. Would it be similar to central CENTRAL INTELLIGENCE (**IT**) of the planet Camazotz as described by Madeleine L'Engle in *A Wrinkle of Time*?

¹¹⁸ L'Engle, 1978: 87.

¹¹⁹ Kaku, 1998: 5.

¹²⁰ Kaku, 1998: 259.

...Everything is perfect on the planet Camazotz, everything is brought into proper order! **IT** takes good care of the planet and its inhabitants: "*Our production level is highest. Our factories never close; our machines never stop rolling. Added to this we have five poets, one musician, three artists, and six sculptors, all perfectly channeled.*"¹²¹ The word "love" is absent in the vocabulary of central CENTRAL INTELLIGENCE, power of love is harmful to **IT**!

*Then, seeming to echo from all around her, Came Mrs. Which's unforgettable voice. "I have something that **ITT** has not....Thiss something is your only weapponn...Bbut you mmust ffind it for yourself... Then the voice ceased, and Meg knew she was alone.... What is it I have got that **IT** hasn't got?" ... She knew! Love. That was what she had that **IT** did not have!*¹²²

Such a scenario evokes images from countless science fiction novels and movies about our possible future, where the body of Earth becomes a lifeless ruin and her intelligence becomes the intelligence of **IT**. Many fictional visions are about stars and wars: the same modern aggression, the same violence, the same hatred, but more sophisticated. I wonder: *is there a chance for our future to embrace the stars, but without wars?*

In *The Cosmic Game: Explorations of the Frontiers of Human Consciousness*, Stanislav Grof writes that even today science and technology have enough potential to make our world less imperfect. Even today it is possible to reduce world poverty, hunger, industrial waste, and to a large degree replace destructive fossil fuels with renewable sources of clean energy. Imagine how different our world could be if humans did not

¹²¹ L'Engle, 1962.

¹²² Ibid: 183.

waste “unimaginable resources” in the “absurdity of an arms race, power struggle, and the pursuit of unlimited growth.”¹²³

If powerful new science continues to manipulate and choreograph nature for the purpose of “unlimited growth,” our world, if it survives, will remain militarized, individualized, and mechanized to the teeth. It will be a familiar disenchanting world, one that successfully nibbles on the stars.

*Can such a world be a happy world?
Is the true meaning of human civilization to be a Dark Thing that eats the stars?
How could we prevent converting ourselves into a Dark Thing?*

These questions leap us into the flatland of modern science education, which remains, unfortunately, a Dark Thing’s nursery....

¹²³ Grof, 1998.

Modern Science Education as the Disenchanted Nursery of a Dark Thing

28 April 1686 is the day Isaac Newton presented his Principia (The Natural Principles of Philosophy) to the Royal Society of London. Book III of this treatise, the one containing Newton's famous 'universal law of gravitation' is entitled "The System of the World." This system has, since Newton's death, become a paradigm, a paradigm which we now see began with the observation and musings of Francis. This paradigm dominated by Western scientific and intellectual thought well into the present century, and continues today, as the foundational model for the social sciences, including education.¹²⁴
(William Doll)

...I had completed all the requirements for the Ph.D. in theoretical physics. But I paid a price for my learning. A dear price that I hadn't even realized at that time. Somewhere, in all of that education, I had lost the magic.¹²⁵
(Alan Wolf)

In the flatland of "its", in the Perfect Machine, the educational system is simple, rational, and efficient. The aim of education is to produce more new machines to join a working force that is needed for further development of a technological paradise. But how do rational people produce machines? Of course, they use assembly lines. This clever engineering design is used in schools/factories for producing machines from raw material:

The school is a more or less well oiled machine that processes (educates) children. In this sense, the educative system (school) comes complete with production goals (desired end states); objectives (precise intermediate end states); raw materials (children); a physical plant (school building); a 13 stage assembly line (grades k-12); directives for each stage (instruction); managers for each stage (teachers); plant supervisors (principals); trouble shooters (consultants); quality control (discipline); uniform criteria (standardized tests); and a basic product available in several lines of trim (academic, vocational, business, general).¹²⁶

¹²⁴ Doll, 1989: 243.

¹²⁵ Wolf, 1991: 35.

¹²⁶ Caley, cited in King, 1993.

The school curriculum developed by Bobbit, Charters, Huxley, Spenser, Hunter, Tyler, and others, was based on mechanistic science and mirrored the flatland of "its", the modern mechanistic universe.¹²⁷ The flatland's curriculum "promised order, organization, rationality, error correction, political neutrality, expertise, and progress."¹²⁸

everything is perfect in the flatland of "its"

all the schools are in proper order

learning is

dissected

separated

quantified

measured

categorized

reduced

predetermined

efficiency calculated

intelligence tested

students labeled

systems closed

changes controlled

order maintained

balance created

knowledge transmitted

knowledge constructed

"the ends are clear"

"the means are precise"¹²⁹

IT IS EXPECTED THAT STUDENTS WILL!¹³⁰

¹²⁷ Pinar, Reynolds, Slattery, & Taubman, 1995.

¹²⁸ Cherryholmes, 1988: 26.

¹²⁹ These two lines are borrowed from Doll, 1989: 343.

¹³⁰ From K-7 BC science IRP (integrated resources package).

The mechanistic school curriculum was born during a time of disenchantment, when the whole living universe was reduced to passive inanimate matter. It was a time when a sober, materialistic, “prosaic mentality”¹³¹ spread throughout all human realms, including education. It was a time when the main goal of education was development of an efficient working force for a technological society. Has anything changed since then?

From the current BC K-7 Science IRP:

*Science curriculum provides a foundation for the scientific literacy of citizens, for the development of a highly skilled and adaptable work force, and for the development of new technologies.*¹³²

Welcome to the assembly line.

*A lesson plan is a description of the sequence of activities engaged in by an instructor and learners in order to achieve predetermined instructional objectives. It includes a description of the instructional session, the aids, devices, and other resources required.*¹³³

No comment.

Prescribed learning outcomes:

*It is expected that students will:
describe basic units of matter
identify common elements and molecules
distinguish between natural and synthetic materials
identify some unique properties of synthetic materials that are useful for society
compare the environmental impacts of using natural and synthetic materials*¹³⁴

¹³¹ Abram, 1996.

¹³² BC K-7 Science IRP: 2.

¹³³ Ibid: 15.

¹³⁴ Ibid: 68.

I read through the British Columbia Ministry of Education Programs and Services K-12 Curriculum and Learning Resources (Integrated Resource Packages) or **IRPs**.

I searched through other science curriculum resources in North America.

From the Ontario Science Curriculum for grades 1-8:

The science and technology expectations are organized into five strands, which are the major areas of knowledge and skills in the science and technology curriculum. The five strands, which combine topics from science and technology, are:

- *Life Systems*
- *Matter and Materials*
- *Energy and Control*
- *Structures and Mechanisms*
- *Earth and Space Systems*

*The knowledge and skills outlined in the expectations for the science and technology program are mandatory.*¹³⁵

You can browse through science curriculum resources too. You can use the brightest light and the most powerful magnifying glass, but nowhere, I guarantee, will you find any hint of enchantment. There is no feeling, no beauty, no love, no awe, no intrigue, no magic, no mystery, no purpose, and no soul. There is no breathtaking oneness with the world. Everything is ultimately material, dead, predictable, calculable, reducible, and objective. Get real! Get material! Get technological! It is mandatory! This is the basic nature of the contemporary North American school science curriculum. Coming from the former Soviet Union, I can make cross-cultural comparisons: the situation is the same. School science education is

*chained to the mechanistic cage
which contains blind forces
which act upon prosaic passive matter
which occupies empty space
which is hopelessly empty
that is why it has a perfect ability to separate all things*

¹³⁵ <http://www.edu.gov.on.ca/eng/document/curricul/scientec/scientec.html>.

that constitute a modern fragmented world

*A petri dish sits on the windowsill.
An angel passes unnoticed outside the window.¹³⁶*

IT IS EXPECTED THAT STUDENTS WILL!

*“Almost all the joyful things of life
are outside of IQ tests”,*

says Madeleine L'Engle.

“Educational theories regarding science teaching,” writes educator and philosopher Azam Mashadi, “have been largely based on out-moded eighteenth century conceptions of the physical universe.”¹³⁷ Since a primary goal of science education is the development of a scientific worldview, the challenge for 21st century science education lies in devising an educational theory that incorporates understandings achieved in new developments in science. “It is not sufficient to merely include in the curriculum new scientific facts; the way of thinking that arises from these theories must be brought into science education as well.”¹³⁸

Dramatic changes in education are a must!

Dissertations are written, articles are published, and curriculum reforms are proposed. Thomas King synthesized curriculum reforms in North America, which occurred during the past hundred years.¹³⁹ Like waves, they recycle and repeat; however, nothing has really changed for one reason: “twentieth century educational philosophy and practice had been and still is based on a classical mechanistic science paradigm.” King

¹³⁶ Fels, 1999: 106.

¹³⁷ Mashadi, 1997: 1.

¹³⁸ Mashadi, 1997: 4.

¹³⁹ King, 1993.

believes that “unless something revolutionary happens in curriculum epistemology, “the 21st century will be a very unbrave old world, slowly but increasingly rushing to its entropic death.”¹⁴⁰ Educator David Orr expresses a similar thought:

It is time, I believe, for an educational “perestroika,” by which I mean a general rethinking of the process and substance of education at all levels, beginning with the admission that much of what has gone wrong with the world is the result of education that alienates us from life in the name of human domination, fragments instead of unities, overemphasizes success and careers, separates feeling from intellect and practical from theoretical, and unleashes on the world minds ignorant of their ignorance.¹⁴¹

According to King, no reforms will work unless the worldview, which provides the very foundation for education, is changed.¹⁴² Today the new image of reality unfolded by new insights in science “portends a radical revision of how the world and human consciousness itself is to be comprehended.”¹⁴³ This is why, writes Mashadi, “it is perhaps time to re-assess the foundation on which school science currently rests and the *mode of thinking* that it promotes.”¹⁴⁴

What mode of thinking can be promoted if science education is based on the emerging worldview portrayed by avant-garde science? Mashadi understands this mode as liberating and non-mechanistic. I wish to stretch this idea further into re-enchantment, since I believe that state-of-the art science provides us with the conceptual framework for educating *magical* or *enchanted* consciousness which, using Glucklich’s definition, is “the awareness of the interrelatedness of all things in the world by means of a simple but refined sense of perception.”¹⁴⁵

¹⁴⁰ Ibid: 14.

¹⁴¹ Orr, 1994: 17.

¹⁴² King, 1993.

¹⁴³ King, 1993: 70.

¹⁴⁴ Mashadi, 1997: 4.

¹⁴⁵ Glucklich, 1997: 12.

Thomas Berry understands this awareness as “forms of intelligence that enable us to see the earth [and the universe] as a living body with senses and soul with memory.”

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We need to fertilize the growth of enchanted consciousness because, as David Orr writes, so far educated people from K through the Ph.D. have nearly destroyed the Earth and humanity itself.¹⁴⁷ The modern detached, disenchanting mode of thinking converts our civilization into the Dark Thing!

It won, oh, yes, my children, it won!

Writes Farren:

The answer: a total change of mind-set around the globe. Nothing less. Nuclear arms control and non-proliferation efforts won't do it. Peace research and teaching non-violence won't do it. Surely more annihilative weapons on both (or all) sides won't do it. Essentially: a total change of mind-set.¹⁴⁸

William Quinn believes that to find the way out of the confusing labyrinth of modernity, we need to develop and teach a new spiritually-oriented planetary culture that believes in the “homology of person/planet/universe.”¹⁴⁹ Since we are brought up in a “scientific” society, continues Quinn, we might readily see “the unity, the sacredness, the oneness of life, owing to its universal acceptance as a scientific fact.”

Developing such a scientific vision, from my perspective, should be the most important aim and mission of re-enchanted, re-imagined science education. To see what contemporary science can offer for this re-imagining, let's make several nonlinear steps--

¹⁴⁶ Berry, 1989.

¹⁴⁷ Orr, 1994.

¹⁴⁸ Cited in Neutopia, 1994.

¹⁴⁹ Quinn, 1997.

magic circlets that are spiraling down deeper and deeper into the re-enchantment. We will fly into these circlets on the wings of Madeleine L'Engle's chant:

*In this fateful hour
All Heaven with its power
The sun with its brightness
The snow with its whiteness
The fire with all the strength it hath
The lightning with its rapid wrath
The winds with their swiftness
The sea with its deepness
The rocks with their steepness
The earth with its starkness
All these I place
Between myself and the power of darkness.¹⁵⁰*

¹⁵⁰ L'Engle, 1978.

CIRCLET 1

SCIENCE OF COMPLEXITY AS A STEP INTO
MODEST
RE-ENCHANTMENT

*We appear to have been profoundly wrong.
Order, vast and generative, arises naturally.¹⁵¹*

¹⁵¹ Kaufman, 1995: 25.

A Crazy Pendulum Swings into the Mystery of Chaos

...a new paradigm we are seeing emerge from insights of chaos theory requires of us nothing less than a brand new start in the description of nature--a start which will affect our metaphysics and our physics, our cosmology as well as our logic.

(William Doll)¹⁵²

Pendulums are strange creatures. They like to swing backward and forward, to and fro, pro and con. In the idealized abstract mathematical universe, their movement is always rhythmic and always repetitive. There is not much mystery around pendulums' linear and predictable behaviour. No surprises. If you are not too lazy to measure just two variables, angle and velocity, you can easily calculate their trajectories at any given moment. In the real settings, forces of friction usually bring unwanted complications, but you can neglect them for your convenience, reducing, and as such, "idealizing" a swinging pendulum into a simple, predictable, and calculable system. The behaviour of a real pendulum remains rhythmic and periodic, even though stubborn friction forces eventually slow it down. For instance, when placed between two magnets, a pendulum rhythmically moves back and forward, to and fro...

The picture changes dramatically when a pendulum is forced to move between three magnets. In this case, a mystery comes into play and possibilities for reducing a pendulum into a simple system become questionable. When you push a pendulum only slightly, it swings repetitively and regularly, periodically attending each set of two magnets. Under a stronger push, however, the pendulum exhibits a strange behavior. Being perhaps offended by such impolite action as a push and feeling perhaps completely out of equilibrium, a pendulum seemingly loses its mind, starting to swing wildly and

¹⁵² Doll, 1993: 91.

chaotically between the three magnets. It moves without any apparent rhythm or particular direction: the previously regular behavior of the pendulum is now chaotic. Under such conditions, do not even try to predict its trajectory of movement. The trajectories of a chaotically swinging pendulum never repeat themselves. However, seemingly chaotic behavior of a pendulum is not as random as it seems to be. Pushed out of equilibrium, a pendulum swings into an intriguing space where randomness and order shake their hands. How can this be? Is it really possible to unite such opposites as *randomness* and *order*, as different as *yes* and *no*, or *day* and *night*? If it is, what could possibly unite them? To address this interesting question, we need to get acquainted with the *chaotic* butterfly.

Let's pretend you conducted an experiment, observing the movement of a chaotic pendulum, moment-by-moment, snapshot by snapshot. After collecting data, you graph results, representing all variables of the system by a single point that corresponds to each moment of movement. By doing so, you will end up in an abstract mathematical space called the phase-space, the diagram where the trajectories of a single point describe an entire system, moment-by-moment.

For the ideal abstract pendulum such a diagram looks like a closed loop, but for the real periodic pendulum with friction, it looks like a curve spiraling inward toward the center. This central space where the system eventually "settles down," is called a *point attractor* because it "attracts" trajectories of a single point. Guess how the phase-space diagram would look for a chaotically moving pendulum, providing that it is inventive enough to never repeat itself. You perhaps would think that the representation of the points on the diagram would be a chaotic mess, and that would be quite logical. Surprise.

As a symbol of interplay between order and randomness, a strikingly beautiful and complex pattern emerges out of the chaotic trajectories of a single point. It looks like a butterfly with stretched wings. The existence of this pattern indicates that trajectories of a single point are not repeatable and not predictable, yet are restricted and bounded by a complex shape. As William Doll writes, "...the trajectories have both *bounds* and a center *attractor* area. Neither of these are precisely defined, but as the trajectories fly out from the center area, they are attracted back, only to fly out again."¹⁵³

Increasingly explored, behaviors of other chaotic systems reveal various shapes of patterns, but a chaotic butterfly remains a symbol of cunning chaos that cannot be understood as a simple and unpretentious disorder. This complex pattern, the chaotic butterfly, resembles a mysterious mask. Is it simply a coincidence or is it a hint that playful chaos likes to hide its true ordered nature? Writes Katherine Hayles : "...not only does chaos perform its magic within bounds or limits, but the deep within chaos itself there is a universal structure."¹⁵⁴ The structure hidden within chaos...I sense an enchantment here!

The butterfly's metaphoric involvement in chaotic "endeavors" is not limited to the shape of a complex pattern. A "butterfly effect" is a poetic metaphor for the interesting property of chaotic systems to produce far-reaching, widely varying, and unpredictable responses under small initial changes. What could be more minor and innocent than the flap of a butterfly wing? Chaotic systems, however, behave in such a manner as if a butterfly's flap of a wing can generate storms, tornadoes, and hurricanes

¹⁵³ Doll, 1993: 94.

¹⁵⁴ Doll, 1993: 95.

on distant planets. Oh, butterfly, butterfly...these chaotic systems are quite strange, aren't they? This is why their chaotic attractors are called "strange."

Writes Isabelle Stengers:

An attractor is a stationary state or regime toward which an evolution described by the well-determined system of equations leads. Usually, an attractor is stable: different sets of different initial conditions determine evolution toward the same attractor (for example, a state of thermodynamic equilibrium, the immobile state of a real pendulum, from which one has not abstracted friction; or "limit cycle"). Once this attractor has been reached, the system will no longer spontaneously depart from it, fluctuations aside. "Strange attractors," on the other hand, do not have this property or stability. Two neighboring initial conditions can generate very different evolutions. The slightest perturbation can push the system from one regime into a very different one. Instead of stabilizing into a predictable and well-determined state, the system wanders between possibilities; in other words, although governed by deterministic equations, it adopts an aleatory behavior.¹⁵⁵

The number of possibilities available for chaotic systems to evolve is infinite because strange chaotic attractors have an infinite number of dimensions. As Coveney and Highfield write, chaotic attractors are *fractals* that can have "one-and-something" or "two-and-something" or many other unconventional dimensions.¹⁵⁶ At this point, we enter the kingdom of fractal geometry, the land of irregular shapes, where, in addition to familiar one- or two- or three- dimensions, an infinity of "in-between-s" comfortably exist.

Have you ever thought about the world in terms of beautiful patterns? Have you ever admired the intricate shapes of clouds, leaves, coastal shores, flowers, or snowflakes? Look around and see for yourself. Instead of neat triangles or squares, our world is full of irregular shapes and forms, called *fractals*. As Fritjof Capra notes, fractal geometry is "a language that speaks to clouds--to describe and analyze the world around

¹⁵⁵ Stengers, 1997: 7.

¹⁵⁶ Coveney & Highfield, 1995.

us.”¹⁵⁷ To study and to reproduce a variety of natural shapes, fractal geometry has to use magical imaginary numbers that are square roots of negative numbers. These imaginary numbers, according to the common mathematical sense, cannot exist. Yet, they are unavoidable for real-world calculations! “We may truly assert that they are neither nothing, nor greater than nothing, nor less than nothing, which necessarily constitute them imaginary or impossible.”¹⁵⁸ Perhaps, for these reasons the prominent mathematician Karl Gauss stated: “objective existence can be assigned to these imaginary beings.”¹⁵⁹ Existence of something which cannot exist...hmm...sounds like the very definition of magic...Could it mean that in order to create all the amazing variety of shapes and forms, Nature uses the magic of her imagination?

Motif within motif, within motif, within motif, and within motif: fractals can endlessly repeat themselves.¹⁶⁰ The tiny rock repeats the shape of a larger rock that, in its turn, repeats the shape of a mountain. A small innocent cloud resembles its huge and heavy stormy sister, and a cloverleaf bristle with smaller clover shapes that bristle with even smaller clover shapes, and so indefinitely.

So, naturalists observe, a flea
Hath smaller fleas that on him prey
And these have smaller fleas to bite ‘em
And so proceed *ad infinitum*¹⁶¹

As Biscop writes, “fractal geometry allows mathematicians to describe the structure of the universe in terms that include pattern, repetition, scale, randomness, and a part-for-whole relationship, in which the part is a replica of the whole.”¹⁶²

¹⁵⁷ Capra, 1996: 138.

¹⁵⁸ Ibid: 143.

¹⁵⁹ Ibid: 143.

¹⁶⁰ This property of fractals is called “self-similarity”.

¹⁶¹ Coveney & Highfield, 1995: 172.

Computer generated fractals range from beautiful abstract forms to realistically looking biological and physical shapes, including clouds and cloverleaves. Together, revealed and displayed by powerful computers, patterns of chaotic systems and fractal shapes inspire novel forms of art, as they “have an intrinsic beauty that engenders a response in many akin to that experiences by observing nature and human works of art, whether realistic or abstract.”¹⁶³ The beauty of the chaotic fractal butterflies is re-enchanting because it reconciles the art of nature with the nature of art...

A Chaotic Butterfly Flies into the Science of Complexity

*Now a new branch of science is attempting to demonstrate why the whole universe is greater than sum of its many parts, and how all its components come together to produce overarching patterns. This effort to divine order in a chaotic cosmos is the new science of complexity.¹⁶⁴
(Coveney & Highfield)*

A flap of the wing and a butterfly flies into a bursting rhapsody of colours, joining a swirling warm air. A flap of the wing and a chaotic butterfly flies into the science of complexity and as a result, into “a new way of thinking about nature, the physical world, and ourselves.”¹⁶⁵ The science of complexity was born when study of chaos moved deeper into real-world situations. What a surprise: chaotic properties are intrinsic to natural phenomena.

The real-world chaotic systems, just as abstract mathematical chaotic ones, evolve toward strange attractors, managing to survive in the world of chaotic butterflies, in this intriguing space “in-between.” This space is twilight, where day and night kiss each

¹⁶² Biscop, 2000: 11.

¹⁶³ Coveney & Highfield, 1995: 341.

¹⁶⁴ Ibid: 5.

¹⁶⁵ Ibid: 18.

other; it is an ambiguous “maybe” that escapes the certainties of “yes” or “no”. This space is the creative and risky “edge of chaos,” where order and randomness co-exist. Imagine whirlpools and vortexes that suddenly appear and disappear in the running river. They maintain structured shapes within a never-stopping chaotic flow of water, following therefore the rule of the chaotic butterfly, which is *bounded randomness*. Real-world manifestations of abstract chaotic systems are called *complex systems*. Indeed, you need to be sophisticated and complex to manage survival on the edge of chaos, to maintain structure within randomness, to preserve permanence within constant flux. Naturally, it makes you unstable, sensitive to even slight changes in conditions, and dependent on numerous variables.

*Complexity is a staggering number of critical dependencies and interactions among the huge number of important variables.*¹⁶⁶

It is not so easy to depend on everything, you know. Under such stressful conditions you are entitled to exhibit nonlinear and unpredictable behavior. As is increasingly understood, an unstable attitude is natural to the majority of world phenomena. “The macroscopic world abounds with complex processes and systems. Religious rites and ephemeral emotions, musical musings and muddy meadows, global stock market crashes and wet Sunday afternoons. This complexity is intrinsic to nature.”¹⁶⁷

In recent years, weather forecasting, fluid mechanics, chemistry, astrophysics, economy, population biology, and brain research provide abundant data for exploring unpredictable, dynamic, chaotic behavior. Models for chaotically behaving systems are

¹⁶⁶ Bardbury, 1998.

¹⁶⁷ Convey & Highfield, 1995: 32.

based on nonlinear equations with multiple, complex, and often unexpected solutions. Solving nonlinear equations became possible only recently with the development of a powerful computer technology. This is not surprising since millions of numbers are entered into nonlinear equations describing a complex problem.

If complexity is intrinsic to nature, this means that mechanistic science simply missed a point by creating an idealized scientific world, while collapsing all complex natural phenomena into simple predictable systems and eliminating all but a few variables within experimental designs. Simplicity was the motto and seduction of reductionist science, but the real world turned out to be more unpredictable, more chaotic, and more complex than we imagined while residing in a mechanistic universe. Intricate markings on a butterfly's wings, shapes of snowflakes, rhythms of our hearts, the collaboration of nerve cells within our brains, turbulently running a top water, the functioning of our body, the dynamics of ecosystems, complex societies, swirling galaxies, and all-embracing Cosmos; there is no shortage of ever-increasing complexity in our ever-evolving world. But...how can it be?

Minutes from Teaching Mechanistic Science

How can it be? Why is the world so incredibly complex? Something does not make sense here...Heretic thoughts kept popping into my mind as I taught classic thermodynamics in a community college, years ago. The second law of thermodynamics, also called the entropy law, proclaims inevitability of chaotic equilibrium as the ultimate state of any physical system. Entropy is thermodynamic function that measures degree of chaos, and chaos in the eyes of classic thermodynamic is nothing other than plain mess

and disorder, period. According to the second law, all spontaneous processes in nature are progressing toward disorder and therefore, toward increasing entropy...

*entropy is a strange function...
why does this entropy like chaos so much?
chaos is actually not a very convenient state to be in,
since absolutely everything is mixed and misplaced...
if I were entropy,
I would not strive to be increased toward chaos
and I would not lead all the world
toward randomness and disorder
simply
because I like order better
just imagine how wonderful the world would be
where all the processes are directed toward order
inhabitants of this world would have a very easy life
because houses would be built by themselves,
garbage would voluntarily put itself into proper places
nobody would die, because death is chaos
a clean organized world without death
isn't it a lovely picture?
Yes,
I definitely like order better,
but, unfortunately,
entropy has a different opinion...*

True. Unfortunately, buildings tend to become ruins over time and garbage usually does not express desire to take care of itself. The moving motor dissipates heat energy, particles of solute diffuse in solvent, and black marbles tend to mix with white ones. Spontaneous processes tend to be directed toward maximal probability, which corresponds to maximal entropy, and as such to maximal chaos, randomness, and disorder. Fair enough. However, how then can we account for life evolving spontaneously toward complexity and how then was the universe born in the first place? The second law of thermodynamics makes life itself highly improbable.

There is something depressing about this law. On a grand scale, governed by the careless law of entropy, the universe slowly and inevitably disperses energy, approaching

a heat death, which is the state of absolute chaos. I could not help thinking that if death and absolute chaos are the final universal state, why do I even teach this thermodynamics course? Ultimately, my course, as well as my entire life, has no meaning. My thoughts resonated with questions of Nietzsche who wondered why God created anything if it was going to be destroyed eventually. I thought...

*where is the beginning of everything?
maybe, in a small weak sprout
piercing the hard cold ground
after winter's freeze?
maybe, in sun being reflected
by a drop of shining morning dew?
or... in a simple "hello?"
where is the end?
maybe in the vanishing light of a dying star?
or... in the last lonely leaf clinging to a tree
and suffering from the harsh winds of autumn?
or... in the dark and cold chaos
of the universe?
what is the rule, which leads every existing thing
to its end from its beginning?
and... who is in charge of this rule?*

Classical thermodynamics created a "negative" arrow of time in nature. This arrow pointed toward dispersion of energy, mess, waste, simplicity, randomness, and ultimate equilibrium. The evolution of our world, however, has a "positive" arrow, pointed toward ever increasing complexity. From the perspective of the second law, the very process of evolution is highly improbable. Interesting puzzle. Complex systems stubbornly exist and even evolve, though they are not supposed to. They pretend they are not aware of their high improbability. The question is: how can complex systems manage to overcome the universality and inevitability of the second law?

To approach this perplexing question, the new science of complexity suggests rethinking our vision of the natural world: “Nature is not strictly a succession of causes and effects. Embodied within nature, defining its very essence, is the powerful force of creation, of spontaneous action, of self-organization.”¹⁶⁸ Self-organization is the key. What is it though?

The Magic of Self-Organization

*Imagine the experiment.*¹⁶⁹

The liquid in a container is placed between cold and hot plates. When the temperature gradient between plates is small, nothing observable happens. The system is quite uniform, symmetrical, and stable. The system “liquid in the container” is in the state near equilibrium. When the temperature gradient is increased, the system moves further and further from equilibrium, finally reaching so-called “bifurcation point” where thermal convection suddenly shapes into a striking organized pattern of hexagonal “cells.” These cells are formed through the synchronized movement of millions of particles. A new order of organization jumps spontaneously into existence. Such a process illustrates an amazing correlation between a huge number of particles “...everything happens as if each volume element was watching the behavior of its neighbors and was taking it into account, so as to play its own role adequately and to participate in the overall pattern.”¹⁷⁰

Self-organization is the spontaneous emergence of new order out of chaos. As Sardar and Abrams write, “the richness and diversity of interaction between a host of

¹⁶⁸ Doll, 1993: 55.

¹⁶⁹ The Henri Bernard’s experiment described in Capra, 1996: 86.

¹⁷⁰ Prigogine, cited in Kirk, 1991: 24.

interdependent variables allow complex systems to self-organize. The process of self-organization happens spontaneously, as though by magic.”¹⁷¹ Sounds enchanting, doesn't it? The rule of self-organization is that the whole is more than the sum of its parts; therefore, we cannot sufficiently know the whole through reducing and dissecting it into the manageable units. Writes Ludwig von Bertalanffy:

....isolation of ultimate particles and forces can never provide more than a partial explanation of any phenomenon, since --the whole is clearly more than the sum of parts....if two particles are put together in an "organized way", instead of the formula $1+1=2$, we get $1+1<2$, and...this is the basic equation in biology. Thus if an electron and nucleus come together in an organized way, a hydrogen atom is born, which is more than an electron and nucleus. If atoms are built into a molecule, something new is born, which can no longer be described solely in terms of atoms. The same holds true when small molecules are built into macromolecules; macromolecules into organelles; organelles into cells, cells into organs, organs into individuals; and individuals into society or ecological associates.¹⁷²

Enchanted by phenomena of spontaneous self-organization, the Nobel Laureate chemist Illia Prigogine developed the theory of dissipative structures.¹⁷³ He noticed that a new order of self-organization emerges only when the system is open¹⁷⁴ and exists in a far from equilibrium state, where matter and energy flow as a boiling mountain river. The faster the river flows, the further the complex system shifts from the equilibrium. At a bifurcation point, the system reaches instability and spontaneously transforms itself into a new structure with increased complexity. This means, in a state far from equilibrium, ordered structures may not only comfortably exist, but may even evolve toward more complex order.¹⁷⁵ While exploring this phenomenon more deeply, Prigogine realized that

¹⁷¹ Sardar & Abrams, 1999: 83.

¹⁷² Ludwig von Bertalanffy cited in Heyneman, 1993: 45.

¹⁷³ Prigogine & Stengers, 1984.

¹⁷⁴ In terms of thermodynamics, an isolated system does not exchange anything with an environment; a closed system exchanges energy, and an open system exchanges matter and energy.

¹⁷⁵ Prigogine & Stengers, 1984.

systems existing far from equilibrium must be described by nonlinear equations, which often offer multiple outcomes and unexpected results.

One of the important properties of nonlinearity is self-reinforcing feedback loops. Coveney and Highfield offer a simple explanation of this phenomenon.¹⁷⁶ In the linear and predictable world, relationships between two qualities are directly proportional. As an example, when you are going to the store to buy oranges, you expect to pay ten times more for ten oranges than for a single orange, providing you studied mathematics in school.

In the non-linear world, things are not as simple. Here you may go to the store and see the sign “Buy nine, get one free!” which means that you will not pay ten times more for ten oranges. Without going into deep thinking about linear versus nonlinear relationships, you simply may decide to buy more oranges than anticipated in the first place. In this case, “a concomitant effect of this nonlinearity was feedback—the outcome of an effect goes on to trigger more change.”¹⁷⁷ For instance, when you bought more oranges, the delighted and inspired owner of the store decided to discount the price even more. Another lucky purchaser came and decided to buy all the oranges and to open a marmalade business. A small initial change: “Buy nine, get one free!” resulted in a chain of significant events. In the linear world, small changes produce small effects. In the nonlinear world, slight changes trigger dramatic effects that occur due to the amplifying power of self-reinforcing feedback loops. A single flap of a butterfly wing and...

In the experiment with liquid placed between hot and cold plates, when the temperature gradient is insignificant, small fluctuations caused by molecular motion do

¹⁷⁶ Nonlinearity explained by Coveney & Highfield, 1995.

¹⁷⁷ Coveney & Highfield, 1995: 58.

not produce any noticeable changes, since the system is near equilibrium. However, in the state far from equilibrium, the “butterfly effect” comes into play. Positive feedback loops amplify random chaotic fluctuations into the emergence of new, more complex honeycomb-like structures. When the temperature difference between two plates increases more dramatically, the system moves further and further from equilibrium until a new point of instability is reached. At this new bifurcation point, the honeycomb of structured cells self-organizes itself into spirals, the beautiful expressions of a new, higher level of complexity.

Another striking example of the self-organization phenomenon is a chemical clock.¹⁷⁸ It is a chemical reaction that produces spontaneous ordered oscillations under conditions far from equilibrium. For instance, in the case of the magical Belousov-Zhabotinski reaction, the initially homogenous mixture of malconic acid, potassium bromate, and cerium ions spontaneously and periodically changes its colour from red to blue and vice versa. When concentrations of reagents are even further from the equilibrium, beautiful waves and spirals as a new order of complexity emerge at the new bifurcation point. This transformation is amplified by positive feedback loops, known in chemistry as autocatalysis, and in mathematics as iteration.

There is always an element of the unpredictable in the dynamic realm of bifurcation points. When reaching this point, the system “chooses” the chaotic attractor to be drawn to, deciding on what path to take among several possibilities.¹⁷⁹ The choice cannot be exactly predicted, as it actualizes within the complex interplay of the history of the system, multiple histories of related systems, and environmental conditions. As

¹⁷⁸ Kaufman, 1995.

¹⁷⁹ Prigogine, 1996.

Stengers writes, complex systems are unstable and subject to the butterfly effect; this is why little deviations of initial conditions lead to dramatically different and often unexpected paths. Recognizing the inherent unpredictability of chaotic behavior enables us “to break a circle of sufficient reason, since it constituted the ideal of a complete definition, which lets nothing escape.”¹⁸⁰ In *The End of Certainty: Time, Chaos, and New Laws of Nature*, Prigogine says that acceptance of unpredictability in science means acceptance of a new kind of knowledge that overcomes the prejudice of determinism and leads us to novelty.¹⁸¹

One of the reasons for unpredictability is the previous history of the system. In the disenchanted universe of mechanistic science, physical systems did not have history since inanimate matter did not know the difference between the past, present, or future. In its deepest essence, the world of mechanistic science was time-symmetrical, with all processes being completely reversible. As Prigogine notes, even today for many scientists there is no arrow of time in nature. For them, time exists only within the human phenomenological realm. In the reversible physical world, however, nothing would ever evolve. Where “both future and past are interchangeable, there is no room for history, novelty, or creativity.”¹⁸² In a reversible world we would not have the chance to discuss the issues of reversibility since we simply would not exist. Writes Illia Prigogine:

Science is a dialogue between mankind and nature, the results of which have been unpredictable. At the beginning of the twentieth century, who would have dreamed of unstable particles, an expanding universe, self-organization, and dissipative structures? But what makes this dialogue possible? A time-reversible world would also be an unknowable world.¹⁸³

¹⁸⁰ Stengers, 1997: 28-29.

¹⁸¹ Prigogine, 1996: 4.

¹⁸² Capra, 1996: 184.

¹⁸³ Prigogine, 1996: 153.

The difference between time-symmetry and time-irreversibility is the difference between static being and dynamic becoming. Becoming, states Prigogine, is the *sine qua non* of science and of knowledge itself. The second law of thermodynamics introduced irreversibility and therefore the process of becoming in nature, but when becoming is directed toward ultimate disorder, waste, and degradation, is it really becoming? The concept of becoming assumes evolution toward complexity and novelty. As Isabelle Stengers states, “the notion of complexity is close to that of emergence.”¹⁸⁴

Science of complexity reversed the direction of the arrow of time toward emergence versus destruction, elevating the process of self-organization into the universal natural law. Did it then contradict the second law? In Prigogine’s theory, there are no contradictions or violations. The total system-environment entropy increases in accordance with the universal law of entropy, but not uniformly. Complex structures “are islands of order in the sea of disorder, maintaining and even increasing their order at the expense of greater disorder in their environment.”¹⁸⁵ These structures dissipate energy to maintain their existence at the edge of chaos. This is why they are called *dissipative*. Such structures can be understood as patterns or seeds of emergence within the totality of destruction. For their own convenience, the dissipative “islands” create a negative entropy, “negentropy.”¹⁸⁶ This means that while existing in a state far from equilibrium, they “suck” the order from their surroundings. You and I, by the way, are such complex dissipative islands, somehow managing to exist at the edge of chaos.

¹⁸⁴ Stengers, 1997: 12.

¹⁸⁵ Capra, 1996: 189.

¹⁸⁶ The term coined by quantum physicist Shroedinger.

Confession

*as a highly improbable
open
complex
self-organizing
dissipative
system*

I confess

*that I have absolutely no clue
how in the world I manage to maintain
my highly ordered physical structure
at the edge of chaos*

Reversing the arrow of time toward increasing complexity makes the destiny of Cosmos less depressing, since within the sadness of the maximal entropy, seeds and celebrations of new, more sophisticated worlds might be hidden. While emerging at some unimaginable bifurcation point, these new interesting worlds will embrace previous universal history, and this very manuscript is a part of it. This means I do not write it for nothing, which is good news. I would not want my work to disappear without any trace in the mess and coldness of the universal waste. Reversing the arrow of time in a positive direction is re-enchantment from the mechanistic spell of meaninglessness. It gives a conceptual comfort, whereby I can perceive my work and my very being/becoming as related to universal self-organizing power.

Interrelatedness is a fascinating aspect of the self-organization phenomenon. It reveals itself during the process of spontaneous emergence of complex and structured dissipative patterns. Such an event requires billions of particles to communicate. If particles were randomly moving mindless balls, how then could they act so collaboratively? How would they know how? As Prigogine notes, self-organization leads

to “coherence, to effects that encompass billions and billions of particles. Figuratively speaking, matter at equilibrium, with no arrow of time, is “blind”, but with the arrow of time, it begins to “see”.¹⁸⁷ The ability of inanimate matter to “see” sounds like re-enchantment to me. For so many years I taught science which portrayed matter as inherently passive and ultimately blind.

Capra summarized the concept of self-organization as “the spontaneous emergence of new structures and new forms of behaviour in open systems far from equilibrium, characterized by internal feedback loops and described mathematically by nonlinear equations.”¹⁸⁸ In the book *Between Inner and Outer Space*, John Barrow stresses the significance of exploring the phenomenon of self-organization.

A study of how complex systems organize themselves is currently one of the greatest frontiers of scientific research. It promises to tell us new things about economic systems, ecological balances, weather systems, turbulent liquids, even the working of the human mind.¹⁸⁹

Self-organization is everywhere, from the very small to the very large, from atoms organizing themselves into molecules, to galaxies gathering into clusters. It is happening through total interrelatedness of everything: “trees with climates, people with the environment, societies with each other. We no longer stand alone. Nothing does.”¹⁹⁰ This new understanding is re-enchanting.

¹⁸⁷ Prigogine, 1996: 3.

¹⁸⁸ Capra, 1996: 85.

¹⁸⁹ Barrow, 1999: 15.

¹⁹⁰ Sardar & Abrams, 1999: 84.

Re-Enchanting Dimensions of the Science of Complexity

*We have only begun to invent science that will account
for the evolving emergent order I see out of my window, from a spider weaving her web,
to a coyote crafty on the ridge top, to my friends and me.¹⁹¹
(Stewart Kauffman)*

The science of complexity is still very young, but it already offers an astonishing “opportunity to stand back and consider the global interactions of fundamental units—atoms, elementary particles, genes—to create a synthesis that crosses the border of scientific disciplines, to see a grand vision of nature.”¹⁹² This new grand vision re-enchants the world.

Indeed, the realization that our reality is irreducibly complex, self-organizing, often unpredictable, and intricately interrelated is re-enchantment. Retrieved from an abstract mechanistic spell of simplicity, determinism, and reductionism, the real world of oceans, ecosystems, exploding stars, swirling galaxies, human brains, bacteria, economies, and atoms gradually emerges today as a beautiful butterfly. It emerges along with all its pulsations, nonlinearity, messiness, fuzziness, turbulence, irregularity, novelty, surprise, adaptation, multiple choices, instability, nonpredictability, irreversibility, and creativity. This world until now “slipped through the meshes of the scientific method.”¹⁹³

This new vision re-enchants the human approach to Nature from “domination and control” to “respect, cooperation, and dialogue.”¹⁹⁴ Science of complexity develops

¹⁹¹ Kauffman, 1995: 304.

¹⁹² Barrow, 1999: xxii.

¹⁹³ Alfred North Whitehead, cited in Prigogine, 1996: 189.

¹⁹⁴ Capra, 1996: 193.

“systemic thinking,”¹⁹⁵ the increasing awareness of the total interconnectedness of all systems in the world. This awareness brings forth questions of moral responsibility for actions and of the price to be paid for simplistic and abusive treatment of Nature.

Thinking about the risks of human-made chaotic complexities and about the consequences of creating new, polluting and destroying “butterflies” is definitely re-enchantment.

Swinging away from the mechanistic world, the pendulum of our vision of reality enters the edge of chaos, the magic land of the possible and the unexpected, the twilight zone of interplay between flux and permanence, randomness and structure, “chance and necessity,” “fluctuations and deterministic laws,” “stillness and motion,” “time arrested and time passing,” “being and becoming.”¹⁹⁶ Departing from the static and unchangeable reality toward the dynamic realm of the edge of chaos is re-enchantment because it introduces creativity as an inherent quality of Nature. Writes Prigogine:

We are observing the birth of a science that is no longer limited to idealized and simplified situations but reflects the complexity of the real world, a science that views us and our creativity as part of a fundamental trend present at all levels of Nature.¹⁹⁷

An understanding of “human creativity and innovation as the amplification of laws of nature already present in physics and chemistry”¹⁹⁸ bridges nature and culture, providing conceptual tools “to respect the activity of physicists without having to believe that it is neutral, that is to say, divested of passion, subjected to reality that would be capable of dictating the manner in which it must be unraveled.”¹⁹⁹

¹⁹⁵ Ibid.

¹⁹⁶ These are expressions of Prigogine and Stengers from their book *Order out of Chaos*, 1984.

¹⁹⁷ Prigogine, 1996: 7.

¹⁹⁸ Prigogine, 1996: 71.

¹⁹⁹ Stengers, 1997: 29.

Discovering irreversibility, instability, turbulence, risks, bifurcations, and creativity within the very processes of births or deaths of galaxies and stars is re-enchantment because “it is this instability of trajectories, these bifurcations together with the bifurcations and creative risks in our lives, that are today a source of inspiration to us.”²⁰⁰

At this note, while drawing inspiration from a newborn blue star and recognizing that my own creativity is a part of the universal creativity, I will imagine into existence elements of science education that take steps into re-enchanting dimensions of the science of complexity.

in a dramatic moment
when the unimagined is imagined
a sudden breath of possibility
stops us mid-step
we breath-dance
unexpected journey-landscapes into being
and in the space-moment of dance
recognize absence
embodied in our choreography-geography
on the edge of chaos
and are momentarily awed.²⁰¹

In the meantime, I will make myself a cup of coffee and look around, admiring all complexities of life...

²⁰⁰ Stengers & Prigogine, *The Reenchantment of the World*, in Stengers, 1997: 15.

²⁰¹ Fels, 1999: 32.

The Story of the Self-Organized Lesson: The World Through a Red Filter

A soap opera “Days of the Physical Science in Elementary Schools Course”

There was darkness suddenly interrupted with flashes of light. There was silence, suddenly exploded with loud music. The enchanted kingdom of colours, lights, shadows, rainbows, and sounds welcomes you. This intriguing “hook for attention” began the lesson prepared by the teaching team of five. The purpose of this lesson was an overview of light and sound energy. A humorous “homemade” video connected the topic of the lesson with the complexities of everyday life. Various hands-on experiments were interwoven with arts.

The closing activity was “It’s A Secret” that integrated math, colouring with crayons, science, and...mystery. The assignment was to solve equations written within several patterns of an intricately shaped figure. The colour of the pattern depended on the answer. For instance, if the solution was “one”, the colour would be blue; the answer “two” corresponded to the green pattern and so on. Different solutions to the equations brought about red, orange, purple, blue, pink, and green colours. At the end of the activity, everyone had a patterned figure as colourful as a rainbow. Then a presenting team invited the class to look at the figures through a red filter. Interesting! Green, purple, and blue patterns looked dark. The rest of the patterns magically disappeared.

During the discussion regarding science behind this phenomenon, Tamy suddenly exclaimed: “Hey, the way we see the world depends on how we look at it! All around looks differently through the red filter.” Oh, yes, indeed, through the red filter we see a

different world. Responding to Tamy's thought, I invited the class to explore things in the room and outside through the red filter.

*The lesson self-organized itself in an unexpected direction: **the way we see the world depends on how we look at it.** I did not plan this discussion at all. It just happened. Suddenly popped out of the blue. However, I became attracted to this idea and decided to extend our discussion further.*

If you look through the window of your house, what do you see? You probably see other houses, pedestrians and cars ever hurrying and rushing; you see green trees, colorful flowers, and many other familiar things. Now imagine yourself looking at the same world through the window of an airplane. You will see everything differently. From the sky, houses look like match boxes, people like tiny bugs, cars like little toys, and trees as a uniform green lawn. If you lived on an airplane forever, you would think this is how the world actually looked. Now imagine yourself looking through a window made of a magnifying glass. A previously invisible world of innocent little bugs would become a land of huge, scary monsters.

The way we make sense of the world depends upon our worldview that is a "filter" or "window" through which we look at the world. Looking through the disenchanting filter of mechanistic science, we see the static, simple, cold, emotionless, fragmented collection of universal natural laws, blind forces, mindless particles, and different forms of energy. Through the re-enchanting filter of science of complexity, the world is dynamic, interconnected, self-organizing, ever-emerging, and creative system.

Writes Doll:

The complex movement of the planets, which Ptolemy posited and Nicholas Copernicus simplified by placing the sun, not the earth,

at “the center,” was mechanistic. It is still portrayed that way in school classrooms throughout the country, with their gear and pulley models of the solar system. This leaves out, or bypasses, the issue of the universe as a pulsating, creating, dynamic system.²⁰²

The flush of meaning, born suddenly within me: “This is how I should begin this course next year. Through the activity, “It’s a secret,” I will invite my students to discuss different “filters” or worldviews. What a powerful hands-on way to introduce the concept of re-enchantment and to discuss a worldview afforded by new scientific insights. Later, looking through the reflective journals of my students, prospective teachers, I realized that I was not the only one who found this activity useful.

From Dan’s reflective journal:

The “It’s a Secret” activity (experiment) really captured the spirit of enchanted science, and it integrated mathematics as well. The visual puzzle presented science as a mystery (to be solved). This kind of magical quality of science is often lost in the traditional and dogmatic science. This activity is one that I would use.

To teach science not as a mechanical tool for mastering the world, but as a mystery to be solved...what could be more re-enchanting and more attract/or/ive?

The Chaotic Attract/or/iveness of the Self-Organizing Curriculum and Pedagogy

*If postmodern pedagogy is to emerge,
I predict it will center around the concept of self-organization.²⁰³
(William Doll)*

One speaks of complexity with respect to “strange,” “chaotic,” or “fractal” attractors, writes Isabelle Stengers.²⁰⁴ We can perhaps think about attractors as doors leading the system from a chaotic state to the new higher order. Two main characteristics

²⁰² Doll, 1993: 64.

²⁰³ Doll, 1993: 163.

²⁰⁴ Stengers, 1997: 7.

of attractors produce complex behavior. First, they are very sensitive to initial conditions. Imagine that the world you see behind the door changes depending on the slightest difference in how you step over the threshold or open the door. Second, as fractal objects, attractors have many dimensions, containing infinity of possibilities confined to a finite region. The system endlessly traces the same pattern within many dimensions, and in doing this, unifies order and randomness.

Just as real butterflies like to fly from flower to flower, chaotic butterflies like to fly nonlinearly in the lands far from equilibrium, from one chaotic attractor to another, towards ever-increasing variety and complexity, via the process of self-organization.

*Butterfly, butterfly,
oh where are you butterfly fluttering through the wind?*

Multiple contributors to the book *Learning as Self-Organization*, edited by Karl Pribram and Joseph King, stated that the very nature of learning is the process of self-organization.²⁰⁵ As the flight of a chaotic butterfly goes from one pattern of organization to another, learning occurs within dynamics of a never-ending journey, from one newborn meaning to another. Learning as a non-linear flight of a chaotic butterfly seems to be a reasonable metaphorical definition to me. It reconciles fluidity of information and experiences with ever-evolving and ever-emerging structured patterns of knowing.

According to the science of complexity, self-organizing processes are deeply embedded in nature. If so, nonlinear self-organization appears to provide a more natural basis for learning than artificial linear determinism. Recently, various researchers attempted to conceptualize the dynamic and nonlinear nature of learning and teaching on the basis of

²⁰⁵ Pribram & King, 1996.

theory complexity, advocating a self-organizing curriculum and pedagogy.²⁰⁶ Self-organization is related to:

dancing at the edge of chaos
perturbation
strange fractal chaotic attractors
adaptation
sensitivity to slight changes
ambiguity
nonlinearity
irreversibility
spontaneous emergence
ultimate interconnectedness
the whole more than the sum of parts
transformation
open endedness

As Coveney & Highfield suggest, associative memories provide illustration of self-organizing processes. "Using the language of attractors, such associative memories occur when the basin of attraction for a piece of music is shared with one linked with a lover, perhaps caused by recollections of a passionate embrace enjoyed on the dance floor. The attracting memory state contains a representation of both song and lover."²⁰⁷ My thinking about self-organization in education attracted certain memories, which self-organized themselves into a vivid picture...

A soap opera "Days of the Physical Science in an Elementary Schools Course"

I am in the classroom. It is the last day and actually, the very last moment of the course. I just wished my student teachers all the best and now I am watching them leave the class in silence and disappointment, without even the usual polite "thank you" or "good-bye". It was three years ago, but even today I cannot help but feel a tremendous

²⁰⁶ Cherkes-Julkowski, 1996; Doll, 1993; Davis & Sumara, 1997; Jannone, 1995; Rea, 1997; Rea & Ambrose, 1999; Fels, 1999.

²⁰⁷ Coveney & Highfield, 1995: 167.

guilt and pain. Unfortunately, within the self-organizing progression, my course ended up in a genuinely random state. A new, higher order did not emerge out of this chaos.

This is the trick, write Rea and Ambrose. Applying the theory of complexity to the classroom system you have to be able to create a “responsively complex system” that balances and evolves at the edge of chaos, in the space between “permissively chaotic” and “strictly ordered” systems.²⁰⁸ The challenge is to dance on the illusive rope, without shifting into extremes.

The continuum: chaos, the edge of chaos (complexity), and order can be compared to gaseous, liquid, and solid states of matter, respectively. According to Rea and Ambrose, knowledge from the perspective of complexity is perceived as creative fluidity of understanding versus chaotic spontaneous interest or ordered accumulation of facts and skills. Complex curriculum is co-planned, interdisciplinary, multidimensional versus chaotic, unplanned or versus ordered, preplanned. Motivation is achieved through “serious fun” versus chaotic fun and games or versus ordered serious work. Management style is participatory versus chaotic permissive and ordered authoritarian.²⁰⁹

Davis and Sumara believe that the self-organizing teaching style is “neither totally teacher nor student-oriented but rather is an interactive style that encourages students to converse with each other and the teacher. The traditional distinctions between teachers and students, different disciplines, classrooms and community are blurred and fluid.”²¹⁰

Stadler, Vetter, Haynes, and Kruse propose that self-organizing curriculum and pedagogy

²⁰⁸ Rea & Ambrose, 1999: 1.

²⁰⁹ Ibid: 10.

²¹⁰ Cited in Rea & Ambrose, 1999.

should allow students to learn nonlinearly and to find their own self-organizing rhythms.²¹¹

I thought I understood this all and when designing and instructing my course “Physical Science in Elementary Schools,” I celebrated self-organization. But...after the first year of my teaching this course, I was watching my students leave in disappointment and I knew what was wrong. All my good intentions to create a self-organizing and therefore dynamic, creative, interactive, open-ended, fluid, nonlinear, and cross-disciplinary course never self-organized themselves into a higher order. The chaotic butterfly never emerged from the randomness. “The chaotic classroom tends to be out of control,” write Rea and Ambrose.²¹² That is exactly what happened.

In their anonymous evaluations, students commented that the course was too confusing, too strange, and too disorganized. It embraced too much “other stuff” and too little “real science.” They invited me to come down to earth. They advised me to read the IRP and to follow it closely. They could not afford to be “fancy.” They needed to survive in the harsh surroundings of a real school. They needed to adjust to *the existing* instead of thinking about *the possible*...

CONFUSION

*we are choosing and we are chosen
but it is not always in harmony
and if not,
the entire world looses
its harmonious image
black seems to be white
white seems to be black
all complicated things
seem so simple
and all simple things*

²¹¹ Stadler, Vetter, Haynes & Kruse, 1996.

²¹² Rea & Ambrose, 1999: 4.

*are impossibly complicated
the beauty around me
is unbearably unattractive
the order of things
is absolutely chaotic
and I am so very cold
under the hot sun of summer²¹³*

As an illustration of nonlinearity in the process of thinking, this forgotten poem that I wrote several years ago suddenly popped up. This poem does not seem to have educational relevance; however, *confusion* can be understood as something that pushes a system (me!) out of equilibrium. Such a state, recalling the theory of dissipative structures, is the necessary condition for self-organization. In this light, confusion, perturbation, disturbance are an essential part of the self-organizing process.

Writes Doll:

One requirement is perturbation. A system self-organizes only when there is a perturbation, problem, or disturbance—when the system is unsettled and needs to resettle, to continue functioning. As Piaget says the unsettlement (disequilibrium) “provides the driving force.” However, as we well know from lived experience, not every perturbation leads to the sort of chaos that takes us not to a new or more complex level of order but to an abyss of destruction. The history of our present century has shown us the real potential of this possibility.²¹⁴

“Under what conditions then does perturbation become a positive factor in the self-organization process?” As Doll notes, there is little literature related to this issue and there is nothing in the educational field. He speculates that multiple perspectives and an atmosphere of exploration are a must in order for perturbation to have a positive effect. “Perturbation will trigger self-organization only when the environment is rich enough and open enough to multiple uses, interpretations, and perspectives to come into play.”²¹⁵

²¹³ Laroche, 1997.

²¹⁴ Doll, 1993: 164.

²¹⁵ Ibid: 164.

Under what conditions does confusion and perturbation become a positive rather than a destructive factor? My own thoughts in regard to this issue self-organized themselves around strange chaotic attractors. I believe that my poor success during the first year of teaching the science education course resulted from an undeveloped, undefined, malfunctioning, and “unattractive” chaotic attractor. Perturbation in the form of my invitation to re-enchant our thinking about ourselves, the world, and teaching science did not lead to the desirable transformation. The course was cross-disciplinary and multidimensional in its approaches to teaching science, but unfortunately it never became more than the sum of bits and pieces of ideas.

In the light of this understanding, the self-organizing curriculum and pedagogy has to be attract/or/ive; otherwise, self-organization simply will not occur. In the mechanistic, ordered classroom, there were point attractors in the form of rigid plans and prescribed outcomes. *It is expected that students will!* Life is easier when the certainty of point attractors protects you. Strange chaotic attractors however, have multiple dimensions and are subject to influences of the butterfly effect, and as such, to small perturbations. The trick is to invent an attractor that would be strange enough to attract students, but not so strange it turns them away.

Curriculum, pedagogy, and the teacher need to become chaotic attractors that evoke transformation toward a new higher order of complexity. For this purpose, it is important to create a chaotic butterfly, a pattern that allows the course to have a freedom of expression but yet to be bounded by an overall attract/or/ive idea. During 2nd and 3rd years of teaching the same science education course, I attempted to create such a chaotic butterfly.

Anonymous evaluations of the course from these two years indicated that the chaotic butterfly is not born yet, but a hint of its silhouette is gradually emerging from the midst of playful chaos. I hope the higher order of my understanding will eventually emerge as I approach the bifurcation point through the amplifying feedback loops of my readings, research, conversations, teaching and living experiences, thinking, dreaming, reflecting, and imagining.

... Your re-enchanted approach to physical science has inspired my teaching. The interdisciplinary connections to our emotional connections plus experiences in the physical world make "science" something real. Thank you for helping me to learn to see, appreciate, understand, and feel able to incorporate this approach into my teaching.

...I found all of the "enchantment " of the course very interesting plus exciting (such as outside walks, the poems/stories, drama, etc.) I will definitely incorporate these "enchanting" ideas into my teaching--thank you for this great new ways of teaching plus learning science.

...I really enjoyed the different approach to teaching--enchanting!

*...I enjoyed your class much, especially close to the end. **I sometimes felt frustrated because directions of lessons were unclear. Try introducing concepts plus ideas plus explaining the purpose of activities at the beginning.** This will help your students understand where you are going. Your knowledge of science is so competent. Don't be so nervous!*

*...Great approaches to teaching science. **Need some transitions from standard science to (re) enchanted science.***

*...Very enthusiastic! The multi-media and enchanted aspect was wonderful. **However, to change science education we must bridge tradition and enchantment.***

*...I have enjoyed this class. The instructor presents science in an unorthodox plus exciting manner, which stresses student participation. **I would have preferred more concrete examples/step by step.***

...The reason I chose this specialty was to increase my confidence. Science plus math specifically scared me--including my own practicum. Now, honestly, I am looking forward to teaching science, and can't wait to explain to a principal why. I love it, when in interview I can talk, talk, talk, about a favorite lesson or unit plan. Now, I can do it about science. It is accessible to me.

...Made me look at science in a completely different way. Covered a lot of material and clarified many things for me. Gave me confidence in being creative and how easy it could be.

*... Your knowledge of science is obviously very thorough. I will use a lot of your experiments. I will use some of enchantment techniques in the classroom, but not to the extent that you use it. I find some of the enchantment is merely a good "hook" to start a lesson or unit. **It was a little too much of one style for me.***

*...Very interesting course. **Needs to be a little more organized.** Field trips around campus were great. Many interesting ideas and concepts presented. **Evaluation criteria should be more clearly set.***

...The course was very student-centered and we were given many opportunities to decide how the course should be organized.

*...Overall this class was well-worth taking. **A suggestion, though: organize the class more--it will help you a lot too.** Your ideas are great! Good luck!*

...I would suggest a bit more structure

*...The basic concept of this course show that it has great potential, however, **it must be more organized.***

*...**Please have a more organized course next time and let the students know what is expected from them at the beginning of the course.**...Next time do not allow students to instruct the course., they were too confusing. Link all subject matter to the IRP as that is what is useful for us. You need to communicate your expectations more clearly.*

...What an adventure this course was. It was a science course that brought out the artists in us. I think I leave it more curious than I began.

...Very insight into the different complexities of science! I was tuned in plus interested with all the technology and interpersonal aspects provided which gives me more motivation and enthusiasm for teaching it.

Ahh...all these messages could look more or less like a happy ending, if one neglected a "little" detail that nearly one-third of my students simply remained silent. Also, in the middle of my 3rd year of teaching the course, the majority of the class did not support my nomination for the teaching prize. As the course approached the end, the situation improved dramatically, but...there is definitely something to think about.

From the anonymous course evaluation:

Lyubov, I just wanted to say that I think you do a great job and you put a lot of effort. I really do appreciate it, and I do think you are a great teacher. Honestly, though, I did not sign my name for that teaching award thing. Maybe, I should have. It's just you had things in your course that seems too "spiritual". Being part of the cosmos...I don't know if you know this term, but it seemed quite "new age"--like. I did feel very uncomfortable. I did not want to encourage those things being taught to kids. If you take out the "spiritual" stuff, this enchanted science idea is great.

I wonder, how much "spiritual" is not too spiritual? My course became a "strange" chaotic attractor for some, but not for everyone, and even those who were attracted and transformed, repeatedly and consistently suggested more organization and more step-by-step directions. Balancing at the edge of chaos is a tricky and risky task! That is why the nature of chaotic attractors is a vitally important for the self-organizing processes in education. If the metaphor for complex education is "creative fluidity," there has to be something that attracts the flow; otherwise, the liquid will simply spread around.

Following a fractal arrangement of motifs within motifs within motifs within motifs, the attractor of the course needs to be comprised of mini-attractors within the moment-by-moment, routine class experiences. The lesson with the red filter unexpectedly created a mini-attractor reflecting the overall idea of the course: *looking at science and at the world through a new "filter."* The planned and the unexpected touched each other under the wing of a chaotic butterfly.

The self-organizing progression of the "red filter" lesson started with the big idea or chaotic attractor of the course, which was re-enchantment of science education. The smaller attractor was the assignment for the teaching team to prepare the presentation on light and sound energy. Presenters were bounded by finite requirements: the particular

topic of the lesson, linking this topic to complexities of everyday life, a cross-disciplinary approach, integrating science and art, and creating a fun but yet productive and disciplined learning environment. Within these boundaries, student teachers had complete freedom for self-expression. The lesson self-organized itself into a truly attract/or/ive one. It would perhaps end at this level of complexity if Tamy had not commented on seeing the world differently through the red filter. Her comment caused perturbation and instability. The new idea became a new dimension within the main attractor of the course.

Thinking of the attract/or/iveness of a self-organizing curriculum and pedagogy, I remembered that the dictionary defined *enchantment* as an irresistible attraction to something. This means...the very nature of attractors is enchantment! The strange chaotic attractors like the songs of the Sirens, irresistibly attract the system into a new, more sophisticated order.

Self-organization is a symbol of progress and evolution. However, we need to think carefully what attractors we chose to follow. Those who design curricula and practice pedagogy, writes Doll, need to question the faith “in a metaphysical reality that has separated us from a commitment for ourselves as humans, occupying a planet we did not create and do not yet understand.”²¹⁶ According to Doll, the theory of chaos and complexity provides a conceptual framework for creating a process oriented, transformative, open systems²¹⁷ curriculum, one that embraces the concept of “interconnectedness” and “emergence.” It should be based “on an interactive rather than

²¹⁶ Doll, 1993: 156.

²¹⁷ I described open systems in the footnote on the p. 67.

spectator pedagogy and epistemology” and on an ecological, systemic, interrelated worldview.²¹⁸

*They came in the middle of the night.
People dressed in black leather coats.
They told my father to pack his things and they took him away.
No one could find him since.
He simply disappeared from the face of the earth...*

My mother told me this story about the grandfather I never met...It was the time of Stalin when people vanished without guilt and without trace...The totalitarian political system was highly organized and the so-called communist ideology was a very, very “strange” attractor.

The attract/or/ive curriculum and pedagogy must be selective with what attractors to be enchanted. This thought returns us to the question: how much “spiritual” is not too spiritual? I shall discuss the spiritual issues when taking the step into radical re-enchantment. At this point, however, let us focus on thinking how and if it is possible to teach the science of complexity at an elementary level. In other words, *how much of the complex is not too complex?*

²¹⁸ Doll, 1993: 170.

Science of Complexity in Elementary Schools?

*What can poor mortals say about clouds?
While people describe them, they vanish.²¹⁹
(John Muir)*

*If you drink a soup Monday,
it will rain on your wedding day.²²⁰
(An example of a butterfly effect suggested by a third-grader)*

A soap opera “Days of the Physical Science in Elementary Schools Course”

“...then we asked them to imagine clouds and to describe them,” continued Holly, reflecting on her team’s field teaching assignment in the elementary school. “One little boy literally choked me. During the whole lesson he was unnoticeable, quiet, and insecure. This imagery exercise completely transformed him. He described changing shapes of the clouds so vividly and so poetically. I simply could not believe something like that came from the third-grader.”

The topic of the teams’ lesson was weather. If you limit your lesson to hands-on activities, you will have a conventional science lesson. Teaching re-enchanted science requires a flight of fantasy. Connecting the topic of the science lesson with weather folklore and imagery exercises was a definitely re-enchanting idea:

“Lightning never strikes in the same place twice.” Is it true or false?

“A ring around the sun or moon, brings rain or snow upon you soon.” Have you ever noticed that?

“Red sky at night, sailors delight, red sky in morning, sailors take warning.” This saying is taken from the Bible. The sky becomes red at sunrise and sunset when sunrays shine through high cirrus clouds. Cirrus clouds are an indicator of the approach of a warm front. Since most of our weather moves from west to east, cirrus

²¹⁹ John Muir, cited in Dillard, 1999: 63.

²²⁰ From the teaching team’s field lesson in the elementary school.

clouds in the west are the first sign of an oncoming warm front—probably arriving in 24 to 36 hours.

Why just probably, but not for certain?

Because the weather is never completely predictable! Too many different conditions influence it. A butterfly effect!

A butterfly effect through the eyes of third-graders:

Raining and pouring its' most likely to be boring...

If you balance a spoon, there will be a typhoon...

If dogs are drooling it's a clear day in the morning...²²¹

Observing or imagining running clouds and then describing their intricate, ever changing shapes; connecting human complex endeavors with natural complexities through folklore; emphasizing the inherent unpredictability of weather; and even discussing a butterfly effect-- this lesson seemed to be in touch with the very essence of the science of complexity. Was it too complex for elementary kids? There are infinite dimensions for research within a fractal chaotic attractor of questions: *When and how can we start to introduce the concepts of complexity? At what level and through what scientific activities could young children grasp this phenomenon?*

In the meantime, take your class to the river or creek and observe whirlpools and vortices spontaneously emerging and disappearing in the running water. Allow the students to admire (scientifically) the intricate beauty of a butterfly, the complex shape of a snowflake, or the amazing interconnectedness of ecosystems and social systems. Demonstrate the chemical clock as an example of the spontaneous emergence of order or conduct an experiment with a layer of water between hot and cold plates.

²²¹ Courtesy of the teaching team from my science education course.

Kauffman²²² describes sand piles as an example of self-organizing systems: an avalanche on the pile of sand provides a paradigm for how complexity can emerge. Take the class to the beach or playground and let children to play with sand piles. When a sand pile grows, its slope becomes steeper. When it reaches the so-called critical threshold, or far-from-equilibrium state, adding more sand causes surface grains to slide off, leaving the slope unchanged. Regardless of whether the pile starts out too steep or too shallow, it always ends up at this critical state, where sand piles self-organize themselves into a certain structure.

Even traditional experiments, such as growing crystals or watching something rust, can speak on behalf of complexity. Rust is more than just combined oxygen and iron; it has new qualities, different from initial reagents. In chemical reactions, the products are more than the sum of reagents. This is also true for human societies, as well as for the dynamic, evolving, violent universe as a whole. Tell your students an emerging universal story written by the new science of complexity.

I envision a *complex* science curriculum as a slime mold, which is a favorite Prigogine's example of self-organization. The slime mold is something between a collection of single cells and an organism. When there is enough food, separated cells act as solitary wanderers, completely ignoring each other. However, when food disappears, the state far-from-equilibrium is reached. Under stressful circumstances, cells "notice" each other and organize themselves into a single organism, a multi-celled "slug," with a head and a tail.

Just as a slime mold self-assembles from separate cells into a whole organism, *complex* science curriculum self-organizes itself through interacting with other subjects.

²²² Kaufman, 1995.

Since the science of complexity reveals the interconnectedness of all systems and variables, the science curriculum consequently must be cross-disciplinary, diverse, and extend into the communities and natural world. In this light, field trips, museums, community and ecological projects, and other informal activities have great value for the self-organizing science curriculum.²²³

Writes Isabelle Stengers:

This is a lesson of wisdom that is important to underscore. Today, the so-called exact sciences need to get out of the laboratories where they have little by little learned the need to resist the fascination of a quest for the general truth of nature. They now know that idealized situations will not give them a universal key; therefore, they must finally become again “sciences of nature,” confronted by manifold richness that they have so long given themselves the right to forget.²²⁴

You can extend the walls of your classroom by getting out into the world or by bringing the world into the classroom through the dramatic play. Imagine you are visiting a harbour...

The moment, like a harbour at low tide, sea-smells or curricular opportunities for exploration. Why has the local fish processing plant has been closed? What happened to the vanished schools of cod? What life lives beneath the sea? How do barnacles, seaweed, mussels attach to the foreign presence of human construction? What impact does human construction have on the ecology and economies of a bay? What new animal surfaces in the rebirthing of technology and biology? Within whose science, economics, employment, environment, context, experience does this moment happen?²²⁵

“Stop,” invites Lynn Fels: “...understand that curriculum does not and cannot exist apart of the world.”²²⁶ Become. Look at the world through the re-enchanting filter

²²³ From my consulting project with BC Science Council, I realized that increasing attention is paid worldwide to informal sources of science learning since they provide connections with the real world. (In Laroche, 2000b).

²²⁴ Stengers, 1997: 46.

²²⁵ Fels, 1999: 155.

²²⁶ Ibid: 160.

of complexity! Admire unpredictability, interconnectedness, dynamism, self-organization, and the novelty in Nature. Be fascinated with her ability to dance at the edge of chaos and remember that human creativity is an extension of Nature's creativity.

*Do we dance curriculum into
being on the edge of chaos?*²²⁷

The edge of chaos is the illusive ground where *the expected* and *the unpredictable* meet. Acceptance of *the unpredictable* as an inherent quality in the world provides a conceptual comfort for recognizing a "vague" narrative way of knowing as the scientific.²²⁸ In the light of this understanding, the new science curriculum is not only about exploring the world, but also about a dialogue with it.

Says Illia Prigogine:

I have always considered science to be a dialogue with nature.
As in real dialogue, the answers are often unexpected—and
sometimes astonishing.²²⁹

Only through dialogue can science education emerge as open-ended, relevant, contextual, interesting, and as such, re-enchanted. Only within a dialogue is it possible to grasp the concept of complexity. Only dialogue can make self-organizing science curriculum and pedagogy attract/or/ive, and as such, transformative for students. I just finished a consulting project for the Science Council of British Columbia, where I analyzed a large body of the most recent literature related to students' attitudes toward science.²³⁰ The literature pointed out that science continues to be one of the least liked school subjects and that children's interest in science declines over the school years,

²²⁷ Ibid: 160.

²²⁸ Doll, 1993.

²²⁹ Prigogine, 1997: 57.

²³⁰ Laroche, 2000 (b).

starting from the elementary level. There is a definite indication that students are disenchanted with unattractive point attractors of mechanistic school science. This means, there is a need for re-enchanting dialogue, and the science of complexity provides a framework for that. In my opinion, though, the science of complexity is rather a modest re-enchantment. Why do I think so?

Listen, if someone lights up the stars,

*this means, someone needs it!*²³¹

The Weakness of Complex Systemic Re-Enchantment

*in the classroom-complex system
the teacher-complex system
teaches children-complex systems
about complex systems*

*“The child as a self-organizing system: The case against instruction as we know it.”*²³² This is the title of the recent article on educational applications of complexity. It is like a gift for me because it illustrates perfectly my statement regarding the weakness of complexity’s re-enchanting power. Under mechanistic education the child is a unit, an “it”, an object for manipulation. Under the “complex” education, the child is a self-organizing dissipative system...

I wish to express my solidarity with the poet from the film *Mindwalk* who became tired of perceiving himself as a system.²³³ I am not flattered myself to be referred to as a system, even if I am a chaotic, complex, dissipative, interconnected, self-regulating, and self-organizing one. I see a resemblance between mechanistic *objects* and *complex*

²³¹ From the remembered poem of Vladimir Mayakovsky, a Russian poet.

²³² Cherkes-Julkowski, 1996.

²³³ Mindwalk, the video produced by Fritjof Capra.

systems because there is something mechanistic in the word *system*. For me, systems can be open or isolated, adiabatic or isothermal, simple or complex, but in no way can I imagine *feeling* systems, *crying* systems, *laughing* systems... In other words, systems and life do not seem to make a comfortable match. I cannot imagine the system that is “I”, or “we”, or “she”, or “he”. The system is “it”.

Together, chaos and complexity theories are often referred to as dynamical systems theory. As Capra writes, this theory promotes *interconnecting systemic*, versus *fragmenting mechanistic* thinking.²³⁴ This switch is quite significant for the development of our new ecologically centered relationships with the world. However, I agree with Ken Wilber who understands systemic thinking as a subtle mechanicism, a flatland of interwoven “its”:

....a system theory, that included nothing but “its”, nothing but objective processes scurrying through information loops, or gravity acting at a distance on objects, or chemical interactions of atomic events, or objective systems interacting with other objective systems, or cybernetic feedback loops, or digital bits running through neuronal circuits. Nowhere in systems theory (or flatland holism) could you find anything resembling beauty, poetry, value, desire, love, honor, compassion, charity, God or Goddess, Eros or Agape, moral wisdom, or artistic expression. In other words, all you found was a holistic system of interwoven its.²³⁵

In fairness, chaos and complexity reanimated creativity in Nature, but the “complex” creativity has a somewhat mechanical taste. This creativity springs from the mechanistic feedback loops that occasionally go awry, pushing the system to jump toward a different chaotic attractor and therefore toward novelty. From the perspective of complexity, there is neither purpose nor pleasure for Nature to create anything; only mindless countless feedback loops. Sounds disenchanting, doesn't it?

²³⁴ Capra, 1996.

²³⁵ Wilber, 1998.

Even the most amazing property of complexity such as self-organization that results from simultaneous coordinated collaborative behaviour of huge number of particles is understood quite mechanically: "...there is no mystery to it, this complex behaviour can be modeled in the heart of a computer, using nonlinear equations of fluid dynamic."²³⁶ No mystery? Is it really?

Let me ask then: *How do particles manage to be interconnected? How do they know how to communicate? Who taught them nonlinear equations of fluid dynamic?*

Another question: *What if a child is not a system, but the World?*

With these questions in mind,

we will take next step

into a deeper re-enchantment

of the holonomic paradigm.

²³⁶ Coveney & Highfield, 1995: 156.

CIRCLET 2

A HOLONOMIC PARADIGM AS A STEP INTO
DEEPER
RE-ENCHANTMENT

*Ok, we're lousy snowflakes.
Ok, we're the trees...²³⁷*

²³⁷ Dillard, 1999: 199.

How Do They Know?

Writes Laszlo:

Given the ordered complexity that meets our eye, the reasonable assumption is that, somehow, preferential interconnections must exist in nature. If so, there must be some factors in the universe that interconnect (and therewith nondeterministically correlates) the evolving systems. Finding this factor is not a simple matter.²³⁸

In our previous nonlinear chaotic step into re-enchantment, we left the world as an ever becoming, creative, adaptive, and self-organizing complex system comprised of self-organizing complex systems all the way down. The magical process of self-organization is understood by the science of complexity in terms of open systems, random fluctuations, nonlinearity, and multiple feedback loops. Computer simulations indicated that the order-generating process occurred spontaneously if the system was interconnected throughout its totality. It appears that all components of the self-organizing system have ability to correlate and communicate with each other. The question is,

How do they know how?

Applying this question to universal evolution, Laszlo suggests that it would not occur in a fragmented and random manner. As a necessary condition of evolution, along with the diversifying process or divergence in spacetime, there has to be a unifying process or convergence within a higher-order system. "Without the latter property the universe would be populated with nothing more interesting than an array of chaotically

²³⁸ Laszlo, 1995: 4.

varied and mutually uncoordinated particles, randomly colliding in hydrogen and helium gases.”²³⁹

The interconnected world of complexity left us to wonder...What is this crazy glue that interconnects? What is this amazing realm that orchestrates universal processes into coherence and correlation? The total interconnectedness in space and time would not be possible if all universal information was not preserved and stored somewhere and somehow. Imagine the grandiose capacity this storage utility must have!

Laszlo writes that gravitational, electromagnetic, and strong and weak nuclear fields cannot account for the total universal interconnectedness. That is why there is the possibility that an unknown “fifth universal field” exists in nature. A good candidate for this field is the medium likely functioning in a holographic mode. Why holographic? To understand this, we should begin where everything started.

Everything Started from Quantum Kangaroos

Everything started from the strange phenomena described in 1900 by Max Plank. Of course, perhaps this is not how everything really started. Maybe it started from the shimmering light of a vanishing star, or from the song of the spring wind, or from someone's dream, or from something else, but it materialized as a paper about the results of experiments on the distribution of radiant energy from a hot object. This event manifested the birth of quantum physics and, as a result, the beginning of a new epoch in the development of human civilization. Since quantum physics was born, the world has

²³⁹ Laszlo, 1995: 5.

changed. "Straight lines have become curved, the atom is no longer a physical matter, and, some say, science and literature have exchanged places..."²⁴⁰

Plank's experiments repeatedly indicated that energy from a heated object propagated in the form of packets of energy or "quanta." It jumped! It freely violated Newton's law of continuous movement, which says that no object will alternate its path without some external cause. Strangely, there was no apparent cause or reason for energy to "jump." It jumped just because! It moved discontinuously! This innocent custom of quantum micro-kangaroos to jump without any apparent cause had a very serious consequence: "As discontinuity marched into the world of phenomena through one door, causality walked out through another."²⁴¹

What does the term "discontinuous" mean? It means that if you climb stairs, you can be on either the first, second, or third stair, but not in between. Even if you try very hard, there is no way you will be able to stand on 1.8 stair. The movement of a train is continuous, the jumps of kangaroos are not. In 1913, Niels Bohr applied the principle of discontinuity to atomic electrons, proposing that electrons can be "quantized" as well. They can orbit around their nucleus at certain discrete energy levels without losing energy. When electrons jump between levels, they absorb or emit a packet of energy, a photon.

Once born, the concept of discontinuity "continued" its march. In 1915, Einstein explained photoelectric effect as the replacement of electrons from the surface of metals by particles of light, named "photons." It was quite a bizarre statement, contradicting the well-established fact that light propagates as continuous waves of electromagnetic

²⁴⁰ Maffet, 1991.

²⁴¹ Jeans, cited in Trusty, 1991: 31.

energy. The principle of discontinuity resulted in the strange and confusing conclusion that light could be both particles and waves, depending on the experimental context. It contradicted the logic of classic physics and commonsense: if you are a particle, you are supposed to be a particle, and if you are a wave, you had better be a wave. You must make up your mind what you actually want to be, because you can be only “either/or.” However, “objective” experimental data clearly indicated that light was not going to make up its mind. Light felt quite comfortable with having a dual personality, being both waves and particles.

Further experiments led to the idea that electrons and other subatomic particles can also behave as waves and as particles. In 1927, Bohr proposed the principle of wave-particle complementarity, according to which nature can exhibit both wave and particle properties, but not simultaneously. These properties complement each other. The principle of complementarity manifested the departure from the dualistic “either/or” logic toward the more holistic “both/and.”²⁴²

DUAL PERSONALITY

*Particles have a dual personality.
They can be both particles and waves,
depending how you look at them.
Why such mysterious, enigmatic behavior?
Could it be because they have a hard micro-life?*

²⁴². Mashadi & Woolnough, 1997.

Drawing upon work of Bowes and Macrone, the authors described the dual-valued “either/or” logic of Western intellectual tradition as based on Aristotle's laws of thought: the Law of Identity, the Law of Non-Contradiction, and the Law of Excluded Middle. The A must be either A or not-A, nothing in the middle. This logic seems to be in agreement with our common sense; however digging deeper into the meanings of “is” and “is not” may result in semantic difficulties. For instance, a statement “a daffodil is either yellow or not” is not as simple as it seems to be: what does it mean to be “yellow”?

The principle of complementarity undermined the very essence of the analytical reductionist approach to knowledge. Understanding grew that reducing phenomena into manageable parts does not ensure an adequate understanding of the whole.

A profound consequence of Bohr's ideas is that the traditional Western concept of the relationship between macro and micro, the whole and the parts, is radically altered. Bohr claimed that before you can make sense of what an electron is doing, you have to specify the total experimental context; say what you are going to measure, how your apparatus is organized and so on. So, the quantum reality of the microworld is inextricably entangled with the organization of the macroworld. In other words, the part has no meaning except in relation to the whole.²⁴³

These chameleon-like particle-waves represent “a single category of something that are always somehow both. These *somethings* are called *quanta*, and physicists believe that they are the basic stuff from which the entire universe is made of. Quanta are the plural of quantum. One electron is quantum. Several are a group of quanta.”²⁴⁴ Quanta are both particles and waves, but they are also more than just particles plus waves. They are something different. They represent a new order of complexity. The whole is more than the sum of its parts. Recognition that the part cannot be completely understood without its whole became a basic principle for systemic thinking. To move deeper into re-enchanting dimensions, we have to move deeper into the strange quantum world.

²⁴³ Davies & Brown, 1986.

²⁴⁴ Talbot, 1991: 34.

A Pendulum Swings into the Magic of Holographs

The holograph suggests a new kind of knowledge and new understanding of the universe, in which information about the whole is enfolded in each part and in which the various objects of the world result from the unfolding of this information.²⁴⁵

(David Bohm)

As all roads lead to Rome, all paths of re-enchantment start from quantum mechanics. Further quantum experiments resulted in shocking conclusions. These enigmatic particles behaved as particles only when being observed. What goes on between observations is pure mystery!

What an enigma these particles are...

As physicist Nick Herbert writes, when an atom is being observed, it behaves as a little particle with definite attributes such as size, mass, position, momentum, or spin. It pretends to be a good old tiny building block of classical physics. If the physicist looks away for a moment and then observes the atom for a second time, it again displays the good typical behavior of a definite tiny object. However, the physicist is shocked! He or she expected to see the electron in a specific place, which should be easily predicted with the help of the mathematical laws of movement. Surprise, surprise! The electron was in an absolutely different location than expected!²⁴⁶

There is no way to predict a second observation with any certainty. We can calculate only the probability of the whereabouts of the atom. When unobserved, the atom-chameleon changes its identity from a tiny object into strange waves of probabilities, which means that an atom is not located in one place, but is positioned in

²⁴⁵ From the David Bohm's chapter *Postmodern Science and a Postmodern World* in Griffin, 1988.

²⁴⁶ Talbot, 1991.

many possible places at the same time. It is everywhere and nowhere simultaneously and therefore it cannot be a material object with certain coordinates.

For a deeper understanding of this phenomenon, let's conduct the scientific thought experiment suggested by physicist Michael Talbot in his book *A Holographic Universe*.²⁴⁷ Imagine yourself rolling a bowling ball. Before it is rolled, sprinkle talcum powder all over the bowling alley. After starting to roll this quantum bowling ball, turn away without observing it for several seconds. Then look at the ball again and note its trajectory on the talcum. What kind of track on the talcum powder would you expect to see? Using your commonsense, you expect to see a single line. However, this is not what happens in the mysterious quantum world. The quantum ball, as would any self-respecting hard bowling ball, traced a line on the talcum when being observed. When you blinked for a second, the atom stopped tracing a line and instead left a broad wavy strip, like the undulating swath of a desert snake as it moves sideways over the sand.²⁴⁸ When not being observed, atoms behave as a strange wave of probability; however, when being observed, they quit their mysterious and fuzzy dance and “freeze” into tiny objects with definite attributes.

Between observations, “the world exists not as a solid actuality, but only as shimmering waves of possibility.”²⁴⁹ Nick Herbert has the uneasy impression that behind his back, the world behaves as “a radically ambiguous and ceaselessly flowing quantum soup.”²⁵⁰ It seems that the act of observation actualizes a single quantum possibility, whereas all others vanish, or collapse. The possibility, which has been singled out, jumps

²⁴⁷ Talbot, 199.

²⁴⁸ Ibid: 34.

²⁴⁹ Herbert, 1993.

²⁵⁰ Ibid.

into existence. Such phenomenon is called a *quantum jump* or *quantum leap*. This is the magic of the famous *quantum observer* effect:

The observer effect is a sudden change in a physical property of matter--particularly at the atomic and subatomic level--when that property is observed. This is measured by the change in the probability of observing that property. When it occurs, something that was possible suddenly jumps and becomes actual. It is ascribed to the actions of consciousness upon material objects.²⁵¹

Could it mean that we observe our world into existence?

This is a mystery! Our common sense tells us that something can be here or not here. There is no middle way: either/or. But this is not true in a cunning quantum world. It appears that without our perception, the world exists in a strange state that quantum physicists calls *superimposed*. In this state, the endless possibilities of our world exist and at the same time do not exist. They are about to happen. "The effect of perception, however, is immediate and dramatic. All of the wave function collapses, except one part, which actualizes into reality."²⁵²

The most fundamental unsolved mystery in quantum theory, writes Nick Herbert, is the nature of this quantum jump. Is it something that physically occurs in the atom itself, or is it just some kind of a product of the scientist's mind, a sudden increase in knowledge gained by observation?

*... behind the theorist's tools and the experimentalist's results, what is the atom actually doing when we look at it and when we don't?*²⁵³

However, let's assume that we are very polite people and we never turn our back or even blink on the tiniest and most unpretentious particles. We observe them constantly

²⁵¹ Wolf, 1991: 18.

²⁵² Zukav, 1979: 34.

²⁵³ Herbert, 1993: 139.

without interruption. The strange phenomenon is that we still will not know everything about these enigmatic entities.

Physicist Heisenberg was puzzled. Something did not make sense. It was as clear as daylight: if you know the initial position of the object and its momentum (mass, speed, and direction of movement), you can easily calculate and thus predict the whereabouts of the object at any time. This was established by classic mechanistic physics a long time ago. Why then was Heisenberg unable to calculate something as simple as the trajectory of an electron in a bubble chamber?

The problem is that an electron is so tiny, it cannot be seen in the usual visible light: the wavelength of this light is too long and its energy is too low. In order to illuminate the electron, you need to use gamma rays with a shorter wavelength and higher energy. However, the energy of the “gamma light” is high enough to “knock” the electron, changing the momentum of its movement in an unpredictable manner. This is why it is impossible to know the position of an electron and its momentum simultaneously. It is not the matter of an instrument's efficiency, but something inherent to the atomic world. By measuring one property (position) of an electron, we change the other (momentum) and vice versa. The exact knowledge of one variable can exclude the exact knowledge of another. This is the essence of Heisenberg's famous uncertainty principle, according to which there is always an element of ambiguity and randomness in the micro-world, which you simply cannot avoid.

This principle lies at the very heart of quantum theory. Not only did it give basis to quantum mathematical formalism, it radically influenced scientists' view of reality in general and of scientific knowledge in particular. According to the most accepted

Copenhagen interpretation of quantum theory,²⁵⁴ Heisenberg's uncertainty principle

indicates that:

1. Our observations alternate the world unpredictably by the very act of measurement. This means that the observer and the observed are inseparable. We cannot study external reality "out there" objectively and independently of our participation. As a consequence, there is no such thing as "objective," "detached" knowledge. There is always an element of "humanness" in any most "objective" and most detached measurement or interpretation of the world, which we simply cannot escape.

*you were objective in your thoughts
but you did not know
that the Desert creates objective illusions
it shows water where is not
and then changes
the existence of water around
one may say,
that the person seeing the mirage
is not suffering from madness
but from a strange objectivity
he is standing between
the equipment of nature
and organic apparatus of the eye
the two are joined together to create
the illusion of his intention²⁵⁵*

2. We cannot apply the laws of mechanistic science to an individual particle; and therefore we cannot predict the outcome of any single event. You cannot foresee where the particle will go after you have observed it. It looks like the particle independently makes its own decision where to go. You also cannot predict which individual atom will split spontaneously when radioactive substance disintegrates.

Could it mean that particles have free will?

Could it mean our world is inherently irrational, indeterminable, and unpredictable?

WIND AND LEAVES

*O leaves, ask the wind
which of you will be the first to fall off.²⁵⁶*

²⁵⁴ Davies & Brown, 1986.

²⁵⁵ Ahsen cited in Drake, 1995: 50.

²⁵⁶ Soseki, in Burns, 1990.

3. Rational and distinct knowledge has limits. Scientific knowledge can be “fuzzy” and ambiguous. It is recognized that all scientific concepts are limited and approximate. Science can never provide any complete and definitive understanding.²⁵⁷
4. The way we see the world depends on how we organize the experiment. If we wish to measure the momentum of a particle, we organize our experiment accordingly, and if we decided to measure the position of a particle, we will do it through different experimental settings. “What we observe,” writes Heisenberg, “is not nature itself, but nature exposed to our method of questioning.”²⁵⁸

Interpretations of Bohr's principle of complementarity and Heisenberg's uncertainty principle, made scientists realize that we are perhaps not the “objective” nuts and bolts of the Perfect Machine which exists “out there,” independently of us. On the contrary, we are to some degree creators of our own reality. Such a realization shocked many previously “objective” scientists:

I had come to suspect, and now felt compelled to acknowledge, that science and the physical world were products of human imaging--that we were not cool observers of that world, but its passionate creators. We were all poets and the world was our metaphor.²⁵⁹

There are several quantum-mechanical visions of up-to-date reality; however, what has become increasingly clear is that our world is not as objective, mechanistic, solid, firm, predictable, and certain as it was once thought to be. Famous pioneering scientists Albert Einstein, Werner Heisenberg, Erwing Shrodinger, Max Plank, and Wolfgang Pauli “were united in the belief that the universe simply does not make sense--and cannot satisfactorily be explained--without the inclusion, in some profound way, of consciousness itself.”²⁶⁰ British philosopher, Sir James Jeans, exclaimed once: “The Universe begins to look more like a great thought than a machine.”²⁶¹

²⁵⁷ Capra, 1996: 41.

²⁵⁸ Cited in Zukav, 1979: 114.

²⁵⁹ Johnes, 1982: 3.

²⁶⁰ Wilber, 1998: 2.

²⁶¹ Ibid.

Following the prominent quantum physicist Von Neumann, Nick Herbert proposed the quantum animism hypothesis: “far apart from being a rare occurrence in complex biological or computational systems, mind is a fundamental process in its own right, as widespread and deeply embedded in nature as light or electricity.”²⁶² Three principles of quantum theory: quantum randomness, quantum thinglessness, and quantum inseparability give a hint that our reality at its deepest level is more mind-like than matter-like. “These features are the external signs of three basic features of mind: free will, essential ambiguity, and deep psychic connectedness.”²⁶³

Quantum thinglessness is the property (if it can be called a property) of reality to exist and at the same time not to exist. At a deep subatomic level, our world does not appear to be material; it exists in the form of superimposed potentialities. Only ideas in our consciousness can exist in such potential form.

Quantum randomness is the manifestation of Heisenberg's uncertainty principle. The unpredictability of the behavior of a single particle might be an indication that particles perhaps have free will and are capable of making some choices. “To conceptualize quantum randomness is to say that the causes, if any, of atomic behavior do not lie in the physical world. No amount of physical examination will ever allow us to predict exactly what an atom will do next. Therefore, the ultimate cause of material phenomena is not material at all but stems from an essentially mental realm.”²⁶⁴

Quantum inseparability or the *quantum nonlocality principle* or *cosmic crazy glue* appears to be pure magic. What does *nonlocality* mean? In classic physics all interactions are local. This means that two things separated in spacetime can interact only through

²⁶² Hebert, 1993: 3.

²⁶³ Ibid.

²⁶⁴ Ibid: 67.

some kind of force or field, and the speed of this interaction cannot exceed the speed of light. In the case of nonlocal interactions, two separate objects interact instantly with supraliminal speed.²⁶⁵

Amazingly, the mathematics of quantum theory, particularly Bell's theorem, leads to a strange conclusion that if two quantum entities once interacted, they become a single unity even after separation. They continue to communicate instantly without any mediating fields, without any apparent cause for their interactions. Nothing can shield quantum connection; time or distance does not affect it. It has the "same strength at a million miles as at a millimeter."²⁶⁶

Until recently, quantum inseparability or nonlocality existed only as the mathematical expression of quantum theory. In 1982, French physicist Alan Aspect and his group supported this phenomenon experimentally. In his experiment "two particles were separated by more than ten meters. Yet independent measurements performed on them indicated that some form of connection had to exist between them, even though there was no material force connecting them."²⁶⁷ Such connections between particles resemble the mind's psychic telepathic connections. "Since all particles," observes physicist Paul Davis, "are continually interacting and separating, the nonlocal aspect of quantum systems is therefore a general property of the universe."²⁶⁸

*ELECTRON'S TELEPATHY*²⁶⁹

*Electrons (like everybody else) prefer to exist in pairs.
In order to survive each other without unnecessary tension,*

²⁶⁵ Greater than speed of light.

²⁶⁶ Herbert, 1993.

²⁶⁷ Wolf, 1991: 37.

²⁶⁸ In Talbot, 1993: 53.

²⁶⁹ Inspired by Zukov's (1979) description of the Bell theorem.

*electron partners usually spin around themselves in different directions.
When one of the partners spins left, the other spins right, and vice versa.*

Very simple!

*But...if a pair of electrons is separated in the lab by means of a strong
magnetic field, (against their desire)
a strange phenomenon occurs.*

Even separated by distance, the partners continue to "feel" each other.

*If one of the partners is forced to change the direction of its spinning,
the other simultaneously and voluntarily changes its' spin too!*

*It is doubtful that electrons use the telephone to call each other,
saying something like: "Hey, partner, how are you on your own?"*

*These people made me change my spin from left to right,
so hurry up, change yours!"*

*Its also doubtful that electrons signal each other by "shouting"
or by "waving their hands."*

How then do they know about each other's affairs?

How then do they know so instantly?

Before quantum theory came up with the nonlocality phenomena, it existed only in magic, fairy tales, or anecdotal experiences of telepathy. "The only place that nonlocal forces played a role (before quantum theory) was in voodoo, whose practitioners believed that the action on a person's separated part (hair) can affect the whole person."²⁷⁰

hey, do you sense the real re-enchantment here?

Portraying reality as non-mechanistic, quantum theory invites us to get away from the dangerous and rusty Perfect Machine.

DANGER!

*Everyone should urgently jump out
of the Universe-Machine before it reaches a dead end!*

Easy to say, "jump!" We have gotten used to living in the mechanistic universe! We lived here for several centuries! The good news, however, is that now we have choices. Why don't we browse through some advertisements from scientists to see if we can find a wonderful universe to move into.

²⁷⁰ Herbert, 1993.

A huge "Hilbert" space for rent!

*Infinite number of dimensions is available. All quantum possibilities are accommodated.
You must use your consciousness in order to bring the world into existence.
Without participation of consciousness, this world will
remain in a state of pure possibilities.*

According to the Copenhagen Interpretation of quantum experiments²⁷¹ and Von Neumann's extension of this interpretation,²⁷² our reality exists in a thought-like form of superimposed possibilities (probability waves). Until it is observed, it "hesitates forever on the brink of actuality." Compared to the actual world--the old-fashioned, definite "yes" or "no" world of classical physics--the quantum world resembles a fairy-tale land built solely of ambiguous "maybes."²⁷³ This world is quite bizarre, it is thought or spoken into existence by consciousness that performs some kind of measurement or choice. According to Von Neumann, numerous centers of consciousness are spread all over material world.

***A very eclectic "Multiverse"
created from many parallel worlds!***

*A variety of choices!
Between-world traveling through the wormholes!
Read physicist Everett for details*

If you like science fiction, you can chose a multiverse, which is comprised from an infinite number of parallel worlds-spaghetti.²⁷⁴ In such a universe, none of the possibilities collapse, they all actualize in parallel universes. For instance, when you are confronted with a hard choice, either to work tonight or go to a bar, the universe splits into two sub-universes: in the first universe, you work, and in the second one, you go to

²⁷¹ Herbert, 1993.

²⁷² Ibid.

²⁷³ Ibid: 156.

²⁷⁴ The universe of Everett as described in Talbot, 1991 and in Davies & Brown, 1986.

the bar. The rules of a multiuniverse are democratic: all possibilities and choices have an equal chance.

Move into a giant "Hologram"!

Do you feel lonely being fragmented from the rest of the world? If so, this universe is for you because here you are united into an unbroken wholeness with the rest of the world. Do you have a low self-esteem? If so, this universe is for you because here you are a Cosmos! For details please read physicists Bohm, Wolf, Talbot, Pitt, Laszlo, biologist Sheldrake, and psychologists Pribram, Pierce, Grof, Ahsen, Wade.²⁷⁵

Two of the most prominent contemporary scientists, physicist and philosopher David Bohm and neuropsychologist Karl Pribram, independently arrived at the idea that our universe is perhaps a huge hologram. Since then, this model has been increasingly supported by research in different scientific fields.²⁷⁶ I, too, wish to move into the holographic world. It seems so interesting and cozy. Would you like to visit with me the magical holographic reality?²⁷⁷

Holograms, indeed, have truly fascinating and magical properties. They are three-dimensional photographs (or holographs) that appear real and convincing, just as usual material subjects, but if you try to touch a holographic image, your hand will simply pass through. Holographs are produced when a laser beam is split into two separate beams. The first beam is bounced off the object to be photographed. The second beam is allowed to collide with the reflected light of the first. When this happens they create seemingly chaotic, circular interference patterns, which are then recorded on a piece of film.

²⁷⁵ The work of all these authors is listed in the bibliography section of this manuscript.

²⁷⁶ Talbot, 1993.

²⁷⁷ I use the word "reality" not as something which is really "real," but as our vision of what "reality" might be.

When another laser beam shines through these holographic interference patterns, the three-dimensional image of the original object appears.

The most amazing property of holograms is that each, even the tiniest fragment of the holographic film, contains the entire image of the photographed object. The smaller the piece of the film, the “fuzzier” the image, but it is still an image of the whole. In other words, each part of the hologram contains all the information of the whole. In this sense, the hologram is not comprised of any parts; it is an undivided, *unbroken wholeness*.²⁷⁸ The very essence of a holographic principle therefore is “*all in all*.”

For David Bohm, the quantum nonlocality principle, this cosmic crazy glue, provided a strong indication that our reality is perhaps holographic. Particles are able to communicate instantaneously because they are not separate entities, but manifestations of a singular undivided reality, a holographic “oneness”.

In the book *Wholeness and the Implicate Order*, Bohm speculates that our physical world is an *explicate* or *unfolded* holographic image of a deeper, single, and vast nonmaterial reality, which he calls hidden, *implicate* or *enfolded* order.²⁷⁹ This deeper order is an unimaginable level beyond spacetime that comprises all that ever took place and ever will. There are no parts or fragments in a holographic world, and there is no sharp division between mind and matter. Up, up to the galaxies, down, down to the mysteries of atomic and subatomic lands, and here, in between, in this beautiful, phenomenal world, all entities are just a variety of appearances of a deeper implicate order, which might well be pure consciousness. Bohm’s holographic vision leads to a radical re-conceptualization of reality.

²⁷⁸ The term coined by David Bohm.

²⁷⁹ Bohm, 1973. He uses the word “order” not as an indication of a rigid structure, but as a design of the world. For instance, the ancient order of the world was the earth in the center of the universe.

In his general theory of relativity Einstein astounded the world when he said that space and time are not separate entities, but are smoothly linked and part of a larger whole he called the space-time continuum. Bohm takes this idea a giant step further. He says that everything in the universe is part of a continuum. Despite the apparent separateness of things at the explicate level, everything is a seamless extension of everything else, and ultimately even the implicate and explicate orders blend into each other.²⁸⁰

The holographic reality is not static. As the waves in the ocean, it constantly *enfolds* into an explicate order and then *unfolds* back into a deeper order, through the ongoing process of *holomovement*. Two orders “communicate” with each other on a quantum level at the thin borderline between the implicate and the explicate, through the tiny messengers, quanta, that exist comfortably both as material and wave-like entities.

Laszlo believes that Bohm’s model is fundamentally compatible with the contemporary quantum-vacuum interaction (QVI) concept, according to which the deeper implicate order is “made of” a quantum informational holographically unified field (holofield). The only difference is that the quantum holofield constantly evolves, whereas Bohm’s implicate order, while existing beyond spacetime, does not.²⁸¹

What does the concept *quantum-vacuum interactions* mean? First of all, this means that a vacuum has happily changed its status from a boring emptiness to a *plenum* full of energy and possibilities. Physicists calculate that,

...the vacuum energy content is equivalent to 10^{94} g/cm³. This magnitude, according to Bohm, exceeds all energy bound in matter by a factor of 10^{40} . If this energy were associated with mass, the resulting gravitational potential would reduce the curvature of the universe to an order of

²⁸⁰ Talbot, 1991: 49.

²⁸¹ Laszlo, 1995; Wilber, 1997. Both authors criticized Bohm’s model for the static nature of implicate order. I am too more comfortable with the idea that implicate order evolves. If everything predetermined in this world, what is the point of everything then? Later (in Wilber, 1997) Bohm modified his theory. He suggested that implicate order might evolve into implicate implicate order and so on...I will use the term implicate order keeping in mind that it is not static, but ever-evolving.

magnitude several dimensions smaller than the nucleus of the atom.²⁸²

From the new perspective, the quantum vacuum is the pure massless charge flux that contains particles in the virtual state. It can fluctuate, breaking the spacetime continuum. “When fluxes in vacuum cross the energy-threshold of particle creation, its virtual particles transform into ‘real’ particles. Real particles in spacetime seem to enjoy an independent existence: they are endowed with corpuscular, in addition to wave, properties.”²⁸³

In this sense, quanta are solitary waves, or solitons. The main property of solitons is that while having the appearance of discrete objects, they are manifestations of the continuous underlying medium in which they occur. As vertices in the running river, they unfold into seemingly separate existences and then enfold back into the realm where they came from. Since quanta are solitons in a fluctuating holographic vacuum information-reach field, they actually *are* this field. This arrangement explains how and why every photon, every electron, and every nucleon within every atom can be informed about the affairs of the rest of the universe.

Heisenberg’s uncertainty principle indicates that electrons may have some freedom of choice. This freedom, however, as QVI states, is bounded by subtle corrections coming from the entire universe through “an interactive process involving a two-way translation between particles and the quantum vacuum. Here, choice of the quantum state is not random--as in the standard quantum theoretical interpretation--but is linked with the rest of the universe.”²⁸⁴

²⁸² Laszlo, 1995: 28.

²⁸³ Laszlo, 1995: 29.

²⁸⁴ Ibid: 57.

Recall chaotic butterflies, the symbols of bounded freedom. The subtle universal corrections as wings of a chaotic butterfly permit choices and creativity of complex systems within limits. Look at the night sky. Do you see a chaotic butterfly there? According to the non-big-bang multicyclic cosmology of Prigogine, Geheniau, Guniz, and Nardone, universes are enormous solitons. They arise from a fluctuating vacuum as it reaches instability points.²⁸⁵ They jump into existence at the edge of chaos and they die only to give birth to something novel. Universes that once lived and died are never forgotten in the holographic world. Their whispers are encoded and stored in the universal holographic memory. Can you hear the echo of their distant voices? Can you glimpse the shadows of their chaotic butterflies?

The emergent holographic model of reality is truly exciting. If every little corner of the universe enfolds the information of the whole image, this means “that if we knew how to access it, we could find the Andromeda galaxy in the thumbnail of our left hand.”²⁸⁶ In such a universe, everything is the “one thing,” unbroken wholeness, one “enormous something that has extended its uncountable arms and appendages into all the apparent objects, atoms, restless oceans, and twinkling stars in the cosmos.”²⁸⁷ Have you ever felt your holographic *unbroken wholeness* with all these entities?

Psychotherapist, researcher, and author Stanislav Grof provided data that apparently supports the holographic vision of reality. In two books, *The Adventure of Self-Discovery* and *The Cosmic Game: Explorations of the Frontiers of Human Consciousness*,²⁸⁸ Grof described his own and other participants' experiences in a

²⁸⁵ In Laszlo, 1995.

²⁸⁶ Talbot, 1993: 50.

²⁸⁷ Ibid: 49.

²⁸⁸ Grof, 1988; Grof 1998.

nonordinary state of consciousness, which he calls holotropic. Psychedelic drugs, particularly the hallucinogen LSD can evoke such a state of consciousness. Grof also developed non-drug techniques, which yielded the same results.

When people enter a *holotropic state* of consciousness, they have “authentic and convincing experiences of conscious identification with animals, plants, and even inorganic materials.” Participants remember what it was like to be in the womb, or to have mother's childhood memories, or to be a prehistoric creature, and even to see some historical events. In a *holotropic* state, “consciousness appeared to expand beyond the usual boundaries of the ego and explore what it was like to be other living things and even other objects.”²⁸⁹ There were no limits as to who or what participants could become. Participants appeared to be capable of knowing what it is like to be an atom, ocean wave, blood cell, mountain, Gaia, or the Cosmos.

*I am curious, what Gaia may experience
when dancing into the spell of darkness
along with born and vanishing stars...*²⁹⁰

The experiences of the illusory nature of boundaries can definitely be qualified as holographic. After years of conceptual struggle and confusion, Grof became convinced that his data from his research strongly “indicates the necessity to change drastically our image of human nature, culture, history, and of reality.”²⁹¹ He came to the conclusion that your reality must indeed have holographic properties.

Perhaps someone already thought it through, and I did not come across it, but it seems to me that self-similarity in fractals, which means a repeating motif within motif

²⁸⁹ Talbot, 1991: 68.

²⁹⁰ Unfortunately, at this point I cannot support Grof's claims through my own experiences, but I definitely plan to participate in this kind of experiments, in order to “see” for myself.

²⁹¹ Grof, 1988: xiii.

within motif within motif, is a holographic property: *all in all*. Each smaller fractal enfolds information of a more embracing larger one, ad infinitum. Fractals are everywhere in our phenomenal world, and it is another hint on behalf of the holographic model of reality.

Since chaotic attractors are fractals,²⁹² they must have holographic properties. One of the founders of the science of complexity, Illia Prigogine, supports the holographic vision of the world. Complex dissipative structures spontaneously emerge at the edge of chaos, but... where are the blueprints of ordered structures coming from? Prigogine speculates that the holographic quantum vacuum may well be a mysterious Chaos that hides complex patterns of chaotic butterflies.²⁹³ In this light, complex dissipative structures are quantum solutions amplified into a macroscopic phenomenal world. They are constantly unfolding and enfolding on the edge of chaos, within the flux of the quantum holofield. They self-organize themselves into ever-evolving and ever-shifting resonance patterns of a unified holographic world.

We humans are complex dissipative structures emerging from, existing within, and then going back into the flux of the holofield. Neuropsychologist Karl Pribram arrived at the idea that our brains and our senses are possibly holographic. From his numerous experiments, he realized that our memories are not stored in local brain sites, but somehow “distributed throughout the brain as a whole.”²⁹⁴ Later he concluded that perhaps all of our senses and learning skills have a holographic nature. The brain has the capability to transform learned abilities “into a language of interfering wave forms.”

²⁹² In more details on the page 60.

²⁹³ Prigogine & Alskens, 1987.

²⁹⁴ Pribram, 1977.

This capability of the brain might account for the observer effect.²⁹⁵ At the subatomic level, our universe is recorded as a blur of seemingly chaotic semi-real, ever shifting and ever changing, holographic interference patterns. As the laser beam transforms interference patterns into a holographic image, our brain perhaps interprets holographic patterns of reality into the phenomenological world.

In *Changes of Mind: A Holonomic Theory of the Evolution of the Consciousness*, psychologist Jenny Wade proposes that the development of consciousness has holographic origins.²⁹⁶ Laszlo, who summarized related research in physical sciences and psychology, speculates that the stream of human experiences and creativity might arise from brain/informational holofield interactions.²⁹⁷ These interactions, believes Laszlo, can perhaps provide a scientific account for Carl Jung's concept of archetypes arising from "a vast, limitless unconscious process shared by all humanity, emerging from the accumulated experience of years of shared history."²⁹⁸ These archetypes comprise a collective human psyche²⁹⁹ that has its own reality beyond spacetime.

A similar idea is expressed in the hypothesis of formative causations, where Rupert Sheldrake speculates on the existence of hierarchically evolving universal *morphic* fields containing information about the structure, behavior, and individual

²⁹⁵ According to the Copenhagen version of the quantum theory, the world perhaps does not exist before the observation. Bohm's and Pribram's model of a holographic universe and, as I will argue later, Whitehead's philosophy, give more "realistic" account for the observer effect. According to their perspective, there is "reality out there" but in the vague, chaotic, semi-real form. Our senses and our brain have capability to interpret obscure holographic patterns of this reality into the phenomenal world of shapes and forms.

²⁹⁶ Wade: 1996.

²⁹⁷ Laszlo: 1995.

²⁹⁸ Carl Jung in Laszlo, 1995: 135.

²⁹⁹ Psyche comes from Greeks' *psyche*, "the soul personified, the spirit, the principle of life." Thomas Moore (1996) defines the soul as our capacity for compassion, and compassion as something which comes from our interconnectedness with Cosmos.

experiences of all universal entities.³⁰⁰ According to the hypothesis of formative causation, morphic fields “contain a kind of collective memory” from which each organism draws its pattern of organization. Each kind of organism, including humans, rats, or molecules of amino-acids,³⁰¹ has its own formative pattern, which is determined not by strict mathematical laws but by the habits of nature. The organism tunes into the morphic field, resonating with experiences of similar organisms. Morphic fields and organisms influence and co-create each other, reciprocally.

This hypothesis is of course controversial; however, it appears to be testable--to some extent. For example, when laboratory rats learn something new in the USA, rats in laboratories throughout the world “show a tendency to learn it faster.” How do they know? There is also a well-known tendency for new drugs to be produced with greater difficulty the first time, then, “as time goes on, they tend to appear more readily all over the world.”³⁰² People learn the words of an unknown ancient language more quickly than words that were “made up” for purposes of the experiment. How do they know? Does this happen through their tuning into the collective memory, which resides in the morphic fields of the universe? In his conversation with Bohm, Rupert Sheldrake agreed that his model is compatible with the holographic vision of the world.³⁰³

As interconnected components of a complex system, insights on the holographic nature of the world self-organize themselves into a holographic worldview or so-called

³⁰⁰ Sheldrake, 1990.

³⁰¹ From the Sheldrake’s perspective, amino-acids are organisms.

³⁰² Ibid: 89.

³⁰³ In their dialogue, Sheldrake and Bohm came to the conclusion that their visions are compatible. See Weber, 1986.

holonomic paradigm.³⁰⁴ Portraying reality as an undivided unity where matter-dense realm and the quantum vacuum informational holofield are constantly co-evolving and co-in-forming³⁰⁵ each other, the holonomic paradigm provides conceptual foundations for “transdisciplinary unification of our understanding of physical, biological, and psychological phenomena” and provokes “a fundamental change in the way we look at ourselves and the world.”³⁰⁶

Holonomic Thinking: To See the World in a Grain of Sand

*I know it's hard for you to understand about size, how there's very little difference in the size of the tiniest microbe and greatest galaxy.³⁰⁷
(Madeleine L'Engle)*

The image of a holographic universe resonates with me. It elevates my self-worth. Thinking systemically, I am a system within a system within a system. It is a weak re-enchantment. Thinking holonomically, I am the World. It is a deeper re-enchantment. Just as a cell nucleus contains information about the whole organism, I within myself, enfold the information of the entire universe. This vision of reality is emotionally appealing to me. Why? Maybe because my unformulated, hidden memory, older than the Big Bang, gives me a hint that I am a holographic “One.” Writes Ahsen:

*The psyche is not entirely a consequence of inhibitions,
its original pristine sense being mythic, holographic, and poetic”³⁰⁸*

³⁰⁴ Wilber, 1997; Wade, 1996. The term *holonomic* is coined by Jane Wade. I realize the inconvenience of using several terms: *holographic*, *holonomic*, and *holotropic* for expressing the same principle. At the same time, the abundance of terms could indicate emergence of a new metaphorical language for a new paradigm. I chose to use *holonomic* because it sounds less mechanical than *holographic* or *holotropic*.

³⁰⁵ The term *co-in-forming* combines *co-informing* and *co-forming*.

³⁰⁶ Wade, 1996.

³⁰⁷ L'Engle, 1969.

Holonomic thinking is conducive for my self-healing and for self-actualization. When I perceive myself as a Cosmos, the inevitable hardships and disappointments of my earthly life become less significant and depressing, and my creativity and inspiration elevate to the level of a cosmic significance. My life becomes more exiting, meaningful, and fulfilling.

As educator and ecophilosopher Chet Bowers writes, our metaphoric images of reality provide us with a “focal point of understanding” that influences our relationships with the world. As an example, “the mechanistic root metaphor underlying Newtonian science led to relationships characterized by detached observation and measurement.” A mechanistic understanding of nature as “natural resources” allowed and justified modern destructive attitudes towards the environment. The metaphoric meta-narratives of societies frame the nature of human-environment interaction.³⁰⁹

From the holographic vantage point, we are not entities separated from the world, and not even complex systems interconnected with the world. We are the world, and it makes a big difference.

*trying to escape from the lonely world
where everything is separated
where no one cares
where everyone is imprisoned
within their own cocoon
which has absolutely no value
in the context of a cold infinity,
I imagined a different universe
where my life is worth an entire Cosmos
where each drop of the rain on the roof is me
where the wind sweeping away autumn leaves is me
where a whispered mountain echo is me...
I am this star, I am this crying child,*

³⁰⁸ Ahsen, 1991: 71.

³⁰⁹ Bowers, 1995: 33.

*I am an enigmatic atom
puzzled by the question: to exist or not to exist?
as a mountain, I enjoy speaking with clouds
as a cloud, I like to rest on the peak of the mountain
I am a seed, from which the whole world grows,*

I am the world,

*and being the world,
would I hurt myself?*

For David Bohm, the major cause of modern disaster is fragmentary thinking. Such thinking “is giving rise to a reality that is constantly breaking down into disorderly, disharmonious, and destructive partial activities.”³¹⁰ Holonomic consciousness brings about a “different reality” and therefore dramatically changes our relationships with the world. If we perceive ourselves as being “unbroken wholeness” with others, we realize that by hurting others we hurt ourselves. Remember? You are a Cosmos, as well as everyone and everything else.

*To see a World in a Grain of Sand
and a Heaven in a Wild Flower,
hold Infinity in the palm of your hand
and Eternity in an hour.³¹¹*

This is the essence of holonomic thinking, and it is re-enchanting.

³¹⁰ Bohm, 1989.

³¹¹ Blake, cited in Talbot, 1993: 50.

Science Education as the Great Hierarchy of Becoming³¹²

Technological advances are rarely used to their fullest potential by the first generation of users. Only in later generations does a medium become self-defined by its own inherent qualities. Holography's biggest impact is yet to come--holographic principles being applied to the arts, sciences, and humanities.³¹³

(Frank DeFreitas)

Appearances, appearances...they can be so illusive and deceiving. They reflect from mirrors what is not! Sometimes clouds look so substantial, so thick, and so inviting, just like pristine white snow covering the ground. Come, walk on all this blinding whiteness! The white, so pure and monochromic, is in reality a hidden rainbow, a magic bridge of colours into nowhere that connects nothing...The light from many distant stars that appears so real, is just an echo from the past, gone forever. The perfectly flat Earth under your feet is a colossal curving globe. Hold on to gravity, don't fall off! The seed in the palm of your hand is so tiny, but do not believe it. A giant tree lies hidden within its body. Even matter, so solid, so firm, and so reliable, dissolves at the subatomic level into a semi-real tango of the waves of what is about to happen. Appearances...What lies behind these cunning masks? Who makes us play the "hide-and-seek" game? Catch me, if you can!

There was a time when many scientists were certain they had it all. They locked "it" into a mechanical cage. They closed a black box. They drew "objective" scientific conclusions. Everything was ultimately material, dead, predictable, calculable, reducible, and subject to manipulation. Today, fresh winds are blowing. New scientific insights have opened the mechanistic black box. The Genie is out. Catch me again!

Entering this new millennium, our world has become increasingly holographic. As the everyday routine, in the near future, we will have holographic movies, holographic television, holographic computers, holographic art, and the advanced technology of virtual holographic reality. Such holographic popularity is based on the ability of

³¹² Laroche, in press.

³¹³ DeFreitas, 1999. No page number.

holograms to store a vast amount of information and on the amazing property of holographic pictures to be 3-dimensional or 4-dimensional (if moving). They appear real, but their substance is not material. Catch me if you can!

Our discovery of the holographic phenomenon might be a coincidence, but it may also be a reflection of the deep holographic structure of the world. This means that each, even the smallest corner of the universe, including each human being, enfolds all. In the holographic world, each human is a unique and creative expression of *unbroken wholeness*.

*I am in the world and the world is in me.*³¹⁴

Developing consciousness that perceives the world as an unbroken wholeness would be the most important mission of the science curriculum that is stepped into the deeper re-enchantment of a holonomic paradigm. While studying snowflakes, drops of a morning dew, particles evaporating into the air, tears of rain, ocean waves, whirlpools of a flowing running river, or glistening pieces of ice, the *holonomic* science education would emphasize the underlying unity behind all these phenomena: they are all “made of” ever-flowing and ever-recycling water. The same goes for us. While each having unique identities and appearances, we all are manifestations of a single running river of a deeper holographic reality. We are solitions, unfolding from and enfolding into it.

*Our individuality resembles a snow.
The seas evaporate water,
clouds build and loose water in snowflakes which dissolve and go to see...
What have I to do with the ocean,
I with my unique and novel hexagons and spikes?*

³¹⁴ Paul Valery, quoted in Heyneman, 1993.

*Is my very mind a wave in the ocean,
a weave the wind flattens, a flow of the wind draws like a finger?*³¹⁵

Holonomic science curriculum would include detailed study of holograms and their applications for the future, but at the same time, it would strongly emphasize the philosophical essence of the holographic principle. *All in all. Unbroken wholeness. Unity in multiplicity.*

After taking two steps into re-enchantment, we entered a complex and holographic world. While thinking how to unite these two re-enchanting steps and how to describe science education grounded in them, I came across the work of philosopher Arthur Koestler. He suggested a contemporary version of an ancient multi-leveled complex model of reality--Great Chain of Being. In his terms, it becomes a *Great Hierarchy of Being*.³¹⁶ The concept *holarchy* reflects the vision of reality as a spectrum of different levels of complexity, from the simplest to the most complex entities in the universe. *Holarchy* is the hierarchical organization of wider and wider embracing *holons*, nestled in each other. *Holon* means integrated whole. Each holon is a double-faced Janus. From one side, it "looks down" at simpler holons which it embraces. From the other side, it "looks up" at more complex holons within which it is embraced. As Ken Wilber expressed, our universe is comprised of holons, embracing and embraced.³¹⁷ Each atom is a holon, which is part of a molecular holon, which in turn could be a part of a compound's holon, and then cells, tissues, organs, organisms, individual ego structures, societies, species, ecosystems, Gaia, galaxies, the known universe, and perhaps an unimaginable deeper reality...

³¹⁵ Dillard, 1999: 13.

³¹⁶ Koestler, 1964; Koestler, 1978.

³¹⁷ Wilber, 1997.

I wish to extend the concept *holon* into the holographic realm. From the holographic perspective, each holon could be a holographic image which enfolds the entire universe. The more embracing a holon is, the clearer the holographic image is of the whole. They are like windows. The smaller and simpler the holon-window, the more difficult it is to see the entire panorama through it. Holographic reality constantly evolves on the edge of chaos through an ongoing process of self-organizing holomovement, toward increasingly complex and more embracing holons. As Prigogine expressed, the world never “is,” it always “becomes,” therefore, in an ever-evolving universe, the realm of being shifted towards a process of becoming.³¹⁸ In light of this, I propose to modify Koestler’s *The Great Hierarchy of Being* into *The Great Hierarchy of Becoming* as the complex holographic vision of reality. Application of such vision for re-enchantment of science education requires re-prioritizing priorities and re-rationing rationales.

The *rationale* of disenchanting mechanistic science curriculum is very *irrational*, that of developing *a highly skilled and adaptable working force* for construction of a technological paradise. Why is it irrational? Well, let’s think rationally. How could it be considered rational to convert breathing, feeling, and pulsing human beings into an impersonal mechanistic working force?

The *irrational* of a re-enchanting science curriculum is *rational*, that of facilitating the growth of a human being into a Whole Being, within a Great Hierarchy of Becoming. Briefly, disenchanting science curriculum is about the development of human doings, whereas re-enchanting science curriculum is about the growth of human *beings*. This is the difference.

³¹⁸ Prigogine & Stengers, 1984.

From this perspective, the purpose of the *complex* and *holonomic* science curriculum can be expressed through the beautiful and undeniably holographic passage of transpersonal philosopher Ken Wilber:

To reunite humanity with the rest of the Kosmos, to see the same currents running through our human blood that run through swirling galaxies and colossal solar systems, that crash through the great oceans and course through our own veins, that move the mightiest of mountains as well as our glorious moral aspirations--one and the same current moves throughout the All, and drives the entire Kosmos in its every lasting gesture, and refuses to surrender until you remember who and what you are, and that you were carried to this realization by that single current of an all-pervading Love, and here there came fulfillment and a flash of light, and vigor failed the lofty fantasy, but now my will and my desires were moved like a wheel revolved evenly, by the Love that moves the sun and other stars.³¹⁹

To be unified with the world—it sounds so wonderful! To be carried by a current of self-pervading Love... What more could I wish? But is it really possible to develop the holographic sense of unbroken wholeness through science education that portrays the world as nonliving? How could we love and how could we feel at one with the world-machine, or the world-complex system, or even the world-holographic image? As Martha Heyneman writes, we cannot love or relate to something that is not alive.³²⁰

The good news is that both steps, the science of complexity and the holographic model of the world, lead us into even deeper re-enchantment--the world of postmodern organicism. Let us take this step. One, two, three...

*-Oh, my...
-What is happening, Claire?
-Oh my, it is so big!
It is alive. Everything is conscious, every little atom,
and they're all connected. The universe is one gigantic
heart.*³²¹

³¹⁹ Wilber, 1997: 79.

³²⁰ Heyneman, 1993.

³²¹ Herbert, 1993: 61.

CIRCLET 3

POSTMODERN ORGANICISM AS A STEP INTO
EVEN DEEPER
RE-ENCHANTMENT

*Charles Wallace went up to Mrs. Whatsit.
"I see. Now I understand.
You were a star once, weren't you?"
Mrs. Whatsit covered her face with her hands as though she
were embarrassed, and nodded.³²²*

³²² L'Engle, 1978: 87.

The Rationalism of Panexperientialism

*Perhaps... these electrons are worlds with hundreds lands,
with wars, victories, dynasties, catastrophes,
and memories of many centuries...³²³*

(Valeryi Brusov)

Writes David Griffin: "We can therefore envision, without being naively utopian, a far better order, with a far less dangerous trajectory, than the one we now have."³²⁴ In the books, *The Reenchantment of Science* and *Founders of Constructive Postmodern Philosophy*, Griffin and other contributing authors conceptualize constructive postmodern philosophy as "creative synthesis of modern and premodern truth and values."³²⁵ The authors use the term "postmodern" to designate the era beyond modernity. They distinguish two types of postmodernism: deconstructive or eliminative and constructive or revisionary. Deconstructive postmodernism "overcomes the modern worldview through anti-worldview: it deconstructs or eliminates the ingredients necessary for a worldview such as God, self, purpose, meaning, a real world, and truth as correspondence." Constructive postmodernism "seeks to overcome the modern worldview not by eliminating the possibility of the worldview as such, but by constructing a worldview through a revision of modern premises and traditional concepts."³²⁶ The purpose of constructive postmodern philosophy is to imagine a "better", less destructive order beyond the modern world. The worldview portrayed by this philosophy resembles the vision of ancient societies, but approached from the more sophisticated re-enchanting dimensions of contemporary science. This worldview is

³²³ Freely translated poem of Russian poet Valeryi Brusov.

³²⁴ Griffin, 1993: x.

³²⁵ Griffin, 1988; Griffin et al., 1993.

³²⁶ Ibid: xiii.

essentially organic, and for this reason, postmodern constructive philosophy is also called the philosophy of postmodern organicism.

From the perspective of postmodern organicism, “rational” modern science and philosophy are profoundly anti-rational because they do not meet the criteria of self-consistency and adequacy for all the facts of experience. From Webster’s dictionary, rational is a “sane”, “sensible”, “reasonable”, “logical basis”, “exposition of principles”.

Modern philosophy assumes that ultimate units of matter are completely devoid of experiences and “of spontaneity of self-motion—the capacity to initiate movement of any sort.”³²⁷ But is it really rational to think that mental, emotional, and spiritual human experiences can emerge out of non-experiencing passive matter? How could it be sane to believe that my anxieties, intentions to complete this manuscript, or ecstatic feelings of being a mother can spring out of mechanistic collisions of mindless and insensitive atoms? There is no adequate account for this phenomenon in modern philosophy. The best it could come up with is a mind-matter dualism. To recover the ideal of rationality and to account for modern inadequacies, the postmodern constructive philosophy offers *panexperientialism*, the hypothesis that views all entities in the universe as occasions of experience, from the very large--up, up to the galaxies, to the very small--down, down to the mysterious subatomic world.

This is how mathematician and philosopher Alfred North Whitehead, one of the founders of postmodern organicism, approaches such assumptions.³²⁸ There are events as well as substances. Our conversations, intentions, fantasies, and memories are not substances. Thinking rationally, they cannot be ultimately and absolutely analyzed into

³²⁷ Griffin et al., 1993: 3.

³²⁸ Reviewed in Griffin et al., 1993.

the movement of mindless atoms. It is more logical to assume that events occurring in the human world can be analyzed into smaller “atomic” events. “Just as substances such as chairs and tables can be analyzed into component substances such as atoms, so also events like wars and conversations can be analyzed into the component events that make them.”³²⁹ For instance, the flow of experiences during a conversation between two people can be analyzed into momentarily successive “atomic” experiences. As Whitehead states, “all atomic events are occasions of experience.”³³⁰

According to Whitehead, elementary occasions synthesize themselves into human or other-than-human experiences through numerous internal relations. In light of this, an electron within a human body is different from an electron within a rock “by virtue of its *intrinsic* experience.”³³¹ Traditionally, science has excluded the possibility of such experiences from nature. As Kirk writes, taking them into the consideration would “involve a re-conceptualization of science itself.”³³²

This fascinates me. In the mechanistic “billiard ball universe” particles do not have individualities. An electron is an electron. It does not matter whether it belongs to you or me or a dog, or a stone. Ultimately, we all consist of the same bits and parcels. In Whitehead’s universe, the particles within me share mine and the particles within the stone share the stone’s experiences. According to such an arrangement, the whole and its parts reciprocally influence each other, and it is perfectly consistent with the self-organizing principle of complexity.

³²⁹ Griffin et al., 1993: 137.

³³⁰ Ibid: 178.

³³¹ Whitehead, 1978.

³³² Kirk, 1991: 62.

Writes Whitehead:

The doctrine which I am maintaining is that the whole concept of materialism only applies to very abstract entities, the products of logical discernment. The concrete enduring entities are organisms, so that the plan of the whole influences the very characters of various subordinate organisms, which enter into it. In the case of animal, the mental states enter into the plan of the total organism and thus modify the plans of the successive subordinate organisms until the ultimate smallest organisms, such as electrons, are reached. Thus electron living within a living body is different from the electron outside it, by reason of the plan body.³³³

For Whitehead, particles can “feel” or “value” particular situations just as human beings. These “feelings” create their internal experiences even within inanimate matter. Whitehead’s philosophy perceives elementary particles as “organisms” which embody “data” from the rest of the world and respond to it.³³⁴ Such a view makes matter inherently alive. If so, the world must be living and experiencing throughout all its totality. This thought is heretical to the disenchanting modern assumption that beyond reasonable doubt, matter and ultimately the entire world are devoid of any spontaneity, creativity, experiences, history, and life. To understand the world and all it comprises as living and experiencing organisms is a quite deep re-enchantment, isn’t it? However, as I shall discuss next, the two steps, the science of complexity and the holonomic paradigm, definitely lead us there.

³³³ Whitehead cited in Kirk, 1993: 57.

³³⁴ Whitehead, 1978.

I Am, Therefore I Live

*The edge of chaos where possibility seduce
and life dances into being*

*Aha!*³³⁵

(Lynn Fels)

In Whitehead's universe, the stone is an organism comprised of elementary particles, which are smaller organisms, and as such, occasions of experience. For Whitehead, both the stone and I are individuals; the difference is only in our degree of freedom.³³⁶ Thinking about stones as experiencing individuals is somewhat counterintuitive, however. Who would seriously think about stones as living things?

...Everything is simple in the mechanistic world. If you are human, you have a chance to be a temporarily alive machine, but if you are a planet, or atom, or stone, there is no chance. You are automatically dead forever and ever. As for plants, time-lapse photography, shows that plants often act as humans. If they feel pain, they retreat from it. If they feel pleasure, they turn to it. They move their fronds--palms toward the sun, so they can drink sunlight. They suffer without affection. They feel stress when eaten.³³⁷ We do not notice their reactions, but they do...react.³³⁸ They are alive...things....

My daughter studied criteria for separating living things from nonliving things for her science nine class. "It does not make any sense," she said. "Why?" I asked. "How could anything be nonliving if everything is made of moving particles?"

Another question is, are there such things as living things? Answer: living things can exist in the mechanistic universe, which is comprised solely of mechanical

³³⁵ Fels, 1999.

³³⁶ in Griffin et al., 1993.

³³⁷ TV Discovery Program.

³³⁸ Zukav, 1979: 62.

things that have ability to reproduce, to process external information, and to react to this information accordingly.

Life, though, cannot be understood mechanically, writes Fritjof Capra. He synthesized new ideas and concepts in physics, mathematics, chemistry, psychology, philosophy, and biology into the emerging non-mechanistic systemic understanding of life.³³⁹ Capra espouses three essential principles: *autopoiesis*, *dissipative structures*, and *cognition* from which to make a *clear distinction* between living and non-living systems.

The concept *autopoiesis*, developed by the Chilean neuroscientists Humberto Maturana and Francisco Varela, means the pattern of organization of living systems. The term *auto* means *self* and *poiesis* means *making*.³⁴⁰ What does the pattern of organization mean? It is a blueprint, the scheme of an organism's identity. Any living organism constantly exchanges matter and energy with its environment and, therefore, constantly renews itself. We cannot step twice into the same water in a running river. Isn't it fascinating? I look at myself in the mirror and I recognize myself. I look at familiar others and I recognize them as well. We somehow maintain our appearances and identities, but at the same time, we are never the same:

...if you could see your body as it really is, you would never see it the same way twice. Ninety-eight percent of the atoms in your body were not there a year ago. The skeleton that seems so solid, was not there three months ago...Skin is new every month. You have a new stomach lining every four days, with the actual surface cells that contact food being renewed every five minutes...It is as if you lived in a building, whole bricks were systematically taken out and replaced every year. If you keep the same blueprint, it will still look like the same building. But it won't be the same actually. The human body also stands there looking much the same from day to day, but through the process of digestion, elimination,

³³⁹ In Capra, 1996: 169-176.

³⁴⁰ Capra, 1996: 97.

and so forth, it is constantly and ever in exchange with the rest of the world.³⁴¹

Living organisms are highly improbable complex systems existing in a state far from equilibrium. While matter and energy continually flow through them, they manage to sustain a stable structure. They are physical manifestations of an autopoietic pattern or blueprint, and as such, they are dissipative structures, brave and skillful enough to exist in a risky and creative space on the edge of chaos. In the terminology of the science of complexity, the blueprint of the organism is the shape of its chaotic butterfly.

The third main criterion of life, suggested by Capra, is cognition or the process of knowing. Cognition is traditionally identified with an exclusively human ability to think conceptually and to use language. Recently, Bateson and also Maturana and Varela³⁴² proposed a new, revolutionary, systemic view on cognition. According to this view, the mind is not the host in the machine or some otherworldly thing. It is a process, which spreads itself throughout entire ecological systems. Gregory Bateson extends the mind into the world: "...mind obviously does not stop with the skin. It is also all the pathways outside the skin relevant to the phenomenon you want to account for."³⁴³ (Doesn't it sound holographic?)

In light of new understanding, cognition is not exclusively the ability to think, but the ability to live. In order to live, a system has to have a memory, to make decisions, to interact with the environment, and to learn. The living entity knows how to live, and therefore is cognitive.

³⁴¹ Chopra, 1989: 48-49.

³⁴² Bateson, 1991; Capra, 1996; Varela, Thompson & Rosh, 1993.

³⁴³ Bateson, 1991: 165.

This suggests that even the simplest organisms, even entities without brains such as viruses, bacteria, or plants, are capable of cognition. They need to know how to exist in an ever- changing environment. They need to be able to recognize and react to hot and cold, light and darkness, a less concentrated and a more concentrated medium. From the above, I summarize Capra's three key principles of life:

living systems know how to exist (*cognition*)
maintaining their identity at the edge of chaos (*dissipative structure*)
through constant self-making (*autopoiesis*)

The autopoietic organism continually produces, or *makes*, or *self-organizes* itself through *self-balancing* feedback loops. Loop after loop after loop, marching toward ongoing renewal. Once in a while, however, the loops go awry. They branch off, further and further away from equilibrium until the system reaches a threshold, a “bifurcation point.” A new order manifested through increasingly complex dissipative structures spontaneously jumps into existence, propelling the world toward evolution.³⁴⁴

As is increasingly understood, evolution does not progress gradually over time through random mutations, but prefers to jump like a kangaroo. The *propagation* of evolution is a discontinuous process, where long periods of stability are “punctuated by sudden and dramatic transitions.”³⁴⁵ For Maturana and Varela, evolution is not limited to classic adaptations to the changing of environment. It is a *natural drift*, where organisms and the environment co-evolve together. The history of evolution is an ongoing autopoietic process.³⁴⁶ The dramatic evolutionary jumps result from instabilities created through innumerable feedback loops between organisms and the environment. As Capra writes, from the systemic point of view, “evolutionary change is seen as the result of life's

³⁴⁴ Capra, 1996.

³⁴⁵ Ibid: 226.

³⁴⁶ Ibid.

inherent tendency to create novelty, which may or may not be accompanied by adaptation to changing environmental conditions.”³⁴⁷

From the perspective of systemic thinking, life is complex, unpredictable, and inherently creative. Incredibly various in all its appearances, where does life end and where does it begin? Where can we (can we?) draw the line between living and non-living systems?

Applying the three Capra’s non-mechanistic criteria of life, plants and the most infinitesimal bacteria and viruses are alive since they are dissipative, autopoietic, and cognitive systems. They constantly renew themselves. They know how to live. According to Capra, who synthesized the work of Illia Prigogine, the roots of life can be traced into inanimate chemical systems, which can spontaneously produce organized structures, “hypercycles,” through multiple feedback loops. Such hypercycles are stable and capable of self-replication.³⁴⁸ “One of the most striking life-like properties,” writes Capra, “is that they evolve by passing through instabilities and creating successfully higher levels of self-organization that are characterized by increasing diversity and richness of components and structures.”³⁴⁹

Are such systems alive then? Capra does not think so, since they do not meet “certain criteria” of life. Unfortunately, he does not specify which criteria are missing. Systemic thinking “stops” life at a level of complex chemical reactions, which can produce lifelike, but not actually living structures. Here, in the kingdom of complex chemical reactions, somewhere between the simplest organisms and chemical

³⁴⁷ Capra, 1996: 222.

³⁴⁸ Enzymatic biochemical reactions.

³⁴⁹ Capra, 1996: 94.

hypercycles, systemic criteria put a “stop sign” for life. What about “up, up” to the galaxies? Where does life stop there? Does it stop at all?

Addressing this question, dynamical systems theory “found its beautiful expression” in John Lovelock and Lynn Margulis’s *Gaia hypothesis*, the scientific renaissance of intuitive ancient thoughts about the Earth as a living being. The essence of the Gaia hypothesis is that “...earth can be regarded as a single living system, which includes the biosphere, the atmosphere, the oceans, and soil.”³⁵⁰ This huge living system regulates and sustains all of the conditions necessary for the survival of life.

These conditions would include, for example (among other things), the distribution of raw materials throughout the surface of the planet, the stable abundance of oxygen (21%), the salinity of the oceans (3.5%), and the average temperature of the earth's surface (10-20°C), despite the estimated increase of heat from the sun (approximately 30%) over the past 3 billion years.³⁵¹

Just as your or my body regulate themselves, Gaia regulates her temperature, the salinity of her oceans, and the composition of her atmosphere. Realizing that, Lovelock concluded:

Consider Gaia theory as an alternative to the to the conventional wisdom that sees the Earth as a dead planet made of inanimate rocks, ocean, and atmosphere, and merely inhabited by life. Consider it as a real system, comprising all of life and all of its environment tightly coupled so as to form a self-regulating entity.³⁵²

In the Gaia theory, rocks, animals, humans, microorganisms, and plants are not separate things. They are interconnected into the incredible web of Gaia's life. In this sense, the concept *environment* loses its meaning since everything becomes part of an ever changing, ever new life. Just as our bodies constantly renew themselves while

³⁵⁰ Lovelock, 1980.

³⁵¹ Green, 1998: 181.

³⁵² Lovelock cited in Capra, 1996: 103.

maintaining their identity, the body of Gaia constantly renews itself as well. Plants, humans, even mountains come and go, enfold and unfold, in and out of existence, within the ongoing process of kaleidoscopic autopoietic changes. In addition to this, Gaia is definitely a cognitive being since she knows how to exist. For some inexplicable reason, the thought that Gaia might be alive makes my heart melt. It makes me think about stars and galaxies...Are they alive? Michael Green synthesized views of contemporary astrophysicists who are convinced that all galaxies are

...literally alive in the full biological meaning of the term. [They have] been produced by a process of evolution and competition within the Universe...[and the] end-product of this evolutionary process has been spiral galaxies that are very efficient supernova nurseries.³⁵³

In the universe there are at least fifty billion galaxies. Each galaxy contains about a hundred billion stars. Quite an impressive population of stars, isn't it? Stars live, stars die and new stars are born again. A familiar cycle of life. Some stars, like our yellow sun die quietly after fusing all available hydrogen into helium, but massive blue-white stars die violently. They explode, providing the raw material for the birth of brilliant new stars. Galaxies are able to retain their life by the continuous recycling of gaseous molecular material, condensing it into young, bright, shining stars.

Galactic scientists illustrate the autopoietic nature of galaxies when they describe the whole process of a supernovae ejecting material into "new giant molecular clouds" as one of "continuous reproduction" which is a "self-regulating" natural feedback process.³⁵⁴

Scientists increasingly use biological terminology in relation to galaxies. They talk about "ecosystems," "population dynamics," and "baby-universes." They compare the evolution of galaxies with the evolution of life on earth.

³⁵³ Green, 1998: 153.

³⁵⁴ Ibid: 155.

The dramatic implication is that many--perhaps all the black holes that form in our Universe may be the seeds of new universes. And, of course, our own Universe may have been born in this way out of a black hole in another universe....the fact that the laws of physics in our Universe seem to be rather precisely 'fine tuned' to encourage the formation of black holes means that they are actually fine tuned for the production of more universes....If one universe exists, then it seems that there must be many--very many, perhaps even an infinite number of universes. Our Universe has to be seen as just one component of a vast array of universes, a self-reproducing system connected only by the 'tunnels' through spacetime (perhaps better regarded as cosmic umbilical cords) that join a 'baby' universe to its 'parent.' It is relatively easy to see how such family of universes can continue to exist, and reproduce, once something like our own Universe exists.³⁵⁵

From the electronic journal *Science Now*³⁵⁶

Austin, Texas--*Astronomers have identified what may be the most massive single structure yet seen in the universe. The structure, a ribbon of exceptionally rich clusters of galaxies, stretches across at least 400 million light-years of the southern hemisphere sky, according to research presented today at a meeting of the American Astronomical Society.*

Galaxies like our Milky Way tend to clump into tight groups of a few to a dozen of galaxies, which form clusters with hundreds or thousands of members. Finally, ten or more clusters can assemble into vast super clusters, which astronomers consider the largest coherent "objects" in the cosmos. These structures seem to form spidery filaments, leaving behind gaping voids.

Because gravity's attraction is relentless but modest, it requires the universe's lifetime to form super clusters like this one... They are quite difficult to find, because they are in the process of being born...we are watching the birth of the newest, largest things in the universe.

The universe constantly self-organizes itself, evolving toward complexity. Self-organization as we know is the very essence and characteristic of life. I agree with Capra, who says that it is "philosophically and spiritually more satisfying to assume that the cosmos as a whole is alive, rather than thinking of life on Earth existing in the lifeless universe."³⁵⁷ It is so lonely to be alone in the universe...

³⁵⁵ Gribbin, 1993: 245.

³⁵⁶ Iron, 1999: 1.

³⁵⁷ Capra, 1996: 217.

From the vantage point of systemic thinking, the world appears to be living on a larger scale. Systemic worldview is therefore ecological or biological rather than mechanistic. Such a view re-enchants the world, overcoming fragmentations of mechanism by connecting all animate and inanimate systems into network relationships in the web of life. From the systemic perspective, Gaia and Cosmos are possibly living systems. The stone, however, is not as lucky. The most it can hope for is to be part of a network between animate and inanimate systems. By itself, the stone is not a living, nor an experiencing entity. It does not appear to be autopoietic, dissipative, or cognitive system, and it is incapable of *structural coupling* with the environment.

Structural coupling is a concept introduced by Maturana and Varela.³⁵⁸ It is the process of ongoing interactions of the system with the environment that “stimulates structural changes in the system.” For instance, the stone and the dog interact with the environment differently. “Kicking the stone and kicking the dog are two different stories.”³⁵⁹ The stone, as a nonliving entity, reacts to being kicked passively and linearly. It will not get angry for such an impolite action. Its movement will obey simple mechanical cause-effect laws. We can predict the trajectory of the kicked stone through formulas of classic physics. The dog, however, will react stubbornly and unpredictably. It may run away, bark at you, or even bite you. So, you may learn something from this experience. You may not want to kick the dog anymore. The dog perhaps learned something too. It may decide to stay as far away as possible from you.

According to Capra, “...as a living organism responds to environmental influences with structural changes, these changes will in turn alter its future behavior. In

³⁵⁸ Capra, 1996: 66.

³⁵⁹ Ibid: 67.

other words, a structurally coupled system is a learning system.”³⁶⁰ The dog may learn not to approach you anymore. The stone did not learn anything. It remains on the road, passively awaiting its destiny. If you are in a particular mood, you can easily kick it again. That is “because, of its structural coupling, we call the behavior of animal intelligent, but we would not apply that term to the behavior of the rock.”³⁶¹

We think stones do not react to anything. But can we be absolutely sure? Maybe they do react, but very slowly. Maybe to detect their reactions, we need time-lapse photography, which requires millennia between exposures!³⁶² But...since a millennium is not a convenient interval of measurement for us, we have no way to prove or disprove whether stones react or not. How can we be absolutely sure that the stone's only response to being kicked is its movement in accordance with the laws of classic physics? How can we be certain the stone did not sense anything intrinsically? Did not learn anything? How can we assume that particles inside the kicked stone do not feel differently than particles in a non-kicked stone?

This is where the disenchantment is hidden. Endowing Nature with life and creativity at a macro-level, the systemic view leaves it ultimately dead at a micro-level. From the systemic perspective, Gaia and even galaxies are perhaps alive. Matter itself, however, although self-organizing and active, is still somewhat mechanistic, dead, and lost in the labyrinth of random nonlinear feedback loops. No internal experiences, purposes, or intentions exist in the world of “systemic” matter.

I feel sorry for the stone in the mechanistic or systemic universe. How boring it must be to exist for centuries and centuries, without memories or experiences. How

³⁶⁰ Ibid: 68.

³⁶¹ Capra, 1996: 69.

³⁶² Zukav, 1979: 63.

terrible it must be to know you will never learn anything, even if kicked. In the holographic world the stone has more hope. Recall Grof's experiments, where people in a holotropic state of consciousness were able to describe experiences of a stone, mountain, sun, or atom. Such experiences "make it easy to understand the beliefs of animistic cultures that see the universe as being *ensouled*. From their perspective, not only all the animals, but also the rivers, the mountains, the sun, the moon, and the stars appear to be sentient beings."³⁶³

The holographic model of the world, where each stone, each human, and each atom embody the entire Cosmos appears to support Whitehead's panexperientialism. In Whitehead's organic and experiencing world, internal relationships are the central issue. Through these relationships all entities "internalize" the rest of the universe, "creating a unity which is unique to it."³⁶⁴ Each particle knows what others are up to. What could be more holographic?

In the Whitehead's world as well as in the holographic one, atoms are alive and experiencing entities. From the position of the science of complexity, atoms are self-organizing systems, but are not living. From my perspective, however, atoms seem to satisfy Capra's three criteria of living systems as autopoietic, dissipative, and cognitive entities. This is what David Griffin, in *The Reenchantment of Science*, writes:

Scientists found that imaging and memory seem necessary to understand the behavior of bats and bees. Daniel Koshland and his colleagues have provided evidence of rudimentary forms of both "memory" and "decision" in bacteria. There is reason to believe that DNA and RNA macromolecules are not simply passive entities, which change as their parts are changed, but that they are active organisms, which actively transport their parts. It has been suggested that the

³⁶³ Grof, 1998: 17.

³⁶⁴ Whitehead, 1978.

Pauli Principle provides the reason to think of an atom as a self-regulating whole.³⁶⁵

The Pauli Exclusion Principle is “a rule stating that no two electrons in an atom can have the same quantum numbers.”³⁶⁶ In other words, this rule organizes electrons within an atom. If you open any quantum physics book, you will learn that there is a whole zoo of particles within the atom. Literally hundreds. Photons, electrons, muons, tau, neutrino, pions, kaons, eta, protons, neutrons, lamdas, sigmas, omegas, and many others. Within this madness of variety, no single particle remains still. Not only do particles move frantically at crazy speeds; they also annihilate, vanish into “nothing,” and then new particles re-appear into existence. “This happens when particles interact and it also happens, literally, out of nowhere... The subatomic world is a continual dance of creation and annihilation, of mass that changes into energy and energy that changes into mass.”³⁶⁷ Where are particles going when they disappear? Recalling quantum-vacuum interaction (QVI) hypothesis, elementary particles are solitons, the waves of the informational holofield that are coming into a seemingly separate existence and then merging back into the quantum vacuum implicate realm to share their experiences with the entire holographic world and to give birth to new solitons.

Amazingly, atoms manage to maintain their identity despite the ongoing flux of subatomic quanta in and out of material existence. This means that the atom continuously renews itself, yet manages to remain an integrate whole. It sustains its dissipative structure within the ongoing process of autopoiesis. The atom of each element, despite

³⁶⁵ Griffin, 1988: 15.

³⁶⁶ Quantum numbers-- n , l , m_l , m_s . The first three quantum numbers characterize the orbital that describes the region of space where an electron is most likely to be found; we say that the electron "occupies" the orbital. The spin number, m_s , describes the spin orientation of an electron.

³⁶⁷ Zukav, 1979: 197.

the constant process of particles' change, is able to preserve the pattern of organization, keeping the number of particles constant. For instance, an atom of oxygen has eight protons, eight neutrons, and eight electrons and within its neutrons and protons, a plethora of subatomic quanta constantly enfold into and unfold from the quantum informational holofield. Just a slight variation in the number of particles triggers a dramatic qualitative change. Nitrogen has only one fewer protons, neutrons, and electrons than oxygen, but it possesses very different properties. In order to preserve its identity, each atom is extremely careful in maintaining a certain pattern of organization.

A soap opera "Days of the Physical Science in Elementary Schools Course"

Fill in the blank space:

A dialogue between elements in the periodic table:

Calcium: Hey, neighbour! How many electrons do you have?

Potassium: That is actually not a very polite question, but since you are my neighbor, I will tell you... I have _____

Calcium: Just _____?!

Potassium: Yes... So what?

Calcium: Nothing... it is just pleasing to know that I am _____ electron (s) richer!

Elements in the periodic table illustrate a natural evolution towards increasing complexity. Today humans pick up Nature's torch and expand her creativity. They artificially create unstable complex elements, such as Mendeleevium, Nobelium, and others. The evolution of elements is still going on....

Thus far, atoms satisfy two main criteria of living beings: autopoiesis and dissipative structures. The third criterion is cognition. Hmm...they definitely "know" how to exist and so must possess some kind of mentality. As physicist Johnes writes, "*the modern theory of matter begs the question.*" It explains the symmetries of crystals in

terms of the arrays and lattices, but does not explain how “mindless” particles know how to make a snowflake.³⁶⁸ Some scientists think, “crystals and DNA molecules show signs of memory, and even atoms and elementary particles have propensities.”³⁶⁹ According to the QVI concept, memories and intentions of particles could be the result of their ongoing interactions with quantum vacuum holofield. Being manifestations of the undivided unity, they know everything the universe knows and vice versa.

Thus, from the perspective of three systemic criteria of life, particles are perhaps not inanimate. In Bohm's experiments with high-temperature plasma³⁷⁰ electrons behaved as if they were aware of the whole to which they belong. Michael Talbot describes

Bohm's amazement:

Although their individual movements appeared random, vast number of electrons were able to produce effects that were surprisingly well-organized. Like some amoeboid creature, the plasma constantly regenerated itself and enclosed all impurities in a wall in the same way that a biological organism might encase a foreign substance in a cyst. So struck by these organic qualities, he later remarked frequently, he had the impression that the electron sea was “alive”.³⁷¹

Later, working with electrons in metals, Bohm observed the same phenomenon. As a whole, electrons behaved not in a disordered way as a crowd does, but rather they exhibited a choreographed movement as ballet dancers. Is matter inherently alive?

Quantum physicist Alan Wolf believes it is. “My new view was that matter is fundamentally alive; that life exists everywhere, even in a table and chair. Life cannot be explained just by mechanical action.”³⁷²

³⁶⁸ Johnes, 1982.

³⁶⁹ Griffin, 1988: 19.

³⁷⁰ Talbot, 1991.

³⁷¹ Talbot, 1991: 40.

³⁷² Wolf, 1991: 164.

Another physicist, Nick Herbert, writes:

The commonsense belief that stars, rocks, and atoms are unconscious has no real scientific basis and should rightly be regarded as groundless superstition. The belief that matter is “dead” has the same experimental status as the opposite animistic belief that matter is “alive”. Both beliefs rest on equal logical footing, although, the animist can in his favor point to at least one material system that is 'alive' while the materialist cannot point to any kind of matter that he knows with a certainty is 'dead'. The real status of the inner life of 'inanimate' objects awaits for its resolution by a deeper kind of science than we currently possess.³⁷³

From the overlap of insights of the science of complexity, a holographic model of the world, and panexperientialism hypothesis, the world appears to be experiencing, self-renewing, self-organizing, and cognitive, and therefore alive, throughout all its totality, from galaxies to the subatomic lands. In such a world, “...even a rock is in some way alive, for life and intelligence is not only in all matter, but in *energy, space, time, the fabric of the entire universe*, and everything else we abstract out of the holomovement and mistakenly view as separate things.”³⁷⁴ In a huge living hologram, according to Bohm, the clear cut between living and nonliving things loses its meaning.

At this point, let's return to our stone, patiently awaiting its destiny. In the mechanistic universe, where matter is dead, inert, and passive, the only results of your kicking the stone will be its movement and perhaps a subtle deformation of the stone's structure and tiny temperature changes due to friction between your foot and the stone's surface. The situation is different in the living holographic universe that learns immediately about the experience of the particles within the kicked stone through quantum-vacuum interactions. The information from this experience will be stored forever and ever in the universal hologram. Each small event “writes itself” into the

³⁷³ Herbert, 1993: 13.

³⁷⁴ Bohm, cited in Herbert, 1993: 50.

holographic interference pattern within a deeper informational reality, simultaneously changing both implicate and explicate orders. The entire unbroken wholeness learns, and the ability to learn is the very essence of life. Amazingly, life itself appears to have holographic properties.

Genetic engineering has been able to produce a replica of a parental organism, a clone, from the nucleus of a single cell. I recently watched a TV program about genetic engineering. "Dolly," a famous sheep, was cloned from a single cell. "It is amazing," exclaimed one scientist, "each tiny cell enfolds the entire information of a sheep!" The camera moved from the microscopic cell to the cheerful sheep. It was as impressive as it was holographic...

Thinking that our universe is alive throughout all its holographic totality, I almost want to cry, experiencing a warm and sentimental feeling. I agree with Rupert Sheldrake who writes: "As soon as we allow ourselves to think of the world as being alive, we recognize that a part of us knew this all long. It is like emerging from winter into a new spring."³⁷⁵

So far, three steps into re-enchantment have taken us into the complex, holographic, living, and experiencing world, where atoms, the Cosmos, and I are reciprocally enfolded within each other. If so, the universe must possess not only a physical body, but also those qualities that mechanistic science regarded as being strictly human. This means that the re-enchanted world is aware of my sorrow, joy, music, poetry, dreams, and imagination...

³⁷⁵ Sheldrake, 1990: 188.

Welcome into Imaginary Dimensions

Ken Wilber believes that our reality has not only exterior dimensions, but also interior dimensions of “consciousness and spirituality (imagination, intuition, myth, soul, spirit, value, morals, ethic, and art).”³⁷⁶ According to the famous Copenhagen interpretation of quantum theory, “the universe simply does not make sense--and cannot satisfactorily be explained--without the inclusion, in some profound way, of consciousness itself.”³⁷⁷ David Bohm speculated that the deeper implicate order of reality might well be pure consciousness.³⁷⁸ Contemporary String Theory placed our universe in a ten-dimensional fabric of spacetime. Vibrations of four dimensions give us physical spacetime. “Vibrations of the unseen fifth dimension reproduces properties of light. Similarly, by adding more and more dimensions, we can reproduce higher forces, such as a weak and strong nuclear forces.”³⁷⁹ From the vantage point of ten dimensions, all particles and interactions in the universe can be unified into one panorama (*a hologram?*). The recently formulated M-theory (*magic-theory?*) suggests that the universe might exist in eleven dimensions.³⁸⁰ Intriguingly, some scientists add imaginary dimensions in addition to physical ones:

The new dimensions differ in at least two ways from space and time. Space and time are “exterior” dimensions in which the fundamental particles move; the new dimensions are “interior” consisting of degrees of freedom associated with changes in intrinsic particle properties such as spin and charge. So far, these new dimensions have been used to explain only the world's physical properties, but the very notion of an interior dimension is suggestive to the possibility of a true unification of forces that would include the powers of mind along with conventional physical forces.³⁸¹

³⁷⁶ Wilber, 1998: 58.

³⁷⁷ Wilber, 1998: 2.

³⁷⁸ Bohm & Hiley, 1992.

³⁷⁹ Kaku, 1997: 349.

³⁸⁰ Maddox, 1999.

³⁸¹ Herbert, 1993: 279-280.

In his book *Complex Relativity Theory*, Jean Charon suggests there are dimensions of universal inner experience; “every real dimension has an *imaginary* counterpart whose properties are measurable in mental terms.”³⁸² Another model of a multidimensional universe, *hyperspace crystallography*, proposed by the Consciousness Theory Group, includes forty-eight dimensions of physical space and even more in the mental realm.³⁸³ In *The Seven Dimensions as the Keys to a General Theory of the Universe*, philosopher Donald Scott includes love and peace as universal imaginary dimensions.³⁸⁴

Let’s not forget bizarre square roots of negative numbers, these imaginary entities that somehow belong to the real world. They appear to be messengers connecting imaginary and physical dimensions: while being nonexistent, they are demonstrably vital for modeling diversity of natural forms. Asks Sheldrake: “Could creativity on Earth be a product of the imagination of Gaian mind? And could such an imagination, working through the natural world, be the basis of evolutionary creativity in nature the same as in the human realm?”³⁸⁵

Now we are entering a very deep re-enchantment. In addition to being complex, holographic, and living, our reality might well be conscious and imaginative. Philosopher Martin Heidegger understands the imagination as a “unity-building power” that projects “horizons”:

Heidegger sees the imagination much as a farmer sowing seeds in the field, sketching a horizon in which objectivity is to be countered. Things will come into being. Thus it is that the comprehension of Being takes place within a horizon, and imagination provides

³⁸² Herbert, 1993: 280.

³⁸³ Herbert, 1993.

³⁸⁴ Scott, 1996.

³⁸⁵ Cited in Laszlo, 1995: 43.

that horizon.³⁸⁶

This is truly exiting! The science of complexity, while recognizing creativity in nature, reduces it to countless feedback loops. The holonomic paradigm places natural creativity into the realm of quantum-vacuum interactions through which the holographic universe orchestrates its own evolution via subtle converging corrections.³⁸⁷ But I still wonder, where the criteria for universal corrections are coming from? Could it be that they come out of the universal imagination, that is Heidegger's "unity-building power"? Could it be that the huge cosmic organism imagines itself? Even more, could it be that the "driving force" of this "unimaginable" universal imagination is pure enjoyment? For Alfred North Whitehead, enjoyment is Nature's aim and purpose in creating:

By this term "aim" is meant the exclusion of the boundless wealth of alternative potentiality, and the inclusion of that definite factor of novelty which constitutes the selected way of entertaining those data in that process of unification. The aim is at that complex of feeling which is the enjoyment of those data in that way. "That way of enjoyment" is selected from the boundless wealth of alternatives. It has been aimed at for actualization in that process.³⁸⁸

Perhaps Nature enjoys creating novelty as much as a child enjoys drawing colorful pictures, or as a poet enjoys writing poetry. Michaly Csikszentmihalyi observes that enjoyment is a program for human creativity.³⁸⁹ Human creativity is an extension of Nature's creativity, and if so, the mysterious quantum leaps, the spontaneous emergence of complex dissipative structures, the formation of new universal holographic patterns, the outburst of a poem, the formulation of scientific laws, the birth of new galaxies, all of

³⁸⁶ Murray, 1986: 63-64.

³⁸⁷ For more details please return to the page 119.

³⁸⁸ Whitehead, cited in Kirk, 1991: 66.

³⁸⁹ Csikszentmihalyi, 1996.

these are manifestations of a unified cosmic creative force, which is driven by pure enjoyment!

Once upon a time, I lived right on the ocean. It was a great gift because it gave me the chance to notice something not so pronounced in urban settings. Day-by-day, I looked at the grandiose spectacle, in deep amazement by the talent behind Nature's art. It was especially impressive in the early mornings, as if someone who created all of that had a fresh look after a night's rest. Exhibitions of clouds danced above the water and incredible palettes of colours never repeated themselves. Such creations manifested a truly rich imagination. The moon hung too huge and too golden to be real and the sun rose too smiling to believe. It was pure enchantment without unnecessary definitions. No way something like that could spring exclusively from mindless feedback loops...

The Pendulum Swings Back to the Future: As Above so Below

I find myself not in a world but as a world which is neither compulsive nor capricious. What happens is neither automatic nor arbitrary; it just happens, and all happenings are mutually interdependent in a way that seems unbelievably harmonious.

Every this goes with every that. Without others there is no self, and without somewhere else there is no here, so that— in this sense—self is other and here and there.³⁹⁰

(Alan Watts)

What a dizzying nonlinear quantum leap! Just like a mad scientist in his funky time machine, we spiraled back to the future. We leaped into the living, experiencing, conscious, feeling, imaginative, and mysterious macrocosm that resembles the enchanted holistic organic world of alchemists and astrologers. As above so below. All in all.

Omnia omnibus. Unity in multiplicity. Unbroken wholeness.

The materia prima was original chaos. It was many things and had many names. It was cold, silent, and strangely semi-real. It is nothing (yet), and everything (in potentia), it is all things that wait to exist.³⁹¹

³⁹⁰ Watts, 1966: 116.

Here we are again. We arrived in the kingdom of ancient *materia prima*, which at the same time could be the land of hidden complex chaotic butterflies, which at the same time could be a shimmering sea of quantum probability waves, which at the same time could be an informational vacuum holofield, which at the same time could be a breathing magical world where something that seems to be, actually is not...

“A world dies when its metaphor has died,” said Archibald MacLeish.³⁹² Today the rusty modern Machine is being collapsed under the pressure of new scientific insights. Starting with quantum mechanics, new developments in various scientific fields self-organize themselves into a new order of complexity, stating boldly the necessity to re-conceptualize radically the nature of reality.

“Finally,” the universe perhaps thinks, “I am not a machine anymore!” Indeed, today it can enjoy a plethora of metaphoric choices: “Great Thought”, “Unfolding Flower,” “Hologram”, “Garden”, “Self-organizing Being”, “Breathing Cathedral”, or “Cosmic Organism”.³⁹³ Such plurality of metaphors suggests that the emerging post-mechanistic world remains under creation; however, there is something undoubtedly common to all these metaphors. They portray an organic world.

When I perceive the world as not mechanistic but organic, I feel more comfortable imagining that “the same currents running through our human blood run through swirling galaxies and colossal solar systems.” This, in turn, gives me a conceptual comfort for imagining a deeply re-enchanted science curriculum that educates a holographic sense of oneness with the living world. To imagine such

³⁹¹ Burckhard, 1960: 85.

³⁹² Cited in Johnes, 1982.

³⁹³ Maffet, 1991.

curriculum into existence, I shall conceptualize a *holonomic inquiry* as the research methodology that fertilizes a *great holarchy of becoming a unity with the organic world*.

Quantum Leaps of a Pulsing Heart: A Holonomic Inquiry as a Research Methodology

*Thus you can throw yourself flat on the ground, stretched out upon Mother Earth,
with the certain conviction that you are one with her
and she with you.³⁹⁴
(Ervin Shroedinger)*

*If we knew how to access it, we could find the Andromeda galaxy
in the thumbnail of our left hand.³⁹⁵
(Michael Talbot)*

1. holonomic inquiry for beginners

Writes Carl Leggo:

I want research that begins in a place of unknowing, with a leap of faith, a courageous willingness to embark on a journey. I want research that seeks out mysteries and acknowledges even muddled, mad, mesmerizing miasma that rises up as a kind of breath and breathing, connected with the pulsing and compelling rhythms of the heart.³⁹⁶

A “place of unknowing,” as suggested by poet and academic Leggo, seems to be a perfect place from which to begin my holonomic inquiry. This place is a chaotic shadowy sea of shimmering quantum probabilities that cannot wait to become written into the ever-changing holographic pattern of a chaotic quantum vacuum field, and then actualize into the ever-emerging explicate phenomenal world.

³⁹⁴ Ervin Shroedinger, cited in Watts, 1967: 100.

³⁹⁵ Talbot, 1993: 50.

³⁹⁶ Leggo, 1999: 120.

My purpose of my holonomic inquiry is to change the universe (s). No more, no less. This might sound a little ambitious, but let us remember that quantum theory stated a hundred years ago that even the most “innocent” measurements and the most “detached” observations inevitably change the world, whether we want it or not. Our every step, our every word, and our every decision recreate reality. We cannot escape ourselves in our research. Using the “river” metaphor, the holonomic observer is not one who sits on the edge of the stream and not even one who navigates the boat. The observer is the stream itself. She or he is a self-organizing wave, a whirlpool, an eddy of the ever flowing and changing river of reality.³⁹⁷ Quantum leap by quantum leap, holographic pattern by holographic pattern, the observer and the observed co-evolve together as one unbroken wholeness. Through the observer the observable observes itself.

WHO OBSERVES WHO?

The Observer to the Observed: I would like to observe you!

The Observed to the Observer:

Oh, how nice! We have mutual interests!

We all participate in an ongoing weave of holographic resonance patterns of our ever-new world. We have no choice. We are hopelessly entangled with our reality. Holonomic inquiry states this phenomenon boldly, saying that I am the world, and through me the world constantly re-imagines and re-creates itself.

*quantum leap
by
quantum leap
I weave
my holographic pattern
thread by thread
from a chaotic web*

³⁹⁷ Thrusty, 1991.

*I knit
atoms
I design
galaxies
the shimmering dance
of the possible world
entangled
within me
I, atoms, and galaxies
leap in a dizzying tango
of our entanglement
quantum leap
by
quantum leap...*

Quantum leap by quantum leap, with a “leap of faith,” I will create a pathway for my journey and by creating it, I will recreate the universe, which will never be the same again. Mindful of this cosmic responsibility, my holonomic inquiry follows the poet's invitation to connect the mysteries of the breathing world with the “pulsing and compelling rhythms” of my heart. Entering research through the heart opens the door into inner dimensions of my soul with all its obscurity, passions, and obsessions. That is why holonomic inquiry requires thorough preparations. Never should we attempt re-creating world (s) while having a “dirty” soul. The results could be disastrous!

I was responsible for everything that I was experiencing, for everything that had ever happened. I was looking into the face of my creation. I did this. I am doing this. I chose for all this to happen. I chose to create all these horrible, horrible worlds.”³⁹⁸

A SPRING CLEANING OF MY SOUL

*In the middle of the autumn
I began spring cleaning;
a little too late
but better late than never.*

I swept away the garbage of envy and anger

³⁹⁸ Grof, 1998.

*from the dark corners of my soul,
then washed the spots of evil and greediness,
then polished up several dusty friendships.
They shine like new again.*

*I unlocked my soul's rusty dresser drawers
and unexpectedly found
several thousand forgotten smiles.
I think I still can use them.*

*On the broken old shelves
of my soul's library
I discovered hundreds of
voluminous poetry books,
fragments of beautiful music,
a bottle of love potion,
pieces of breathtaking art,
chaotic piles of memories,
and dreams about the future
which needed to be brought
into a reasonable state of order.*

*After thoroughly washing
the doors and windows of my soul,
I opened them widely
inviting in
the clean rains,
the radiant rainbows,
and
the fresh winds:*

Hello, world!

My inquiry is an invitation rather than search. It invites to re-imagine, to re-create the world and consequently school science curriculum. To do that, I need “courageous willingness” and a “leap of faith.” Today science curriculum is “geared to a materialistic, deterministic, atomistic, reductionist, and objective vision of the universe.”³⁹⁹ Do I have enough power to shake the thick and strong chain that links modern science education to a rusty, old machine and to move it into complex, holographic, and living reality? This task

³⁹⁹ Gough, 1987: 4-5.

is challenging, but the pulse of my heart “pushes” me onto this path, a path I approach intuitively through years of living and teaching.

In the mechanistic universe, the research methodology has to be “crystal cut.” Messiness of obscure variables is not accepted for high-quality research. “Crystal cut” sounds good and clean, but there is a problem. Reductionist cuts, I’m afraid, will kill the living, complex, holographic, unpredictable, mysterious, chaotic, and ever-becoming world of re-enchanted science education. To imagine this new world into existence, I need research that dances on the edge of chaos, that walks through “a maze whose walls rearrange themselves with every step you take.” This metaphor, writes Patton, “fits a great deal of fieldwork in real-world settings, but the implication can be threatening to our need for order that we ignore the rearranging walls and describe the maze with a single static diagram.”⁴⁰⁰ I realize that the richness, fuzziness, and wholeness of the deeply re-enchanted world cannot be imprisoned within prosaic static diagrams. This is why,

*“I want research that hangs out in the spaces between
a poetics of possibility and a poetics of impossibility.”⁴⁰¹*

The rational “irrationale” of re-enchanted science curriculum is to develop a sense of unity with the world, to grow a unique cosmos from each young human being, to enable students “to see the same currents running through our human blood that run through swirling galaxies and colossal solar systems.” However, before I expect a transformation in the students’ worldview, I need to undergo my own transformation. This means, I need to re-imagine my own world and for this purpose, I need to conduct a

⁴⁰⁰ Patton, 1990: 82.

⁴⁰¹ Leggo, 1999: 122.

holonomic inquiry, which fertilizes a *great holarchy of becoming unified with the living world*. The holonomic inquiry is aimed at helping me to move out from the fragmented dead mechanistic reality where I lived and taught science for so very long. Conducting this inquiry, I hope to re-create my universe, and therefore to re-design its intricate holographic patterns, quantum leap by quantum leap toward an increasing order of complexity, via the flight of a chaotic butterfly.

2. *intricate quantum leaps of universe (s) re-creation (s)*

“*We will do it, whether we want it or not.*” These were the words of a scientist on a recent TV program about genetic engineering. Fascination with human potential to choreograph the evolution of the universe has started to penetrate public media. In a Vancouver Sun article *Building a Better Mouse Brain May Make Humans Smarter*, scientist Arthur Caplan writes, “...what we are looking at are baby steps toward a world in which we can design our descendants.”⁴⁰² Emerging empowered science, based on synergy between quantum revolution, biomolecular revolution, and the computer revolution, is rapidly increasing its capability to seize Nature's torch in the process of ongoing creation.

We will do it, whether we want it or not. This could be taken as an adage of the cosmic creative principle, the elemental force that is deeply embedded in our inner dimension.⁴⁰³ In *The Eye of Spirit: An Integral Vision for a World Gone Slightly Mad*, philosopher Ken Wilber synthesized contemporary integral studies of human consciousness, “a series of multidisciplinary, multicultural, and multimodal approaches

⁴⁰² Vancouver Sun, Thursday, September 2, 1999: 1.

⁴⁰³ Grof, 1998.

that together promise an exhaustive mapping of the entire range of consciousness.”⁴⁰⁴

These studies, involving hundreds of researchers and embracing both East and West, history and the present, “are rapidly piecing together a master template --a spectrum of consciousness--using the various approaches to fill in any gaps left by the others.”⁴⁰⁵

So far, the findings of state-of-the-art consciousness research echo spiritual mystic visions of perennial philosophy. The growing field of contemporary transpersonal psychology, inter alia, indicates that the essence of a human being is not merely “skin-encapsulated ego.”⁴⁰⁶ To the contrary, the human psyche has transpersonal cosmic origins and the boundaries between individual human existence and the rest of the world are illusory and arbitrary. Each human is an intelligent Cosmos in itself. Sounds holographic, doesn’t it? As psychotherapist Stanislav Grof writes, such a vision is indeed consistent with the holographic model of the world and, of course, it is at odds with the mechanistic perception of human consciousness as an accidental by-product of evolving passive matter.

The findings of my research and contemporary consciousness research in general essentially confirm and support the position of ancient teachings. They are thus in radical conflict with the most fundamental assumptions of materialistic science concerning consciousness, human nature, and the nature of reality. They clearly indicate that consciousness is not a product of the brain, but a primary principle of existence, and that it plays a critical role in the creation of the phenomenal world.⁴⁰⁷

In the light of consciousness research, all the intricate diversities of our phenomenal world may well manifest the art and creations of Supreme Absolute consciousness (*implicate order? quantum vacuum holofield? primordial Chaos?*) driven

⁴⁰⁴ Wilber, 1997.

⁴⁰⁵ Grof, 1998: 30.

⁴⁰⁶ Ibid: 30.

⁴⁰⁷ Ibid: 7.

to actualize its “pre-existing potentialities.” Since no boundaries exist between the individual and the Cosmos, each human life is “the cosmic creative principle itself, and each of us is ultimately identical with a divine source of creation. We thus are, “collectively and individually, both playwrights and actors in this cosmic drama.”⁴⁰⁸ We are both, creators and creations in this incredible, mysterious world.

We will do it, whether we want it or not. The cosmic creative principle pulses within our hearts. This elemental cosmic force “pushes” us to weave the holographic patterns of our reality, leaving us with no choice but to create. It is not up to us to stop the flow of this force, but perhaps it is up to us to choose its direction.

Do humans absolutely have to invent new weapons?

We are responsible for the reality we create. However, how do we actually create our reality?

QUANTUM LEAP:

My bodily intelligence enables me to translate the holographic patterns of chaotic implicate order into the phenomenal explicate world.

Quantum mechanical experiments illuminate an intriguing phenomenon, the observer effect, which is a sudden change in a physical world ascribed to the actions of consciousness. It appears that the act of observation forces the world into material existence out of a shimmering sea of quantum probabilities. From the perspective of the holographic vision of the world, quantum probabilities are written into the blur of apparently chaotic, semi-real, ever-shifting, ever-changing holographic interference patterns of quantum vacuum holofield. As a laser beam, my brain “reads” vague

⁴⁰⁸ Grof, 1998: 39.

universal hologram patterns into the phenomenal world with “tools” provided to me from my birth as a human.

To me, this holographic scenario is compatible with the vision of Alfred North Whitehead, who distinguishes between “sense-reception” and “sense-perception.”⁴⁰⁹ The sense-reception is a primitive, obscure awareness of a chaotic primordial world. This type of experience is “vague, haunting, unmanageable.” This “heavy, primitive” awareness constitutes “experience dominating primitive organisms.” This sense-perception is the construction of our sense organs and our brain. It arranges the world into shapes, forms, sounds, and colours as they are perceived by humans. “It displays a world concealed under an adventitious show, a show of our own bodily production.”⁴¹⁰ My body, therefore, is the very first instrument for creating my phenomenal reality.

We perceive the world through our human frame, and, therefore, we can more or less reach consensus as to how reality appears to us. However, to other experiencing beings, reality appears different. As Husserl stated, our knowing the world is not objective, but intersubjective.⁴¹¹

The more differences in the scheme of beings, the less similar the universe appears to them. If, for instance, my co-researcher was a worm, I don't think our consensus about how the world looks or tastes or smells could be easily reached despite the worm's being quite a respected scientist in the wormy community. The worm knows a different world. Its bodily intelligence would translate the holographic patterns differently. Or, I would perhaps hurt a spider's feelings if I ever described her spider web in gray colours, as it appears to me. For the ultraviolet-sensitive eyes of insects, the spider

⁴⁰⁹ Whitehead, 1959.

⁴¹⁰ Whitehead, 1959: 43-44.

⁴¹¹ The work of Edmund Husserl synthesized in Abram, 1996.

web is a brightly coloured piece of art. The spider and I share the same, yet different worlds.

If our reality is indeed holographic, the observer effect is the act of translating seemingly chaotic patterns of the universal hologram into a phenomenal world of forms, patterns, shapes, smells, sounds, and tastes. I look at a beautiful tree wearing its fashionable dress of autumn colors. In order to observe it, I did not organize any lab experiments and did not measure anything. I simply and innocently looked at the tree. However, I altered reality by my observation. My bodily intelligence instantly transformed the world from an ambiguous vagueness into a kingdom of distinct appearances. The phenomenal world suddenly leaped into existence for me.

QUANTUM LEAP:

I interpret bodily readings with the "tool" of my cultural metaphorical language.

I perceive reality as meaningless colors, patterns, and shapes unless my cultural metaphoric language enables me to interpret them into trees, flowers, stars, and cars. At this hermeneutic step, I create my reality from my interpretation of it. As philosopher Martin Heidegger noted, we humans are interpreting entities; our "Being and interpretation are inseparable."⁴¹² The meaning is the story of human life. The human is *homohermeneuticus*.

I create my world as far as my body reads the holographic patterns of the universe and as far as my belonging to a particular culture permits me to select and interpret these

⁴¹² In Davis, 1996: 19.

readings. In their book *Embodied Mind*, biologists Humberto Maturana and Francisco Varela write that we “bring forth the world” by enacting it biologically and socially.⁴¹³

Exercises for holonomic researchers:

**EXERCISE ONE:
PERCEPTION WITHOUT INTERPRETATION⁴¹⁴**

The purpose of this exercise is to take a first step toward becoming aware of the mind's figurative creative process by consciously trying to stop it. The next time you walk down a street (preferably a fairly safe, untrafficked one), try to be aware of the pure sensations you experience, and, at the same time try to avoid interpreting them. That's not a tree trunk you're passing; it's an elongated vertical brown area in your visual field... It's simply a raw brownness, enlarging, changing, diminishing, nothing more... What you see is just a variable continuum of shapes and colors, not delineated things separated from each other by space, but a multicolored unified pattern of variations... I do not recommend this exercise as a steady diet, but only as an experiment in becoming aware of figuration, of a way to participate in creating our environment and the relativity of our experience in the world.

**EXERCISE TWO:
RED FILTER**

Look through the red filter, and you will see a different world.

The cultural metaphorical language is a “red filter” which shapes your interpretation of the world. The aim of holonomic inquiry is to look at the world through the filter of re-enchantment in order to see unbroken wholeness instead of mechanistic fragments.

QUANTUM LEAP :

*My (universal) imagination enables me
(the universe) to search for horizons.*

⁴¹³ Varela, Thompson & Rosh, 1993.

⁴¹⁴ Johnes, 1982: 220.

Martin Heidegger writes about the mystery of human life as There-Being or *Dasein*.⁴¹⁵ Dasein, while being “thrown” into the world, is inseparable from it. The impossible task is to determine where one ends and another begins. (Again, it sounds holographic.) Existing in the midst of the world, Dasein tries to make sense of his experiences using imagination as the adhesive for putting these experiences together into a comprehensible wholeness. Imagination, writes Whitehead, enables us to make abstractions and inferences from the constant flux of information and experiences.⁴¹⁶

Dasein always lives ahead of himself, constantly searching for “horizons,” while “throwing before self the possibility as possibility, and letting it be as such.” This is how humans “bring into the picture of existence the realm of possibilities.” This is true for routine everyday endeavors, as well as for the fancy, artistic realms. Human imagination makes possibilities possible within a range offered by the rest of the universe. This spectrum of possibilities is constantly changing and shifting, and here the element of uncertainty comes into play. To me, Heidegger expressed the very essence of the “chaotic butterfly” principle, which is a freedom within boundaries. From one chaotic attractor to another, our imagination is free to fly in search for horizons. It enables us to make choices within limited possibilities and then to materialize chosen possibilities into existence. Our imagination re-writes universal holographic patterns, as far as the universal boundaries of our existence permit us the freedom to do that.

*Destiny is not a matter of chance.
It is a matter of choice.
It is not a thing to be awaited for.
It is a thing to be achieved.*⁴¹⁷

⁴¹⁵ Heidegger, 1962.

⁴¹⁶ Whitehead, 1929/1967.

⁴¹⁷ Bryan, cited in Kaku, 1998: 56.

I would say that in accordance with the rule of the chaotic butterfly, our destiny is the interplay of chances and choices. Chances emerge from the jungle of quantum probability waves that reside within the patterns of the quantum vacuum informational holofield. I react to the situation accordingly by actualizing one of the chances offered to me by the rest of the universe. My action changes the universal holographic patterns. If I reacted differently, the universe would evolve along a different path.

WHO KNOWS...

*Heavy rain without an umbrella
puts you in the same position as the rest of the world
where
roofs, pavements, grass, and leaves
are overflowing
with enveloping, penetrating, warm moisture...
Walking along an empty wet street
without her umbrella,
She had absolutely nothing to lose.
A passerby invited:
"Would you like to join me under my umbrella?"
You are completely soaked!"
"Which is why I do not need an umbrella anymore,"
She declined, smiling.
He smiled back and went along his way.
She watched him dissolve into the gathering gloom
Thinking:
who knows... maybe
a not-chosen and therefore not-happened destiny
has just vanished
over the rainy horizon,
while hiding under an old umbrella...*

Our imagination, which enables us to make choices, is a powerful force re-shaping the world. Look around and see for yourself: houses, roads, machines, hospitals, malls, art, music, literature, science, schools, all is a frozen manifestation of human imagination. Where does our imagination come from? Its primary source, writes

image psychologist Akhter Ahsen, is our primordial nonlocal holographic connection with the world.⁴¹⁸ Similarly, psychologist Johnson suggests that our imagination springs from our embodiment of the world.⁴¹⁹ In other words, the source of our imagination is the Cosmos itself. It makes sense in the holographic universe, where I am a Cosmos, and therefore, my bodily sensations, consciousness, emotions, spiritual feelings, and imagination have cosmic origins.

quantum leap
by quantum leap
I weave my holographic pattern:

Experience-Absorb-Translate--with bodily intelligence

Reflect-Intuit -Interpret -- with cultural metaphorical language

*Imagine-Transcend-Create Anew--the never-ending story.*⁴²⁰

"And all this through the ever enchanting mix between the personal, social, natural worlds", writes Bowles.⁴²¹ ...And all this through an awareness of cosmic responsibility for my creation. And all this toward a new order of complexity.

3. a new order of complexity

The cosmic creative principle pulses in my heart. That is why I create and that is why I have a cosmic responsibility for my creation. If I re-imagined the universe, I must internalize it. I must start living in the world *as if* it is not mechanistic but complex, alive, and holographic. I have to "prove" the authenticity and meaningfulness of this new reality through my own living in it; otherwise, my imagined world will become yet another abstract, idealized world.

⁴¹⁸ Ahsen, 1991.

⁴¹⁹ Johnson, 1987.

⁴²⁰ I modified words of Steve Bowles in Bowles, 1996: 4.

⁴²¹ Ibid: 6.

While imagining the re-enchanted holographic universe, I shall look at my own experiences, seeking a hint that, indeed, I am an unbroken wholeness with the living world and that “the same currents running through our human blood run through swirling galaxies and colossal solar systems.” This is the essence of a holonomic inquiry. In *Process and Reality*, Whitehead comments that experience is not a vehicle to help us to understand a reality abstracted from us; on the contrary, experience is the “really real” reality of our being.⁴²²

I must explore the nature of my immediate lived experiences in the re-imagined world. It makes my research phenomenological.⁴²³ I must explore the emotional, passionate, intuitive states of my existence. It makes my study existential or transpersonal.⁴²⁴ I must interpret the meaning of my experiences in the context of the imagined new world, and in so doing make my research hermeneutic.⁴²⁵ I must organize into a cogent story the chaotic amorphous mass of my thoughts, intentions, and images. It makes my inquiry narrative.⁴²⁶ To conduct all these explorations, I must imagine the world into existence through my performance in it. It makes my study performative.⁴²⁷

In my ongoing hermeneutic spiraling from whole to part and vice versa, I need to view my experiences from the perspective of the whole; therefore, my inquiry is autobiographical. As poet Carl Leggo writes, autobiographical research seeks to “stand over lived experience, to view lived experience from a perspective of over-standing, an aerial view.”⁴²⁸ The aerial view over my experiences enables me to trace a dynamic,

⁴²² Whitehead, 1978.

⁴²³ Patton, 1990: 69.

⁴²⁴ Broud & Anderson, 1998.

⁴²⁵ Gadamer, 1989.

⁴²⁶ Czarniawska, 1998.

⁴²⁷ Fels, 1999. More details on the page 202.

⁴²⁸ Leggo, 1997: 85.

nonlinear evolution of the whole organism comprised of myself, my research, and the rest of the universe.

According to Leggo, autobiographical writing is not just a linear story with a pre-determined plot, but a “living compost” of my stories, and within my stories, the stories of other experiencing beings. An autobiographical story, therefore, is a story of quantum inseparability. Once you contact something or someone, you become forever entangled. Within your own story, you internalize stories of others.

Autobiographical, phenomenological, transpersonal, narrative, hermeneutic, and performative inquiries overlap through emphasizing our embodiment and internalization of the world. The concept of embodiment, however, is the core of the holographic principle: *all in all*. Also, all these methodologies highlight an ongoing life-world co-emergence, and this is the essence of a holonomic inquiry that fertilizes a *great holarchy of becoming an unbroken wholeness with the living world*.

What new then do I propose? How different is my methodology from existent methodologies? Departing from mechanistic reductionism, I approach my argument for a new methodology not from the angle of differences, but from the position of a new order of complexity. Being an intricate bricolage of various research methodologies, which stress embodiment and emergence, holonomic inquiry is more than the sum of parts. The uniqueness of a holonomic inquiry is manifested in its research question: *through what experience and under what circumstances do I feel unified with the world?* While aiming to “*find the Andromeda galaxy in the thumbnail of our left hand*,”⁴²⁹ holonomic research invites to *listen* to ourselves and others with understanding that our experiences are cosmic experiences. In the re-enchanted world, where the researcher is the Cosmos, his or

⁴²⁹ Talbot, 1993: 50.

her presence within research is not hidden; on the contrary, it shines throughout the entire project as a light reflected from the sparkling diamond.

4. a light from the sparkling diamond

“The most important lesson which reduction teaches us, is the impossibility of a complete reduction,” writes Murray.⁴³⁰ Since I attempt to create a complex, multidimensional universe, I shall reflect on an entire intricate spectrum of my experiences, including my bodily, mental, and spiritual experiences. The light reflected from the multifaceted diamond of my experiences might help me envision a new, re-enchanted world.

The metaphor of a diamond might help to explicate the varieties of experience. We might imagine that each human being encounters life as if experience were a crystal diamond, with each individual facet reflecting another's experience to create yet more brilliant diamond reflecting our essential communal and interconnected nature. Our experiences, especially uncommon experiences, lead us to transcend realities beyond the limits of egos and personalities. Reflected in these realities, we can become more integral and whole, finding our more authentic and creative selves. In finding ourselves, we learn to trust our impulses toward transcendent realms beyond our limited self.⁴³¹

In the mechanistic universe, the researcher who explores her or his own experiences is reduced to the label of a “research sample”, “object”, or “subject”. In the systemic universe, the researcher is a “system within a system within a system.” In the re-enchanted holographic world, the status of the researcher is elevated to that of a multifaceted diamond reciprocally reflecting the entire universe. In this sense, holonomic inquiry resonates with heuristic research, which belongs to the family of transpersonal research methodologies, and is largely existential-phenomenological-hermeneutic self-

⁴³⁰ Murray, 1986: 39.

⁴³¹ Braud & Anderson, 1998.

inquiry. "Heuristic research refers to a process of internal search through which one discovers the nature and meaning of experience....the self of the researcher is present throughout the process and, while understanding phenomenon with increasing depth, the researcher also experiences a growing self-awareness and self-knowledge."⁴³² This sounds holographic enough. By exploring the world, the researcher explores himself or herself and vice versa.

Heuristic inquiry is a process that begins with a question or problem, which the researcher seeks to illuminate or answer. The question is one that has been a personal challenge and puzzlement in the search to understand one's self and the world in which one lives. The heuristic process is autobiographic, yet with virtually every question that matters personally, there is also a social--and perhaps universal--significance.⁴³³

The world *heuristic* is related to two sources. *Eureka! Aha!* In the holonomic inquiry, the *eureka* moments correspond to quantum leaps of meaning that result in the ongoing emergence of new universal holographic resonance patterns, when a new order of complexity and therefore a new world is born. There is something else which makes the philosophy of holonomic inquiry resonate with the philosophy of heuristic research. Both methodologies are aligned with a poet's invitation to connect the researcher's pulsing heart with a breathing world. Such a connection assumes a spell, passion, enchantment, and therefore an unbroken wholeness between the researcher and the researched. This is of course in concurrence with a holographic principle.

*to look at any thing
if you would know that thing,
you must look at it long:
to look at this green and say:
"I have seen spring in these woods"
will not do--you must
be the thing you see:*

⁴³² Moustakas, 1990: 9.

⁴³³ Moustakas, 1990: 15.

*you must be the dark snakes of
stems and ferny plumes of lives,
you must enter into
the small silence in between
the leaves
you must take your time
and touch the very place they issue from⁴³⁴*

Like the heuristic researcher, I seek to “gather within myself the full scope of my observations, thoughts, feelings, senses, and intuitions.”⁴³⁵ I learn to “accept as authentic and valid whatever will open new channels for clarifying a topic, question, problem, puzzlement.”⁴³⁶ It makes my holonomic inquiry an open-ended self-exploration aimed at comprehending the “outer” through the prism of the “inner.” I learn to accept the cosmic value of my “inner”, and therefore, I sing myself holographic!

5. I sing myself holographic⁴³⁷

*Ancient Tantric texts suggest that the human body
literally is a microcosm that reflects and contains the entire macrocosm.
If one could thoroughly explore one's own body and psyche,
this would bring the knowledge of all the phenomenal worlds.⁴³⁸
(Stanislav Grof)*

The idea that our universe is perhaps living and holographic is truly fascinating and emotionally appealing. In such a universe, everything is enfolded in everything. All in all. My experiences are universal experiences. I am not alone here, not fragmented, not isolated, and that is a very cozy feeling. I definitely like that, but...

...do I really, really feel holographic?

⁴³⁴ Moffit cited in Moustakas, 1990: 12.

⁴³⁵ Moustakas, 1990: 13.

⁴³⁶ Moustakas, 1990: 13.

⁴³⁷ Talbot in *The Holographic Universe* has the chapter “I Sing my Body Holographic.” I modified his expression into “I sing myself holographic.”

⁴³⁸ Grof, 1998: 58.

Did I, do I have enough experiences in my life that could give me a hint that...
yes, my world is not a fragmented machine, but a holographic unity. The very heart of the
holographic principle is "unbroken wholeness"; therefore, I must look for experiences of
feeling at one with humans or more-than-human individuals. It is not going to be easy
since I am coming from a disjoined materialistic world. How could I, with my own ego,
skin, history, destiny, likes, dislikes, customs, desires, and intentions can possibly feel at
one with...let's say... the homeless man sitting on the corner of a wet street?

*I recall an event from two years ago. I walked along Vancouver's hectic Robson
Street, aiming for nothing in particular, simply enjoying being in the midst of the
boisterous crowd... Unfortunately, there are many homeless people in downtown
Vancouver. They are an attribute of the city's interior. I often give the homeless a little
money, then pass them by, immersed in my own little world. They have their reality and I
have mine. I suspect their reality must be terrible, but I do not really internalize it since I
have never been there. How could I know something I have not experienced? This is what
I thought until once upon a time, wandering along Robson Street, I saw a homeless man
who, while sitting in the rain on a street corner, was reading the philosopher Spinoza.*

*on the corner of a cold wet street
surrounded by all necessary
attributes of homeless life
easily fitted into several old bags
he read the philosopher Spinoza
oblivious to the exterior world
not even begging for money
not even aware perhaps
of the painfully dramatic contrast
between his untidy appearance
and his intellectual reading...
who was he? why Spinoza?
which dark wind
swept him from the stream of*

*the "normal" human world
onto this wet cold corner?
Was he running from something?
was he looking for something?
bringing Spinoza into his
homeless world which terrifies me,
did he find a truth
that I will never understand?*

I wrote this poem after coming home. I had to let my emotions out. For some inexplicable reason, when looking at this man, I had the acute sense of knowing how it felt to be homeless on the corner of a wet, cold street. How could I know? Could it be that the language of intuition told me that both he and I were an unbroken holographic wholeness?

*There was something else striking about this strange meeting. The evening before, I'd read a book of Arthur Deikman's *The Observing Self: Mysticism and Psychotherapy*.⁴³⁹ Refusing to believe in the reality of what had happened, I opened the book to the page I'd read the evening before:*

Spinoza's definition of intuition is closest of all the philosophers to that of mystical science. Writing in the seventeenth century, Spinoza distinguished between knowledge derived from the sense perception and careful reasoning about observed phenomena ("opinion" and "reason") and the highest knowledge, in which the whole of the universe is comprehended as a unified interconnected system. This highest knowledge he termed intuition, something which grows out of empirical and scientific knowledge but rises above them. In essence, it is knowledge of God.⁴⁴⁰

I'd read about Spinoza before I met the homeless man who read Spinoza. My intuition told me how it might feel to be homeless. Spinoza was the one who coined the term intuition. Was there some meaning to this event? Why was this man reading Spinoza?

⁴³⁹ Deikman, 1982.

⁴⁴⁰ Deikman, 1982: 48.

Carl Jung termed this phenomenon *synchronicity*.⁴⁴¹ Occasions of synchronicity are too meaningful to be just a simple coincidence. They occur between events that are connected not through causality, but through common symbolic or metaphorical content. The physicist Roger Johnes, in *Physics as Metaphor*, describes his own striking case of synchronicity.

While writing the preceding section on counting and cardinality, I had an unusual experience. Looking up momentarily from my typewriter, I glanced out of the window and saw a beautiful red bird alight in my backyard. You guessed it--a cardinal.⁴⁴²

As another physicist Michael Talbot writes, each of us can perhaps tell of an event of synchronicity which happened “at some point of our lives, such as when we learn a strange new word and then hear it used in a news broadcast a few hour later, or when we think about an obscure subject and then notice other people talking about it.”⁴⁴³

Throughout his long practice, Carl Jung became convinced that synchronicity is an *acausal* principle which science has yet to discover. According to physicist David Peat, synchronicity provides a hint of the holographic nature of our reality, where our physical world and our inner psychological world influence each other.⁴⁴⁴ Synchronicity might be the echo of a deeper implicate order of reality, where events are connected by meaning and harmony, and not by simple causality.

So one does best simply to stand before this whole matter in wonder and awe, trying to fathom, but not too consciously, some inner connection among the ideas or some deep synthesis of amount, fundamentality, and wholeness.⁴⁴⁵

⁴⁴¹ In Talbot, 1991.

⁴⁴² Johnes, 1982: 30.

⁴⁴³ Talbot, 1991: 76.

⁴⁴⁴ Peat, 1991.

⁴⁴⁵ Johnes, 1982: 30.

Exploring my imagined holographic universe, I became more attentive to the experiences that may be referred to as synchronistic. Who knows, maybe they represent “scientific evidence” for the existence of deeper meanings hidden within the depths of an implicate order, within a quantum vacuum field of a holographic reality?

Other experiences that perhaps indicate the nonlocal holographic nature of our world, are telepathy-like communications.⁴⁴⁶ Unfortunately, I am not a psychic who can communicate with other entities at a distance; however, certain experiences tell me that there is something to it. My relationship with this miracle of miracles, my daughter, provides an example of how two physically separated entities can sense each other at a level that is deeper than all usual means of communication. I “feel” her somehow (*telepathically?*) at the distance.

It was time when my daughter and I were a single organism. Could it be that we still are? Does the phenomenon of telepathy indicate that we all, while coming from a single source, are a holographic “one”? Is the phenomenon of telepathy an amplified into the marcoworld principle of quantum nonlocality that, just like crazy glue, “holds” the holographic universe together? Could it be that telepathy is an ancient language, lost in the mechanistic jungles of modernity? Is it possible that this paranormal phenomenon is perfectly normal?

Writes Laszlo:

Anthropological evidence indicates that telepathy is common among so-called primitive people. In many tribal societies shamans seem able to communicate telepathically, using a variety of techniques to enter the altered states of consciousness that seem required for it, including solitude, concentration, fasting, as well as chanting, dancing, drumming, and the use of psychedelic herbs.⁴⁴⁷

⁴⁴⁶ Laszlo, 1995; Talbot, 1993; Wolf, 1991.

⁴⁴⁷ Laszlo, 1995: 89.

David Griffin in *Parapsychology, Philosophy, and Spirituality: A Postmodern Exploration*,⁴⁴⁸ Ken Wilber in *The Marriage of Sense and Soul: Integrating Science and Religion*,⁴⁴⁹ and Ervin Laszlo in *The Interconnected Universe: Conceptual Foundations of Transdisciplinary Unified Theory*,⁴⁵⁰ write that the modern worldview ruled out the possibilities for paranormal interactions to happen at all, and this is inconsistent with overwhelming anecdotal stories. Increasingly, scientific attention is turned to exploring paranormal phenomena such as telepathy, extrasensory perception (ESP), psychokinesis (PK), out-of-body experiences, and near-death experiences (NDE). As Griffin, Lazlo, and Wilber write, scientific experiments indicate that these phenomena are no longer illusive. The task is to discover where it comes from, and it may well come from quantum-vacuum interactions of human mind/brain with the universal holofield.⁴⁵¹ Do I suggest that a holonomic inquirer must practice PK or ESP? At this point, I would not go so far because as a rule, the members of contemporary industrialized informational society are completely unprepared to perform this “stuff.” I can only invite holonomic researchers to be open-minded to the possibilities....

Seeking hints as to the possible holographic nature of reality, I became attentive to my dreams. I never took dreams seriously before moving into the holographic universe. Most of the time I do not remember my dreams, or they do not make any sense to me. But sometimes these dreams appear so real, so meaningful, that they are impossible to forget. Waking up after such a dream, I am not sure whether I was really there, or not...

⁴⁴⁸ Laszlo, 1995; Griffin, 1997; Wilber, 1998.

⁴⁴⁹ Wilber, 1998.

⁴⁵⁰ Griffin, 1997; Wilber, 1998.

⁴⁵¹ Laszlo, 1995; Talbot, 1993; Griffin, 1997.

It was a city of millions of mirrors... Millions, millions, millions of mirrors. They were scattered everywhere. Grass, pavement, bushes, roads, everything was covered with shiny little fragments. I was walking along streets, listening to the sounds of my lonely steps and to the rain jumping playfully on the smooth mirror surfaces. The city was empty. This emptiness looked at me through every open window, through every door clumping in the wind. A strange city. Who had abandoned it, and why? And... what am I doing here? I was obviously alone, but at the same time, I felt a presence emitted from every empty corner. I glanced at my reflection in the mirror, but instead of myself, I saw a crowd of smiling and crying, black and white, attractive and scary faces. I also saw clean, clear, bright stars reflected in the scattered mirrors on the cloudy rainy day. I saw strange colorful geometrical forms changing rapidly. I heard the whispers of many voices from the silence of emptiness. Somehow, I knew that I was both asleep and awake. Surprised, and shocked, I opened my eyes...and... I knew that I did...I did visit this city.

In this lucid dream,⁴⁵² I was one and I was many. *Omnia omnibus*, a holographic universe. Was this dream the result of my constant and conscious self-immersion into thinking about the holographic nature of the world, or was it an actual visit to the parallel level of holographic reality, as quantum physicist Alan Wolf believes? Wolf predicts, “the holographic model will ultimately allow us to develop a *psychic consciousness*, which will enable us to begin to explore more fully these other-dimensional levels of existence.”⁴⁵³

⁴⁵² Lucid dreams are unusually vivid dreams in which the dreamer realizes he or she is awake. Some physicists suggest that lucid dreams manifest our entering other levels of reality. Do I believe in that? I am not sure.

⁴⁵³ Talbot, 1991: 3.

In my dream, I had an experience similar to those in the holotropic state of consciousness described by Stanislav Grof. In this state, people identify themselves with animate and inanimate matter, including the Cosmos itself. According to Grof and his colleagues, the ability to see, think, and feel holonomically can be developed through breathing techniques. For the holonomic researcher, it could be useful to become skillful in entering “the holographic labyrinth that connects all aspects of existence.”⁴⁵⁴

Holotropic self-explorations might enable the researcher to reach beyond the human frame of translating the holographic pattern of the world into the whole kaleidoscope of the multiple worlds of other beings within an underlying unity.

There are moments however when we feel acutely our holographic unity with the world without conscious efforts, exercises, or workshops. Stanislav Grof writes that extraordinary natural, as well as human-made beauty can trigger holographic spiritual experiences of oneness with the world. Grof called such experiences *unitive* states and the founder of transpersonal psychology Abraham Maslow called them *peak experiences*.⁴⁵⁵

In the mechanistic universe, beauty represented an insignificant avenue for knowing the world. The word “beautiful” was not popular in the vocabulary of reductionist science, but...

*when you understand all about the sun
and all about the atmosphere
and all about the rotation of the earth,
you may still miss the radiance of sunset.*⁴⁵⁶

⁴⁵⁴ I signed up for Grof’s workshop, which I am going to attend shortly. I am very curious whether I will be able to have experiences of other experiencing beings. If I were to choose, I would like to have experiences of Gaia. How does she feel? What does she think? What is her life about?

⁴⁵⁵ Grof, 1998; Maslow, 1970.

⁴⁵⁶ Whitehead, cited in Kirk, 1991: 208.

Contemplation gives us “choiceless awareness of that universe not as it should be or might be or could be, but simply as it is,” writes Ken Wilber. “The entire Kosmos is an object of Beauty, just as it is, precisely because the entire Kosmos is in fact the radiant Art of Spirit.”⁴⁵⁷ All-pervading radiant Beauty, continues Wilber, is not an exercise in creative imagination, it is the very nature and structure of the universe.

In *unitive* states of consciousness, people “lose their boundaries and literally merge” with the majestic silence of mountains, the impenetrable depth of the ocean, beautiful music, art, or the huge full moon in the sky. When I merge with world phenomena, I am enchanted. Every enchanting moment is “evidence” of my holographic oneness with the world. Enchantment is a holonomic way of knowing!

*You see, it is not the knowledge of the serpent,
It is not the doubtful honor of experience,
But the ability to be enchanted with the world
That reveals to us the world as it really is.*⁴⁵⁸

Collecting data for my holonomic inquiry, I collect “glorious enchantments”⁴⁵⁹ or miracles that are “unusually marvelous things or facts,” according to the dictionary.

MY COLLECTION

*I collect my miracles
as people collect coins and stamps,
as a miser collects his money.
I collect my miracles
by every minute, every hour,
by every little but magical event.
It might be the scent of spring,
or an exotic flower in someone's window,
or blinding snow on the ground melting rapidly,
or the vanishing sound of a charming song,
or the passing attention of a stranger,*

⁴⁵⁷ Wilber, 1997: 137.

⁴⁵⁸ Eugenyi Eutushenko, the Russian poet.

⁴⁵⁹ Bowles, 1994.

or the smile of my child...

*One night
when a forgotten friend
appeared unexpectedly
out of the blue
just to say "Hi!"
added a lot to my collection...*

Conducting my holonomic research, I became attuned to events that could be qualified as enchantments or miracles, and...now I have difficulty in finding anything under this sky that is not a miracle. When I lived in the mechanistic universe, I was blind. I did not see miracles, but they are literally everywhere!

A soap opera "Days of Physical Science in Elementary Schools Course"

Teacher:

What does the word "miracle" mean?

Chorus:

(a range of different opinions)

Teacher:

Would you consider it a miracle if something that was just now in front of your eyes, suddenly became invisible?

Chorus:

Yes!

Teacher:

Then watch this demonstration of a simple miracle (table salt dissolving in the water).

A voice from the chorus:

I never thought about that!

Teacher:

I too. I never thought about that before I started to look for miracles through the

re-enchanting filter. And now, I see their great abundance throughout the accessible world... When I lived in a disenchanted mechanistic universe, I saw white light in terms of wavelengths and frequencies, but now I also see it in terms of hidden rainbows. What could be more miraculous than a rainbow hidden in white light?

Shannon's poem:

*Colours bridge the sky,
Radiant, brilliant, then gone
Illusion of hope*

Phillip's poem:

*Sparkles of Colour
Arch Across the Summer Sky
As Smile, Upside Down!⁴⁶⁰*

THE MOTTO OF A HOLONOMIC RESEARCHER: *believe in miracles and enchantments, and you will see them everywhere!*

SEEING IS BELIEVING *in a disenchanted universe*

BELIEVING IS SEEING *in a re-enchanted universe*

When I am enchanted, my ego dissolves and my wavelike existence merges into holographic patterns of resonance with the rest of the world.

*A single wave, of which
I am the accumulating sea;
you, of all possible seas the most frugal,
space to be used.
How many of these places in space were already
within myself, many
a wind
is like a son to me.
Do you know me, air,
still filled with my habitations?
You, sometime the smooth outer skin,
the rounding and leaf of my words.⁴⁶¹*

⁴⁶⁰ Shannon and Philip were prospective teachers enrolled in my science education course.

⁴⁶¹ Rilke, cited in Spiller, 1997: 136.

Holographic patterns of resonance can perhaps account for our experiences of empathy, which is a powerful indicator of our connectedness with other human and more-than-human individuals. Laszlo believes that experiences of empathy occur through brain-holographic interactions:

The widely observed natural empathies of so-called “primitive” peoples reinforce this supposition. To cite merely oft-quoted nineteenth century declaration of Native American Chief Seattle: “This we know. All things are connected like blood which unites one family. All things are connected. Whatever befalls the Earth befalls the sons of the Earth.” In Western and westernized societies natural empathies are mainly repressed; they surface principally in the mind of exceptionally sensitive individuals. Poets such as John Donne and William Blake have sung of our oneness with nature, and a handful of scientists, such as William James, Abraham Maslow, Gregory Bateson, and Andre Naess, have sought a detailed understanding of it. But the consciousness of the typical individual rarely effected by such empathies—possibly a major reason why modern societies struggle with incomprehension in the face of increasing environmental deterioration. Feelings of oneness with the environment may be more than remnants of a primitive mentality, or subjective idiosyncrasy of a few poets and scientists: their roots may lie in the interaction of the brain with the vacuum holographic field.⁴⁶²

The feeling of empathy is closely related to the feeling of love, which is, in my view, a very holonomic way of knowing. When we are in love, the entire world changes. We merge with the subject of our love. We are immersed in the contiguity of souls.

The experience of love is as close as most of us get, after childhood's end, to feeling that we are not bound by our skin, that the circumference of self can be moved or penetrated or dissolved in union with another. The ego is the outward bound or circumference of the person; it is the skin the psyche presents to the world. Our surrender to love is a touching of skin to cancel out that boundary. It is a taste of that delightful, mystical transcendence of selfhood.⁴⁶³

CONTIGUITY⁴⁶⁴

*how to describe
this overwhelming joy of closeness
in the night heavy as syrup*

⁴⁶² Laszlo, 1995: 134.

⁴⁶³ Nachmanovitch, 1990: 168.

⁴⁶⁴ Laroche, 1998.

*slowly flowing
under the triumphant banner of Love...
how to express
this all-conquering feeling
of unity
with another Being
through every wave of mind, and soul, and body
in strange desire
to be dissolved in someone's existence
in every its pulsation
beyond space-time
nothing exists nor matters
in the twilight zone
of two
in their contiguity.*

For the holonomic researcher, experiences of empathy and love provide invaluable data that indicate our unbroken wholeness with the world. Laszlo suggests that the holographic unity of our reality also reveals itself through spontaneous communications, when a social group becomes more than sum of parts, transforming into as a single organism. This phenomenon might occur due to holofield-mediated coordination.⁴⁶⁵

A soap opera “Days of Physical Science in Elementary Schools Course”

It is the first day of class. We met in the science lab. It is always so exciting to meet the new students. Intrigue and mystery of novelty: who are they? After the usual introductions, I invited the prospective teachers into another room, where I had made thorough preparations in the form of chairs arranged in a circle, lighted candles, burning scents, fresh flowers, and the chanting music of the group “Enigma.” I started the lesson with a shocking and desperately non-scientific invitation: “Let’s talk about love, empathy, awe, and enchantment.” I intended to use this invitation as a strange

⁴⁶⁵ Laszlo, 1995.

attractor for creating a chaotic butterfly of the unfolding self-organizing course, but I felt acutely that those, who hardly knew each other, spontaneously became a single entity, a newborn organism that sent the strong message of shock, surprise, and non-acceptance: what kind of science class was this? I understood this message intuitively. It was frustrating, I must admit.

From John's reflective journal:

My initial thoughts: What is she talking about? I thought we were dealing with science. Science is not about story telling and about plays and dance. Science is about research and learning facts. What do you mean that we are all connected in some universal way? Where are we going with this? What is this class about? Am I going to learn anything that will help me to become a better teacher? So many questions and so many worries. This is all so new and cutting edge.

My inner voice whispered:

*The chaotic attractor I created is too "strange."
Next time, I have to think of a less shocking beginning.*

THE VOICE IN THE NIGHT

*A voice whispered to me last night.
"There is no such thing as a voice whispering in the night!"
(Haidar Ansari)*

The inner voice whispering to us is the voice of intuition that speaks the language of ancient harmony.

6. *listening to an ancient harmony*

*"What are you really?"
"What are you really?" the unicorn countered.
"You called me, and because there is a great need, I am here."
"You know the need?"
"I have seen it in your mind."
"How is it that you speak my language?"
The unicorn neighed again, the sound translucent as silver bubbles.
"I do not. I speak the ancient harmony."*

*"Then how is it that I understand?"
"You are very young, but you belong to the Old music."⁴⁶⁶*

"I am learning to listen to the light," writes the poet. "...I want to listen to the light that pulses between the beats in my heart, this heart long seen as a beast, uncontrolled, fickle, dangerous. I seek to learn the language of my heart."⁴⁶⁷ Perhaps the language of our heart, our intuitive language, is the language of ancient harmony, the Old music of the universe. The holonomic researcher seeks to become literate in the ancient language of intuition in order to see far beyond the artificial lights of abstraction.

"Artificial lights," the beast sighed. "How very complicated life on your planet must be. Later on you must try to explain some more to me."⁴⁶⁸

If we are literate in the language of intuition, we may be able to see, hear, or smell the magic light that illuminates the Cosmos as a singular, radiantly beautiful, organic entity. To speak the *ancient harmony*, to hear *Old Music* of an organic world, research methodology must be organic.

Several transpersonal researchers offer the metaphor of "the tree" for the organic research methodology. They envision organic research as evolving in five stages: "preparing the soil, planting the seed, roots emerging, tree growing, harvesting fruit."⁴⁶⁹ This approach is "grounded in responsibility, reverence, and awe for the earth and all her inhabitants as well as in mysteries and creativity. Doing this work requires honoring ourselves, our collaborators, our readers, and the context in which we work, as well as consciously keeping ourselves open to the gifts of the unconscious and the divine."⁴⁷⁰

⁴⁶⁶ L'Engle, 1978: 46.

⁴⁶⁷ Leggo, 1999: 115.

⁴⁶⁸ L'Engle, 1978: 165.

⁴⁶⁹ Clements, Ettling & Jennet, 1998: 117.

⁴⁷⁰ Clements, Ettling & Jennet, 1998: 117.

Although a holonomic inquiry is not tied to sequences or stages, the “preparing the soil” stage proposed by the organic research methodology, is appealing. This stage involves “a prayer from the heart thanking everyone who helped to open the channels of the researcher's creative energy.” As physicist Talbot writes, in the holographic universe, the possible effects of prayer are taken seriously since there are no boundaries between the physical and the psychical. In a world where such boundaries are elusive, mind can directly affect the material world.⁴⁷¹

I took to heart the ancient idea of praying. Why don't I pray tonight for the well-being of those who have opened the doors of my creative energy. Why don't I pray for my teachers and my students, for the dark sky outside my window, for the small spider keeping me company in this late hour, and for this unhappy stormy wind that angrily chases innocent clouds over the moon. This night I will pray for those who are involved in my research. In the holographic universe, that means I will pray for everyone and everything. I will pray this night for the whole living Cosmos as passionately as I pray for my child...

*destiny I pray to you
under your wings please save my child
please...
don't let her know
war
illness
hatred
disappointments
the pain of "I do not love you"
waiting in vain
downfalls
betrayal
and all the rest
that makes
this world imperfect*

⁴⁷¹ Talbot, 1993.

*above the dark clouds
destiny
please let my child fly...*

While not propagating through rigid stages, holonomic research evolves along the cosmic DNA spiral, through the kangaroo jumps of newborn meanings; quantum leap by quantum leap; heartbeat by heartbeat; holographic pattern by holographic pattern. Each quantum leap (heartbeat) contributes to the autopoietic process of growing knowledge. Each heartbeat (quantum leap) pushes the hermeneutic “feedback loops” of the dynamic system of my research toward “going awry.” It moves further and further from equilibrium, closer and closer to the edge of chaos...another heartbeat-quantum leap... and...dramatic change! A whole new order leaps into existence.

The emergence of a new order out of the chaotic mixture of my ideas and experiences is wishful thinking. However, in a holographic universe where consciousness can directly affect physical reality, the status of wishful thinking has been changed from being a fairy tale “technique,” into a valuable “research instrument.”

Nevertheless, by no means does my research seek to overcome worldly and otherworldly chaos “from the position of knowing and confidence,”⁴⁷² structuring it into the rigidity of certain answers. Accepting the invitation of the poet, holonomic research “dwells with mystery” recognizing that chaos is inherent to our cunning world which likes to play “hide and seek” games.⁴⁷³ Tell me, where else would you hide a mysterious

⁴⁷² Leggo, 1999: 129.

⁴⁷³ In *Qualitative Evaluation and Research Methods*, Patton writes that chaos theory’s meanings and implications for qualitative inquiry in human settings remain to be developed. At this point, chaos theory offers, perhaps more than anything else, a set of new metaphors for thinking about what we observe, how we observe, and what we know as a result of our observations. It challenges us to deal with unpredictability and indeterminism in human behavior.

implicate order, if not within seemingly chaotic realms? Seeking the emergence of a new order my research does not intend to,

...escape from the bigger chaotic world. The study is the place where the researcher returns when overwhelmed with the riches of the infinite world, searching for sense by scribing sentences in the sensual sea swirling under the skin.⁴⁷⁴

According to quantum theory, our physical universe oscillates.⁴⁷⁵ It pulses as a huge heart. "The world is constantly flashing in and out of existence, being dissolved and recreated from one moment to another."⁴⁷⁶ But where does the universe go in between its pulsations? Where do we go in between our heartbeats? Where do particles go when they flash out of material existence? Could it be a hidden implicate order of a deeper nonmaterial reality, a quantum vacuum holofield from which everything existent jumps into being? In order to make sense of the "infinite" world, poet Leggo invites us to listen to the singing between heartbeats. Could this singing between heartbeats be the echo of the subtle implicate order of a holographic world? Could it be that the poet grasped intuitively the most efficient "research technique" which enables our deep knowing of an ancient harmony, of a cunning, mysterious, and seemingly chaotic world?

While writing about holonomic research, I am constantly driven to cite poetry and to write poetically. It seems that my holonomic inquiry self-organizes into a poetic inquiry. It is natural in an organic world that speaks the poetic language of rhythm and pulsation. It is amazing how rhythmical Nature is. "Life comprises biological rhythms of cycles upon cycles, a biomusic by nature's own Muzak."⁴⁷⁷ Everything here is rhythm, including cycles of galaxies, human lives, seasons, days and nights, ocean waves, or

⁴⁷⁴ Leggo, 1999: 129.

⁴⁷⁵ Davies & Brown, 1986.

⁴⁷⁶ Grof, 1998: 76.

⁴⁷⁷ Fraser, 1987.

sound and light waves. Even more. If our reality is indeed holographic, it means that everything, including us, is “made of” vibrating and resonating waves. It makes rhythmic language inherent to us and to the entire universe. That is why perhaps the oldest literary form of communication is poetry. It is the language of ancient harmony. It is the first and authentic language of a playful Cosmos, where every space-moment brings its own poetic scenario...

*with the sun
the weather at least
as chaotic as life
itself, the wind
bearing earth's breath
always familiar
always unfamiliar,
no two days the same⁴⁷⁸*

According to Martha Heyneman, poetic language is the “lost language of the whole.”

There have been many recent attempts to discern and articulate “the new paradigm,” but no one seems to have noticed the strangeness of trying to present a “holistic” world view in the language of one small part of the psyche. Thus we have whole books written on the subject of participatory observation in nonparticipatory language, and arguments for the superiority of intelligence of the body or the heart written in this same language, as if the discursive reason was trying to talk itself into abdication.⁴⁷⁹

In the living holographic poetic universe, human life has poetic meaning. It is not a system within a system within a system. It is a sonnet within a sonnet within a sonnet. The sonnet is a stanza of 14 lines. They could be rhymed as ABAB ABAB, or ABAB CDCD, or other variations. Sonnets are a lyric poetry that expresses intense feelings and thoughts. Although they are mostly about love, one of the animating forces of the sonnet

⁴⁷⁸ Leggo, 1999: 132.

⁴⁷⁹ Heyneman, 1993: 25

is the quest for understanding the self in the world. Sonnets are often combined in a sonnet sequence, linked synthetically or thematically. The uniqueness of a sonnet sequence is in balancing each sonnet with the wholeness of the entire collection.⁴⁸⁰ This principle seems holographic to me.

"In your language you have a form of poetry called the sonnet, it is a very strict form of poetry, is it not?"

"Yes."

"There are fourteen lines, I believe in pentameter. That's a very strict rhythm of meter, yes?"

"Yes." Calvin nodded.

"And each line has to end with a rigid rhyme pattern. And if the poet does not do it exactly this way, it is not a sonnet, is it?"

"No."

"But within this strict form the poet has complete freedom to say whatever he wants, doesn't he?"

"Yes," Calvin nodded again.

"So," Mrs. Whatsit said.

"So what?"

"Oh, do not be stupid, boy!" Mrs. Whatsit scolded. "You know perfectly well what I am driving at!"

"You mean you are comparing our life to a sonnet? A strict form, but freedom within it?"

"Yes," Mrs. Whatsit said. "You are given a form, but you have to write the sonnet yourself. What you say is completely up to you."⁴⁸¹

"A strict form, but freedom within it?" Wait a minute, but this is the rule of a chaotic butterfly: *bounded randomness*. In the poetic chaotic holographic living universe, conducting research means writing a sonnet. You are given a form, [biological, social] but you have to write the sonnet yourself!

7. you have to write the sonnet yourself

The term *poiesis* "shares the same Greek root as the word *poetry*."⁴⁸² If so, autopoiesis, an ongoing organism's self-making, could mean at the same time poetry-

⁴⁸⁰ Spiller, 1997: 141.

⁴⁸¹ L'Engle, 1978: 21.

making. This makes sense in an organic world where pulsing life is a constantly evolving cosmic sonnet. In this light, holographic inquiry becomes simultaneously a sonnet *to* and a sonnet *of* the living Cosmos. While writing and re-writing the sonnet of his or her life and research, the holographic researcher writes and re-writes a cosmic sequence of sonnets.

Leaping about in a tango of quantum entanglement, the world and I co-evolve together into a living and ever-changing sequence of sonnets. The meaning that connects the sonnet of my life with the cosmic sequence of sonnets, always shifts and always changes...

*I love lilac
its boiling beauty amazes me
its smell makes me drunk
the time when a lilac blooms
is the time of my internal spring
when my wings grow
when my heart embraces the universe
when I wait for miracles
and they usually happen
small miracles
in the form of an extraordinary sunset,
wonderful news from somewhere,
smiles and compliments,
and other wonderful things
which can only emerge
from the steam of boiling lilac
I love branches of lilac by my bed in a crystal vase
I think, crystal and lilac
make an especially noble combination
every morning when waking up
I let myself sink into the lilac's breathtaking beauty
then emerge into the everyday world
renewed and winged
ready for more miracles
this year I did not have lilac by my bed
and I missed it
but I could not break a lilac's branch*

⁴⁸² Capra, 1996: 96.

*I imagined the lilac's pain
when its arms were broken
and imagining that
I realized I had moved into a different world
a world where a lilac feels pain
when its arms are broken...⁴⁸³*

Holographic inquiry grows from the space where the “inner” and “outer” merge into an unbroken wholeness. But...how can I determine the validity of knowledge that emerged from the deepness of my inner? There are no numbers, graphs, or tables, which I can provide for the “objective” judgment of my research. The only criterion for validation of my holonomic inquiry is obsession.

8. obsession as the criterion for research validation

*The creative process is a spiritual path. This adventure is about us, about the deep self, the composer in all of us, about originality, meaning not that which is all new, but that which is fully and originally ourselves.⁴⁸⁴
(Stephen Nachmanovitch)*

The dictionary defines the word *obsession* as an “abnormal preoccupation with a persistent idea and desire.” This is the key! Deep knowing comes not from “tidy reports”⁴⁸⁵ which can be assessed objectively, but is rushed into being by the researcher's obsession, by the inescapable pressure of the cosmic creative principle.

(SELF) PHENOMENOLOGY OF A COSMIC CREATIVE PRINCIPLE

I feel it pulsing in my heart. It is like sliding down a huge snowy slope. Awe, excitement, a breathtaking flight, which is impossible to stop. Fountains of energy burst from inside, wanting to spring forth. I lose my sense of self under the spell of the

⁴⁸³ Unfortunately, I am unable yet to write rhythmic poems in English. This is why this poem does not appear to follow the rule of sonnets.

⁴⁸⁴ Nachmanovitch, 1990: 13.

⁴⁸⁵ Broud & Anderson, 1998: xvii.

wonderful force that harmonizes me with the rest of the world. I am obsessed with the idea of the re-enchantment of science education. I simply cannot resist. It is my poem, which directs the autopoietic process of my emergence as a teacher and as a researcher. I never stop writing this poem. It writes itself any time and everywhere. It catches me in the classroom, on the street, even in the bar. Sometimes, in the middle of the night, it wakes me up, begging to be put into words. I hurry to write it down because I'm afraid to miss this message...

Perhaps the most honest, real, and “objective” research comes from the subjective inner tension of universal creative energy that gives no other alternative but to strive toward knowing and creating. No matter what. In this case, scientific *truthfulness*⁴⁸⁶ is achieved through “the ultimate depiction of the experience derived through one's rigorous, exhaustive self-searching,” and through the inherent self-honesty of the researcher.⁴⁸⁷ In light of this, there is always a place for scientific objective truthfulness in subjective research.

The process that I want to call scientific is a process that involves the continual apprehension of meaning, the constant appraisal of significance, accompanied by a running act of checking to be sure that I am doing what I want to do, and of judging correctness or incorrectness. This checking and judging and accepting, that together constitute understanding, are done by me and can be done for me by no one else. They are as private as my toothache, and without them science is dead.⁴⁸⁸

As a holonomic researcher, I recognize a cosmic responsibility for my creation. I create because the spells and currents of my inner self-organizing energy have the same origins as the spells and currents of cosmic energy that design new, bright, fashionable

⁴⁸⁶ I use *truthfulness* instead of *truth* to express that although it is impossible to uncover objective truth it is possible to be honest and truthful in the research. In other world, truthfulness is truth as communication.

⁴⁸⁷ Moustakas, 1990: 32.

⁴⁸⁸ Moustakas, 1990: 33.

stars. I create because I am obsessed, enchanted, because I feel the pulses of cosmic creative principle in my “within.”

*only within is near; all else is far.
and this within crowded, and day by day
too filled with all, and what no words can say.
the island's like a too exiguous star
which unperceiving space, without a word,
has shattered in unconscious frightfulness
so that it, unillumined and unheard,
with no ambitiousness
save that all this may somewhere find and end,
goes struggling on some self-discovered line
in darkness, blindly, out of the design
wherein the planets, suns, and systems wend.*⁴⁸⁹

7. out of the design wherein the planets, suns, and systems wend

In a holographic universe, the cosmic design is hidden within holographic patterns of reality. This design constantly evolves under pressure from the elemental creative cosmic force, through the unfolding of “an amazingly complex and intricate cosmic drama.”⁴⁹⁰ In our playful world, every human life has a role in this grandiose cosmic spectacle and in this sense, every human inquiry into world phenomena, is *performative*.

Performative inquiry is a research methodology which enables the researcher to bring forth unknown, unreal, imagined worlds through dramatic exploration.⁴⁹¹ It dances at the edge of chaos, on the thin and elusive line between the real and the unreal, where waves from a shimmering sea of probabilities dash upon the shoreline of the phenomenal world. Performative inquiry progresses non-linearly under the guidance of questions:

⁴⁸⁹ Rilke, 1964: 127

⁴⁹⁰ Grof, 1998: 66

⁴⁹¹ Fels, 1999

What matters?

What if?

So what?

Who cares?

Holonomic inquiry is the performative inquiry stretched to a cosmic scale. While it is a one-person performance, holonomic inquiry simultaneously involves the whole world. It is performed on a stage that is simultaneously as colossal as the universe and as small as the footprint of a child.

What matters? The “red” filter through which we look at the world

What if? We change the filter from mechanistic to re-enchanting

So what? A new complex holographic organic mysterious poetic world, where integrity and meaning of human and more-than-human life is restored, could be imagined into existence.

Who cares? The entire living Cosmos. It means, you, we, I, and they.

Holonomic inquiry results in the emergence of new resonant patterns of the universal quantum-vacuum holofield. Each quantum leap/heartbeat of meaning is another more complex and more embracing *holon* within the *great holarchy of becoming unified with the organic world*. Each emerging *holon* is a newborn chaotic butterfly, a new sonnet within a sequence of sonnets to/of the imagined re-enchanted universe.

imagine-transcend-create anew--

the never ending sonnet,

the sonnet,

which comes out of the design

wherein the planets, suns, and

systems wend...

Science Education as a Sonnet to Life

*The universe implies organism, and each single organism implies the universe—
only the "single glance" of our spotlight, narrow attention,
which has been taught to confuse its glimpses with "separate things",
must somehow be opened to the full vision..."⁴⁹²*
(Alan Watts)

1. who were these individual clouds?

*Who were these individual clouds? What were you doing?
What were your sensations? Who did you tell?⁴⁹³*
(Annie Dillard)

Who were these individual clouds? They were dogs transforming into dragons, then into temples, then funny disproportional people, then exotic flowers, and then mountains. In their dynamic kaleidoscopic nonlinear show, clouds easily mimicked the world below. What was I doing? I was lying on the grass admiring the wind, the sun, and the smell of the earth with every cell of my existence and thinking that watching clouds should be definitely included into the re-enchanted science curriculum as an experiment illustrating the fractal complexity of the world and of the principle "as Above so Below."

Who were these individual clouds? Such a question can be treated as scientific only within a radically re-imagined universe of science education, where everything, absolutely everything is enfolded in everything, and everything, absolutely everything is alive, including trees, stones, atoms, people, knowledge, curriculum, childhood, imagination, and clouds.

Nonlinear overlap of science of complexity, a holonomic paradigm, and postmodern organicism transform the universe of science education from mechanistic

⁴⁹² Watts, 1967: 99.

⁴⁹³ Dillard, 1999.

*hatred and love
interior and exterior
light and darkness,
"yes" and "no",
humans and angels
"plus" and "minus"
quarks and galaxies
poetry and prose,
microcosm and macrocosms
happiness and tears
elements and compounds
music and silence,
soul and science,
the complex and the simple
the past, the present, and the future
all necessary for creating a living and feeling universe*

*the most challenging task is to press
all of that into a singular point*

*big bang
the cosmic egg is broken
order out of Chaos
a quantum leap*

LET IT BE!

Now, when a baby-universe is born, it is time to begin a cosmic story.

3. *at the beginning was a cosmic story*

Tell me a story.

How often we said that as children. Tell me the story.

Story illuminated the world for us in childhood.

Even now we might make a request: tell me a story.

Tell me the story of the river and the valley and the streams and woodlands and wetlands, of the shallfish and finfish.

Tell me the story.

A story where we are and how we got here and the characters and roles that we play. Tell me the story, a story that will be my story as well as the story of everyone and everything about me, the story that brings us together in a valley community, a story brings together the human community with every living being in the valley, a story that brings us together under the arc of the great blue sky in the day and the starry heavens at night...⁴⁹⁵

(Thomas Berry)

Stars, galaxies, circled in cosmic pattern, and the joy of unity was greater than any disorder within.⁴⁹⁶

(Madeleine L'Engle)

Disenchanted mechanistic science curriculum is dead. Indeed, it is quite challenging to stay alive while being dissected into disjointed fragments. You can study states of matter in physical science, the digestive system of a fish in life science, and volcanic activities in earth and space science. Then... what? Studying science turns into collecting isolated bits, facts, and fragments of information about the world. Each school year increases the sheer volume of fragments.

Of what use is the universe?

*What is the practical application
of a million galaxies?⁴⁹⁷*

The story of mechanism is told in the language of numbers, graphs, charts, and proofs.⁴⁹⁸ It is the story of a dead abstract world.

⁴⁹⁵ Berry, 1988: 171.

⁴⁹⁶ L'Engle, 1978: 58.

⁴⁹⁷ Watts, 1966: 117.

Writes Whitehead:

The solution which I am urging, is to eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject-matter for education, and that is Life in all its manifestations.⁴⁹⁹

Re-enchanted science curriculum is alive. Its autopoietic pattern of organization is structured around the living cosmic story. Such curriculum evolves along the broadening hermeneutic DNA spiral of a living Cosmos. Each grade contributes a new turn to the spiral. Just as a sprouting seed contains the blueprint of the whole organism, re-enchanted school science curriculum contains the entire cosmic story, starting from elementary grades, upward. Each school year science begins from the whole, from a cosmic story that becomes increasingly sophisticated from grade to grade. As a living organism, it grows in a complexity, moving back and forward, to and fro, from the whole to specific topics. Students and the cosmic story grow together.

*Stories are like children. They grow in their own way.*⁵⁰⁰

There are no cosmic stories in the modern school science curriculum, and this is, as Swimme writes, a terrible loss: “all our disasters today are directly related to our having being raised in cultures that ignored the cosmos...”⁵⁰¹ Throughout the history of humanity, cosmic stories were as vitally necessary as food or drink. They were used to “install” youth into the universe. Contemporary education ignores the value of these stories, which initiate humans into “the realities and values of the universe.”

Without the benefit of a cosmic story that provides meaning to our existence as Earthlings, we were stranded in an abstract world and left

⁴⁹⁸ Swimme, 1988: 49.

⁴⁹⁹ Whitehead, 1929/1967: 7.

⁵⁰⁰ L'Engle, 1978: 168.

⁵⁰¹ Swimme, 1988: 49.

to invent nuclear weapons, chemical biocides, ruinous exploitations, and waste.⁵⁰²

In *The Holistic Curriculum*, John Miller writes that the story of a new curriculum should reflect the interconnected world portrayed by new scientific insights.⁵⁰³ The contemporary story told by the avant-garde science, unifies humans of all nationalities into the cosmic race. If included into school science curriculum, this story could “install” students into the living and feeling Cosmos, where galaxies are nurseries of the stars, where black holes are baby-universes, where each atom is an experiencing entity enfolding the entire living world, where each human has a cosmic status as a holographic macrocosm, and where the beautiful and fashionable Goddess Gaia is alive, experiencing, feeling, and perhaps, even conscious.⁵⁰⁴

*planet Earth, Mother Earth, Gaia
in the glamour of your blue-white beauty
you dance into the spell of darkness
along with born and vanishing stars...
who knows, maybe at some unimaginable level
you communicate with other living planets
gossiping about some hottest interplanetary news?*

*Or, perhaps while orbiting about the sun,
You are rushing to some important cosmic event
fully ready and prepared:
your winds brushed your hair, crowns of trees,
your fashionable dress is decorated with flowers,
your makeup is composed of a colorful palette,
the red and yellow of your autumns,
the blue and green of your springs,
and the vivid rainbows of your summers.
Your winter diamonds, pieces of ice, glistening radiantly.*

*As you drift in spacetime,
all your creatures, big and small*

⁵⁰² Swimme, 1988: 49.

⁵⁰³ Miller, 1996.

⁵⁰⁴ Goldsmith believes that Gaia not only alive, but conscious. See Goldsmith, 1996.

*unified into an incredible web of life,
are nourished with air to breathe, water to drink, and food to eat...*

Planet Earth, Mother Earth, Gaia...

*Hello, Gaia,
how are you?*

As Miller notes, the image of Earth from space is one of the central images of an emerging new mythology. Astronauts often reflect on an acute spiritual sense of oneness with Gaia. They feel awe, admiration, and pride in her beauty. Russell Schwiegart, a US astronaut, said: "You look down there and you can't imagine how many borders and boundaries you crossed again and again and again. And you don't even see' em....From where you see it, the thing is a whole, and it's so beautiful."⁵⁰⁵

The new story of the world without borders can lead toward developing a new spiritually--oriented cosmic consciousness, writes William Quinn. Planetary [cosmic] culture needs to become a new Traditional culture that believes in the unbroken wholeness of humans, the planet, and the universe.⁵⁰⁶ I agree with Quinn who believes that new science could become a major factor for development of cosmic consciousness because, as Heyman states, people who were brought up in a scientific culture will believe only what comes from science.⁵⁰⁷ In light of this, science education has a cosmic responsibility in weaving holographic patterns of an organic unified world, quantum leap by quantum leap.

The contemporary cosmic story begins with the Big Bang or, according to non-Big-Bang theories, from the spontaneous emergence of a new order out of fluctuating chaotic quantum vacuum. All versions, however, tell us that Gaia, the Sun, the galaxies,

⁵⁰⁵ In Miller, 1996: 2.

⁵⁰⁶ Miller, 1996.

⁵⁰⁷ Heyneman, 1993.

humans, animals, and chemical elements came from the same ancestor eons ago. While coming from a singular “one,” the innumerable entities of the world are entangled into a holographic unity.

The cosmic story glues re-enchanted science curriculum and its world into an unbroken wholeness. Being autopoietic, it constantly “makes” or writes itself through interactions between teacher, students, and the rest of the universe. It writes itself poetically. The language of the new mythology, writes Swimme, is not limited to graphs and charts, but recalls the forgotten language of storytelling, which combines poetry, songs, dance, and chants.⁵⁰⁸

Writes Berry:

We can understand the great intuitions the ancients had of the universe.
We can dance anew the rhythms of the earth. This re-enchancement with the earth as a living reality is the condition of our rescue of the earth from the impending destruction that we are imposing upon it.⁵⁰⁹

I am caught up in an intense feeling that is like flying down a snowy slope. A dizzying, magical moment that is irresistibly breathtaking and grandiose. Imagining a deeply re-enchanted science curriculum requires radical re-conceptualization of what currently exists!

The deeply re-enchanted world is a complex, holographic, evolving organism, alive throughout its totality. In such a world, there is no division between living and non-living entities, and therefore, the arbitrary separation of science curriculum into physical science, life science, and earth and space science loses meaning. “Biology is the study of the larger organisms,” says Alfred Whitehead, “whereas physics is the study of small

⁵⁰⁸ Swimme, in Griffin, 1989.

⁵⁰⁹ Berry, 1986: 21.

organisms.”⁵¹⁰ “And in the light of modern cosmology,” adds Rupert Sheldrake, “physics is also the study of the all embracing cosmic organism, and the galactic, stellar and planetary organisms that have evolved with it.”⁵¹¹

This perspective changes everything! It begs for unifying physical, earth and space, and life sciences into the wholeness of re-enchanted science under the “roof” of an ever-evolving cosmic story of living universe.

*when the peaks of our sky come together,
my house will have a roof*⁵¹²

Not just the structure, but also the entire content of the new school science curriculum has to be re-conceptualized if following the footsteps of avant-garde science. New, deeply re-enchanted science curriculum would be based not on mechanistic, but on *cosmic* worldview, since living Cosmos approaches us not only through space travel, but also through the dimension of our inner space!⁵¹³ What an interesting universe might unfold! What an enchanting science education might leap into existence! Listening to the quantum leaps of my heart, I begin the flight of my imagination, proposing to teach school science as a cosmic Sonnet to/of Life, an exciting story of the complex holographic organic poetic mysterious world.

“A Magic World! Enchanting,”

says Thomas Berry.⁵¹⁴

⁵¹⁰ Whitehead, cited in Sheldrake, 1990: 80.

⁵¹¹ Whitehead, cited in Sheldrake, 1990: 80.

⁵¹² Bachelard, 1994: 38.

⁵¹³ There are many options for terming a new worldview: ecological, biological, organic, holographic, holistic. I coin the term “cosmic.”

⁵¹⁴ Berry, 1986: 19.

"...even rock is in some way alive, for life and intelligence not only in all matter, but in energy, space, the fabric of the entire universe," writes David Bohm.⁵¹⁵

LET IT BE!

A soap opera "Days of Physical Science in Elementary Schools Course"

From Sara's final reflections:

While I learned many details in this course, it was the overall way of looking at physical science as a holistic area of study, as an organism itself, that had the most meaning for me.

*5. the content of a deeply re-enchanted science curriculum :
the fabric of the entire universe is alive*

Matter is alive

"You've studied atoms in school, haven't you?"

"Sure, but--"

"Then you know enough to know that matter isn't solid, don't you?"

That you, Calvin, consist mostly of empty space?"

That if all the matter in you came together you'd be the size of the head of a pint?"

That's plain scientific fact, isn't it?"

"Yes, but--"

"So I simply pushed the atoms aside and we walked through the space in between them." ⁵¹⁶

Atoms...what an enigma. Throughout human history, they have changed their images many times. They enjoyed having various shapes with hooks as imagined by the Greeks. They became magnetic balls in medieval times. They changed into plum puddings with raisins for electrons in Thompson's model. Then Rutherford transformed them into little solar systems; Bohr added energy levels for electrons to travel around

⁵¹⁵ Bohm cited in Talbot, 1991.

⁵¹⁶ L'Engle, 1962: 128.

nuclei, and then....atoms literally vanished into some kind of semi-real existence, into probability waves, into the vastness of quantum-vacuum informational field, into a network of interactions, into rhythms of dancing organic energy. Pure magic. In the organic holographic universe, atoms are nothing but solitons emerged from a single living unbroken totality, and in this sense, they are alive. Just like other living organisms, they are autopoietic and have some kind of mentality.

A soap opera “Days of Physical Science in an Elementary Schools Course”

-Particles with mentality? That is funny!

-Is it? Let us do a little exercise. Have you ever admired the beautiful, intricate, and perfectly symmetrical shape of the snowflake? Have you ever thought about where this shape comes from? Where in the water are these beautiful patterns hidden? How do particles know the blueprint of each amazing design? Let us role play the following situation: we are mindless particles without any memory, without any ability to think, to know, and to communicate with our peers. Now we will try to become a snowflake. That was not very much of a success, was it? To actually create a snowflake, you have to be able to communicate with other particles and know what each is doing.

*Hey, water particles, it's getting cold!
I feel I am losing my energy.
Brr...it's time to make a snowflake.
Who is with me?
You, hold that angle straight.
And you, come closer.
Ok, splendid job.
I remember the last time when I was in a snowflake,
we created something really amazing.
Oh...look at that!
Our snowflake is becoming so beautiful!
We are ready!
The Earth is waiting... Let's fly!*

I maintain priceless connections with some of my former students. One year after my course, Tricia had her own class, grades 2 and 3. I asked Tricia to explore her

students' perceptions about matter through role-playing a "snowflake" scenario. This is what she e-mailed to me.

Dear Lyubov:

I did the snowflake activities with my students and they were very interesting. They said that snowflakes were made from particles of water. They did not think that particles were alive because they are not "people and animals or things that breathe." Because they are not alive, they believed they could not communicate.

They were very surprised to learn that all snowflakes have six sides and that no two snowflakes are exactly the same. They compared this to the way humans are all basically the same parts but never exactly the same. Then we did some dramatic play. Even when they were supposed to be making a snowflake without communicating, they communicated anyway. They found it impossible to know what to do and to figure out what other students in their group were doing without saying anything. They all decided that they really needed to be able to communicate in some form in order to do their skits and make their snowflakes.

The students started off all tight together as particles of water in a cloud. Then they slowly separated and started to drift and float about. Slowly, they began to join to other particles of water that were floating, until six of them had joined together by holding hands in a circle. Once they were all holding hands, they each stick one leg out to form the points of their snowflake. Then the group of them fell to the ground together in one big heap!

In the end they were quite confused. They knew that they themselves had to communicate to make a snowflake skit, but had a hard time understanding how a particle could communicate when it is not an "alive person." They believed that they must be able to communicate in some way, but they do not believe that they are alive.

We really had fun with the activity. Hope this is useful to you!!

Children were confused: water particles cannot be living, but at the same time they had to communicate somehow. The state of confusion, as we already know, is the driving force⁵¹⁷ of self-organization. It could be a good moment to throw the idea (a chaotic attractor) that the world in its totality might be unified and even alive...

Of course, entering the twenty-first century, we are not as naïve as alchemists, who produced dragons in their crucibles or married sulfur and mercury in their test tubes. When residing in a mechanistic universe, we know that chemical reaction between elements is just chemical reaction. There is nothing more to it. But...it is not as simple as

⁵¹⁷ Driving force...often I feel myself caught up in a mechanistic language...

it seems to be, says science writer Garry Zukav.⁵¹⁸ The question is how do chemical elements know when and with which element they are supposed to react or not react. Chemical elements do not react with everything and under all circumstances. They are meticulous. They choose.

TO REACT OR NOT TO REACT, THIS IS THE QUESTION!

Chemical reactions are more radical than physical changes. If elements decide to react, it means they have made up their mind to surrender their own identities and to produce new substances. Chemical elements are fussy about choosing their partners for reaction. Just like people, they need "chemistry" to occur. When choosing partners for reactions, elements probably take into account how colourful or smelly the other element is; however, one of the main criteria for their choice is how many electrons their partner has. After elements decide that everything is right for their reaction, including temperature, pressure, and number of electrons, they produce a new compound. This compound, just like a human child, has its own identity which is different from the identities of its parents. It is a new order, the whole that is more than the sum of its parts. For instance, rust is a product of oxygen and iron, but it has its unique properties.

According to the vision of postmodern panexperientialism, all entities, including planets, atoms, and elements are occasions of experiences. What are these experiences about? We can only guess. Writes Griffin:

But what about nonhuman atomic (unitary) events—for example, those at the subatomic level? Obviously, we cannot analyze them phenomenologically as we do our own experience. Nevertheless, Whitehead believes that these events, too, are what they are because of their pattern of relationships with other events.⁵¹⁹

Can we not know of experiences of atoms, elements, or solutes? Wait a minute!

For what purpose then do we have our imagination?

⁵¹⁸ Zukav, 1979.

⁵¹⁹ Griffin, 1993: 173.

SOLUTIONS FROM OPTIMISTIC AND PESSIMISTIC PERSPECTIVES

*Is it good or bad to be dissolved in a solvent?
Let's address this question
from the solutes point of view.
[solute as we know are substances dissolved in a solvent]*

*anytime we ask someone's opinion,
we naturally expect to hear
both optimistic and pessimistic perspectives.
There are probably optimists and pessimists
among solutes, just as among human beings.*

Let's imagine what could possibly be said by solutes-pessimists:

*Well...it is no fun at all to be dissolved in a solvent.
I used to be a solid, a crystalline structure, and
I was quite proud of my shiny, defined appearance.
All my particles were neatly arranged
and held together by intermolecular forces.
But now, in solution, I am scattered all about,
I am no longer a perfect structure.
Particles of liquid surround me
as policemen surround criminals,
tearing me apart, element by element.
My identity is gone,
I am so depressed....*

*Now let's imagine what could possibly be said
by the solutes-optimists:*

*Well...it is wonderful to be dissolved in a solvent.
I enjoy it tremendously
I used to be a solid, a crystalline structure.
All my particles were so strongly connected;
they could not even travel or change places!

But now, in solution, they are free to move
whenever and wherever they want.
Also, it feels so nice
to be surrounded by the friendly particles of solvent.
I am flattered to be the center of attention.
Yes, I definitely enjoy being dissolved,
but at the same time I am glad to know
that I could become a solid again,
for instance, through vaporization.*

*I have nothing to lose, really.
Being dissolved in a solvent
enriches my experiences!
I am so happy!*

*Considering the optimistic and pessimistic perspectives
the question of whether it is good or bad
to be dissolved in a solvent remains open.
While I personally do not desire
to be dissolved in anything,
I like an optimistic perspective,
since optimism gives the key to happiness
in any situation.*

You might ask if I am serious. Well, I am not. I perhaps “humanized” the chemical and physical world too much. This is actually an interesting question: by attributing some mentality and intentions to atoms, do we anthropomorphize matter, as the ancients did? Yes, agree Bohm and Sheldrake, this is likely the case. However, it is perhaps inevitable since all our explanations of reality are nothing other than an interpretation of human experiences. The mechanical view of reality is anthropomorphic as well. “What could be more anthropomorphic in human modeling than to say that everything is a machine? Machines are entirely and specifically human creations.”⁵²⁰

A soap opera “Days of Physical Science in an Elementary Schools Course”

EXPERIMENT “MYSTERY IN THE AIR”

Purpose:

- *To introduce the concept “kinetic-molecular theory” through an art-based approach*

Equipment:

- *empty flask*
- *balloon*
- *hotplate*

Procedure:

- *Fit the balloon over the mouth of a flask*
- *Put the flask on the plate for about 10 min*

Research question:

- *What happens (if anything) with the balloon after heating the flask for 10 min?*

Your hypothesis _____

Your observations _____

⁵²⁰ In Weber, 1986: 114

Your theory:

The class worked in several collaborative groups. Each group has an assignment. Using any genre (drawing, creative writing, dancing, singing, or acting) generate a story illustrating what happened with particles of air when the flask in which they were contained was placed on a hot plate. This is the opening of the story:

The particles of the air inside of the flask were bored. Indeed, what would you expect from life if you were imprisoned within such a small container, sealed off by a balloon? Of course, you could somehow try to escape, but escaping is not easy, you know. It requires lots of energy. Suddenly....

What a variety of presentations! Particles--student teachers danced, sung in humorous opera, communicated through dramatic play, and became characters in a story:

Suddenly... Boom, boom, boom the secret to escaping this dreadful existence lay in the unknown realm of fantasy... calling the molecules. "Boom, boom, boom...frantically fighting and running to the lures of the deep balloon, the particles became sweaty with anticipation to find their own spaces in their journeys to the promised land. Boom."⁵²¹

Anthropomorphic metaphors expressed humorously the main idea of postmodern panexperientialism, according to which matter is not an inert, mindless, and passive substance merely occupying empty space, but rather an active, experiencing, ever-changing, and learning manifestation of the deeper cosmic order. Isn't it amazing? Socializing matter communicates within itself. It makes choices while self-organizing into the complex structures. It remembers. It renews itself autopoietically even at a subatomic level. It experiences. It lives. Ahh...how far away this understanding of matter is from textbook definitions portraying matter in the manner of "brute facts," "inert particles," and "isolated atoms."⁵²² Ahh...how many mysteries related to matter are yet to be solved!

⁵²¹ From Jeanette's reflective journal.

⁵²² Whitehead, 1929/1967.

The words from the Frank Sinatra's song: "how little we know, how much to discover..." perfectly express surprising and puzzling features of the universe revealed by contemporary cosmology, called "a dark matter." This matter is undetectable through our current experimental methods; however, it exposes itself through its powerful gravitational effects. Rupert Sheldrake writes that recent estimates of the amount of dark matter in the universe range from 90 to 99 per cent!

The magnitude of this mystery is staggering. The great majority of the matter in the universe is utterly unknown, except through its gravitational effects. Yet through the gravitational field, it has shaped the way in which the universe has developed. It is as if physics has discovered the unconscious. Just as the conscious mind floats, as it were, on the surface of unconscious mental processes, so the known physical world floats on a cosmic ocean of dark matter.⁵²³

The dark matter is unconscious universal mind? This is a real re-enchantment.

Let's also not forget the magical anti-matter.

ANTI-ME IN ANTI-UNIVERSE

*Have you heard that scientists
synthesized anti-hydrogen and anti-helium?
Anti-elements have everything the same
as normal elements
except their electrons are positive
and their nuclei are negative.
Anti-elements probably enjoy being originals
with the charges of their particles reversed.
If scientists were able to synthesize anti-matter,
there probably exists anti-universes somewhere...
If so, another question arises:
Is somewhere anti-me?
If so, this anti-me probably likes what I dislike
and probably dislikes what I like
If so, this anti-me probably likes
to clean her room and do lots of homework,
and probably dislikes candies, movies, and games.
I am very saddened by the fact that*

⁵²³ Sheldrake, 1990: 101.

If I ever meet anti-me,
I will not be able to shake her hand..
not because I do not like the idea of her being anti,
but because of the possible outcome of our contact.
The contact between matter and anti-matter
causes a horrific explosion—annihilation
this is why they need to be separated by walls of vacuum..
Ok, if there is such a necessity,
I agree to be separated,
but wouldn't it be nice
to at least have a glimpse of anti-me?
Hey, anti-me, where are you?
In which anti-universe?

A soap opera “Days of Physical Science in an Elementary Schools Course”

Heidi’s metaphor:

Aunty Matter

*An eccentric family member who seems
really positive and cheery on the outside,
but is really negative and pessimistic on the inside*⁵²⁴

So-called anthropomorphic metaphors pop up naturally when trying to comprehend and articulate physical phenomena. Maybe it happens because we have no choice but to perceive the world through our human frame; however, there could be another, deeper reason. What if at some intuitive level we sense our world indeed is alive and what if our anthropomorphic metaphors are expressions of this embodied intuitive knowledge?⁵²⁵

MatterEnergy is alive

From new scientific perspectives, we cannot exclude the possibility that active, self-organizing, communicating, experiencing, and mysterious matter is alive. Such understanding is certainly against our mechanistic commonsense, but don’t forget, we are looking at the world through a deeply re-enchanting filter. Through this filter not only matter, but also energy appear to be alive. Recalling Einstein's famous equation, matter is energy and energy is matter, and altogether is matterenergy. Following simple logic, if matter is alive, energy has to be alive as well.

$$E=mc^2$$

⁵²⁴ Heidi was a prospective teacher enrolled in my science education course.

⁵²⁵ According to Johnson (1987), our metaphors spring from our embodied intuitive knowledge.

From this equation, matter dissolves into energy when moving with the speed of light. I really wish I could achieve such a speed and to transform some amount of my matter into energy, since none of the other weight loss diets seem to work for me! Unfortunately, at this point in the development of human civilization, we can only dream about such a rapid pace of travel (or weight loss!). Circumstances are different for subatomic particles. Quantum mechanical experiments show that particles have no problems moving as fast as light and pop in and out between matter and energy. At the subatomic level, matter routinely and constantly converts into energy and vice versa. Isn't it amazing? I am sitting on a chair, writing this essay, and have no clue about all these frantic activities of matterenergy inside of me...

Energy is a mysterious phenomenon. For instance, gravity acts at a distance, attracting everything to everything. Before Einstein and Newton, the concept of gravity was understood as the soul of the universe, which unified all existing entities.⁵²⁶ In the mechanistic universe, prosaic forces successfully substituted the soul; however, there are some definite similarities between the forces of gravity and the “forces” of love that are predominantly a soul's endeavor. Although the power of love does not directly depend on the mass of the subject as gravity does, love's attraction can be much more powerful than gravitational pull. From my conversation with a friend, a second grader (freely retold):

*I envy inhabitants of the Moon
[if, of course, they exist].
If I were one of them, I would definitely exist
because it is probably a lot of fun to live
under so little gravity.
Since the mass of the Moon is relatively small,
The Moon does not care too much
about attracting anything to its surface.*

⁵²⁶ Sheldrake, 1990.

Thus, inhabitants of the Moon
 can jump so high and so easily,
 they could defeat any record achieved on Earth!
 The one place I would not want to live
 is on the planet Jupiter.
 This planet is huge and has a tremendous
 desire to attract all things.
 Guess what would happen to humans
 if they mistakenly visited Jupiter?
 They would be completely squashed...
 That is not a very desirable perspective, is it?
 In my opinion, our Earth is actually, a nice place to live.
 Of course, you cannot jump very high, but...
 at least you can walk and run without any fear of being squashed!

I think I understand this principle:
 the larger the mass of the objects,
 the greater the gravitational attraction between them.
 Only one question remains:
 what about my friends?
 Their mass is so small
 when compared with the Moon or Jupiter!
 Why then do they attract me so much?

Contemporary scientists seek a fundamental law that will unify all forms of energy, not knowing that poet Dante formulated such a law many centuries ago. For Dante, love is a this unifying energy that “moves the sun and other stars.”⁵²⁷ Following poetic intuition, we can modify the equation of Einstein:

$$E = mc^2 = \text{Love}$$

In the re-enchanted school science curriculum, the experience of love represents a valuable way of knowing, since it gives us a holographic experience of oneness with others.

From my conversation with a 12th grader, a member of the science video club “Gaia:”

⁵²⁷ Dante, cited in Wilber, 1997.

-Love? How could we know what love is, if we are just graduating from a high school?

Writes Lunch:

For many students, school systems can become a training ground where they are taught not to understand but rather control their feelings.⁵²⁸

However, it is (*is it?*) a different story. Returning back to energy, if it equals “love,” it definitely must be alive!

QUANTUM LEAP:

Could it be that the gravitational attraction is Gaia's expression of Love?

MatterEnergySpace is alive

*A vacuum is not inert and featureless,
but alive with throbbing energy and vitality.⁵²⁹
(Paul Davis)*

If you think of space as an empty void, a nothing, pure extension, you reside in the mechanistic universe. Alchemists and astrologers perceived space as the realm of interconnections between humans, plants, animals, heavenly objects, elements in the crucible, and minerals of the earth. For medieval scientists, space was never empty.⁵³⁰ As I mentioned before, current understandings in physics brought us back to the future, to the reincarnation of understanding of space as interconnections and possibilities. Space is comprised of various energy waves, and “every cubic centimeter of empty space contains more energy than the total energy of all matter in the known universe.”⁵³¹ Space is “not

⁵²⁸ In Miller, 1996: 109.

⁵²⁹ Physicist Paul Davis, cited in Sheldrake, 1990: 68.

⁵³⁰ Johnes, 1982.

⁵³¹ Talbot, 1991: 51.

empty; rather it is full of energy and undergoes spontaneous fluctuations that can create new quanta from nothing.”⁵³² Why don't we feel then the presence of anything in space?

This is what the physicist Talbot writes:

A crystal cooled to absolute zero will allow a stream of electrons to pass through it without scattering them. If the temperature is raised, various flows in the crystal will lose their transparency, so to speak, and begin to scatter electrons. From an electron's point of view such flows would appear as pieces of "matter" floating in a sea of nothingness, but this is not really the case. The nothingness and the pieces of matter do not exist independently from one another. They are both part of the same fabric, the deeper order of the crystal. Space is not empty. It is full, a plenum as opposed to a vacuum, and it is the ground for existence of everything, including ourselves.⁵³³

In the universe of the re-enchanted science curriculum, space is not the “nothing”.

It might well be an informational quantum vacuum holofield that hides living matterenergy. In this sense, it is alive. It is saturated with potentialities and possibilities.

It contains something that is about to become...

NOTHING IS "NOTHING"!

*What is it about nothingness?
nothingness within or outside us?
What is it?
Is it really the absence of anything?
nonexistence? Empty space?
Or maybe, just as a white light
secretly contains the colorful rainbow
seen easily through an optical prism,
could nothingness contain...
A spectrum of emotions dispersed by a prism of Love?
Invisible spirals of possibilities,
unfolded by the tools of imagination?
Or, maybe, just as the mirrored calm surface of water
is comprised of hidden waves and splashes,
nothingness could be comprised of waves of existence
which spring to life*

⁵³² Sheldrake, 1990: 68.

⁵³³ Talbot, 1991: 51.

*when the smooth surface of "nothing"
is disturbed by the winds of time
or the stones of events...
Just as silence contains concealed symphonies
of not-yet-heard sounds,
Just as chaos contains hidden patterns of order,
nothingness likely contains "Something,"
long-awaited or unexpected,
unpredictable or planned,
The Something...that is about to be born.*

A soap opera "Days of Physical Science in Elementary Schools course"

Teacher:

What a magical world! An apparent emptiness contains something!

The voice from the chorus:

It is like invisible patterns of a magnetic field that can become visible when we use iron dust. It is so truly magical...

Teacher:

Exactly, you can find magic everywhere when you look at the world through a re-enchanting filter.

MatterEnergySpaceTime is alive

*The melody was clear and pure. The harmony was undistorted.
Time was still young and the sun was bright.⁵³⁴
(Madeleine L'Engle)*

Time was dead in the mechanistic universe. It was an impersonal "t" which passively and uniformly flowed back or forward. In this abstract idealized world of all events involving mindless particles were completely reversible. There existed no history and no future. Time was understood as an illusive property of the human mind. For

⁵³⁴ L' Engle, 1978: 63.

physicist Illia Prigogine, the elimination of temporality is disenchantment since it withdraws from Nature all history, all learning, and all creativity. Einstein united space and time into four-dimensional spacetime. If space is alive, time then has to be alive as well. In his book *Time the Familiar Stranger*, Julius Fraser speculates about the evolution of time. According to Fraser, it perhaps evolved from an “absolute zero of time,” through the simple time of plants and animals, into the complex time of humans, who can think about the past and make projections into the future.⁵³⁵ Sheldrake agrees:

Gaia herself is developing, and the quality of time today is very different from that of the Precambrian (the age of microbes), or the Cretaceous (the age of dinosaurs); what can happen now is very different from what could happen then.⁵³⁶

According to Prigogine, Laszlo, and Whitehead, there never was absolute zero time. Time always was. Time is an inherent quality of physical and (maybe?) nonphysical reality.⁵³⁷ This means that “the something” which we call reality, is in the constant and irreversible process of becoming.

In the re-enchanted universe, time is not a simple collection of minutes after minutes after minutes. It is something, which has qualities of its own. I reflect on my past, I have my anxieties in the present, and I make plans for tomorrow. Through me, time knows itself.

Time has different moods. Sometimes it is gloomy as a heavy, crying cloud; sometimes it is as light and playful as an unpretentious spring wind; sometimes it is sleepy, lazy and does not want to move, period. Cunning time likes to play tricks. It flows impossibly slow when you are desperately waiting for something, but runs quickly during

⁵³⁵ Fraser, 1987.

⁵³⁶ Sheldrake, 1990: 143.

⁵³⁷ Prigogine, 1997; Laszlo, 1995; Whitehead, 1978.

moments of happiness and enchantment. Time is different during the winter and during the spring. Time dances on the roof with the rain and it smiles when the sun glances through the window. Time is not the same in the morning and at night...

*at night, time has wings
while flying through the starry silence
time turns the pages of memory
entering the temple of the past
or it jets skyward into the future,
bringing back a cargo of scenes
of the not-yet-happened...
or when bursting into the dreams,
it blends the future, the present, the past
into eclectic scripts of events
authored by no one
under a mantle of silent night
time flaps its wings
whoosh...whoosh...whoosh
swish...swish...swish...
tic-tock...tic-tock...tic-tock...*

Writes Stengers:

Every complex being is composed of a plurality of times, connected together by the way of subtle and multiple articulations. The history, whether of a living being or of a society, will never again be able to be reduced to the monotonous simplicity of a unique time, whether this time express an invariance or traces the paths of progress or decline.⁵³⁸

In the re-enchanted universe, time is reanimated, as well as matter, energy, and space. Isn't this quantum leap breathtaking? From the dead prosaic predictable timeless world of material things separated by empty space, we spiraled into *MatterEnergySpaceTime* that is incredibly complex, evolving, creative, holographic, and organic. Everything is alive there, including knowledge...

⁵³⁸ Stengers, 1997: 42.

Writes Kirk:

“ If the universe is organic, it is necessary to approach the very possibility of knowledge in radically different ways.”⁵³⁹

4. *waves of living knowledge : growing “the whole” rhythmically*

*Tide leaves his lover as the sands run out
evermore pulled back by the whim of a celestial goddess
restless Sea responds with calculated beauty
the wind at her back cradled in patterns
she chants kindred lullabies of chaos in recursive breath
while her wetness paints sensuous graffiti in the sand
imprinting the transient shore forever—Come back.⁵⁴⁰
(Karen Meyer)*

Whitehead writes that the “central problem of education” is “the problem of keeping knowledge alive, of preventing it from becoming inert,” since “education with inert ideas is not only useless: it is, above all things, harmful.”⁵⁴¹ Modern disenchanted scientific knowledge, this one-eyed mechanical robot, is inert and dead. It observes the world through a disembodied rational objective eye, dissecting it into parts and then gluing these parts together with the help of mathematical formulas into an idealized abstract reality. Inert quantitative knowledge of mechanistic science is superficial. It cannot access all the richness, depth, and complexity of the world.

Analytical understanding is ultimately nothing more than the knife which probes into the joints of things. But the essence is not accessible to mere dissection. Goethe understood this very well when he said that what nature did not reveal to us in the light of the day, could not be forced out of her by “levers and screws.”⁵⁴²

⁵³⁹ Kirk, 1991: 107.

⁵⁴⁰ Meyer, 2000: 85.

⁵⁴¹ Whitehead, 1929/1969: 1.

⁵⁴² Burckhard, 1960.

That does not mean however, that the analytical scientific reductionist approach is not useful for studying entangled phenomena. But it is definitely insufficient for a deep knowing of complex reality: in the living universe, knowledge has to be alive.⁵⁴³ As Nachmanovitch writes, knowledge is alive if it “resonates with the deep structure of the world.”⁵⁴⁴ It continually evolves, but not linearly and smoothly as a well-aligned machine, but rather, as a kangaroo, progressing through a series of creative jumps, mini-paradigm shifts, unfoldments and enfoldments, quantum leaps of ever fresh and ever newborn meaning.⁵⁴⁵ “It takes on the character of an ongoing dialogue with an immediately present, but obscure reality.”⁵⁴⁶ Re-enchanted scientific knowledge emerges through ongoing interactions with the living world. *I interact, therefore I am becoming!* So does the world, reciprocally.

Just as the tree rings grow cyclically wider and wider, waves of living knowledge grow in widening cycles and rhythms. In the chapter *The Rhythm of Education*,

Whitehead writes:

Life is essentially periodic. It comprises daily periods, with their alternations of work and play, of activity and of sleep, and seasonal periods, which dedicate our terms and our holidays; and also it is composed of well-marked yearly periods. These are the gross obvious periods, which no one could overlook. There are also subtler periods of mental growth is a main source of wooden futility in education.⁵⁴⁷

In relation to education, Whitehead refers these periods as romance (play), precision (mastery), and generalization (abstraction). Although such periods are not strictly sequential, they correlate with life’s natural developmental rhythms. Following

⁵⁴³ Kirk, 1991: 107.

⁵⁴⁴ Nachmanovitch, 1990.

⁵⁴⁵ Pelaez, 1997.

⁵⁴⁶ Kirk, 1991.

⁵⁴⁷ Whitehead, 1929/1978: 17.

these rhythms, at the elementary and lower high school levels, romance should be a predominant mode; high school students should develop a mastery or precision, and generalization should occur in the university years. These periods are rhythms of the “natural craving of human intelligence.”

Just as life itself exists on the border between order and chaos, living knowledge develops on the border of discipline and freedom, through their constant interplay. According to Whitehead, the stage of romance is the first period of freedom. It is the initial time of engaging with phenomena through enjoyment, the “vividness of novelty,” “unexplored connections,” and “vagueness of possibilities.” There is no comprehension without romance; it is necessary condition for knowledge to stay alive. Without “interest there will be no progress. The natural mode by which living organisms are excited towards suitable self-development is enjoyment.”⁵⁴⁸

The freedom of romance, if too wide, might kill interest, believes Whitehead. That is why romantic adventures of the mind need to be followed by discipline and accumulation of precise and exact knowledge. Indeed, to express yourself in writing you need to learn how to write, and to build a bridge you need to learn the properties of materials. During the stage of precision, romance remains in the background; otherwise, the organism will not learn. The stage of generalization is returning to the predominance of romance, but at the higher level of self-organization, when something definite is known and internalized. It is the stage of applications of learned principles; it is the space of the enjoyment of knowing and of desire for further explorations. These three rhythms are always present in the process of growing learning. The difference is in the dominance

⁵⁴⁸ Whitehead, 1929/1969: 31.

of one or the other, depending on a students' developmental readiness, according to nature's plan.

In *Magical Child. Rediscovering Nature's Plan for our Children*, Joseph Pierce, while drawing heavily on Piaget, writes that the mechanistic curriculum ignores the "beautifully coordinated natural plan for the development of human intelligence" which evolved from 3-billion years of preparation.⁵⁴⁹ According to this plan, the human child learns through imagination, movement, play, and fantasy. When a child's natural mode of learning is filtered through an abstract adult conceptual scheme, the knowledge becomes inert and dead.

According to Whitehead, the rhythm of romance must always be present in the cycle of learning. It takes us back to the notion of the attract/or/iveness of the self-organizing curriculum and pedagogy. The romance, attract/or/iveness, enchantment is a prerequisite for, and the essence of, growing living knowledge.

A soap opera "Days of Physical Science in an Elementary Schools course"

Danger! A pirates invaded the science classroom!

Music, dancing on the boat, and pirates' costumes-- all of that flew the class into the *performative* inquiry.⁵⁵⁰

What matters when you study waves? *The wind or the source of energy*

What if ? *The wind gets stronger...*

So what? *The waves become stormy!*

Who cares? *The pirates certainly do because the stormy ocean is about to swallow their boat!*

⁵⁴⁹ Pierce, 1977.

⁵⁵⁰ Fels, 1999.

Everyone hold hands!

We are an unbroken wholeness. We are the world. We are waves.

The game “We are Waves” flew us into a *holonomic* inquiry.

Some of you are crests; some of you are troughs; and some in between. Let’s make waves. I will be the source of energy.

What matters? *The source of energy*

What if ? *I will become more and more “energetic”?*

So what? *Crests, jump higher! Troughs, bend lower!*

Who cares? *Waves certainly do. Their amplitudes increase.*

The re-enchanted science curriculum is in the *romance* with the world outside classroom.

Studying waves in the pool.

Let’s jump into the water!

What matters? *The height from which to jump.*

What if? *Ken jumped from the position that is higher than Jeannette’s?*

So what? *Ken made a stronger splash.*

Who cares? *Waves certainly do. Their amplitudes increase when person jumps from a higher position. Why?*

The fieldtrip to the ocean.

It is windy today. Waves are higher when the wind is stronger. Why?

Look at the waves. Listen their chanting rhythmic songs. Tell us what you heard...

Tricia's poem:

WAVES

*Traveling from a far
Many stories to be told
Sit down, watch, listen.*⁵⁵¹

This is how living knowledge grows--out of explorations through the three eyes-- "the eye of flesh" (senses, emotions), "the eye of mind" (logic), and "the eye of contemplation" (beauty, spirituality, intuition, imagination).⁵⁵² This three-eyed creature, living knowledge, not only observes, classifies, and quantifies, but also talks, listens, sees, feels, intuit, contemplates, evolves, branches, pulses, spirals, grows, and creates.⁵⁵³

William Doll analyzes Whitehead's philosophy of education:

Technical proficiency alone, Whitehead believed, would lead only to mediocrity and dullness. He commented that one could "understand all about the sun and all about the atmosphere and all about rotation of the earth" and "still miss the radiance of the sunset"...What was wanted, therefore, was "an appreciation of the infinite variety of vivid values achieved by an organism in its proper environment."⁵⁵⁴

Quyen's poem:

*Beautiful colours
That spread happiness and joy
Mother Earth gave us.*⁵⁵⁵

Whitehead suggests integrating technical rational thought with the artistic, narrative, intuitive, and metaphoric modes of learning into the "relational frame." Only under this unifying condition can multifaceted knowledge evolve and grow.

⁵⁵¹ Tricia was a prospective teacher enrolled in my science education course.

⁵⁵² Wilber, 1997.

⁵⁵³ Nachmanovitch, 1990.

⁵⁵⁴ Doll, 1993: 147.

⁵⁵⁵ Quyen was the prospective teacher enrolled in science education course.

This makes sense to me. For instance, how do we know fire? According to science textbooks, fire is a rapid exothermic reaction of oxidation. Cellulose in wood reacts with oxygen, producing enormous amounts of heat and light. Of course, we can study the phenomenon “fire” quantitatively. We can measure the temperature of fire and we can analyze ashes. We can write the chemical symbols for the chemical reaction of oxidation. We can use our senses to observe fire, to smell it, to touch it (burns!), and so on... However, will this scientific inquiry give us a rich knowledge about the complex phenomenon of fire? Can chemical formulas tell us that fires are different creatures?

Fires are relaxing when you sit by a fireplace watching the flame dancing on the wood and playfully throwing off sparkling fireworks. Your body feels warm and cozy under the spell of the fire's enchantment. You look and look and look...never tiring of looking at the cheerful creature dancing in the fireplace. Fire is frightening, when a huge flame, an untamed monster, reaches the culmination of its devastating beauty and swallows houses, forests, and everything else in its path. Fire too is harmless, if you come from a culture that fire-walks. The internalized cultural knowledge makes your bodily experience of fire different from those who expect fire to burn!

What about fireworks? You look at them with awe, admiring their beauty! Or... what about the emotional fire inside of us? The fire of anger? The fire of love? Is it real? If not, why then does it burn so painfully? How can quantitative “objective” measurements account for all these facets of fires?

*As a butterfly drawn to a flame,
having no power to resist
I flew toward love's implacable torch.
I flew knowing that love
could burn more painfully than fire
and I perhaps will not be able to fly again...*

*But...I was ready to pay a high price
for such an explicit privilege
of being burned in the furious flames of love
and...perhaps...to disappear in its' smoke
lost without any trace, any regrets...*

Ices too can be different. In his book *What is Painting*, James Elkins writes:

Isn't hard-frozen ice, the kind that can grip the tongue onto a metal bar, different from the soft warm ice of an ice cube? And aren't the many senses of snow as different from one another as fog is from vapor or steam? If it weren't for high school science, few of us would normally associate ice, water, and steam as the same chemical. For me, there is not one ice, but several. Like the proverbial Eskimos, I would count hard cold ice as different from warm ice, and I would separate rocklike ice (as in glaciers) from black ice (as in deeply frozen lakes), singing ice (as in fracturing ice floes), and watery ice as in spring slush). Snow would be different creatures, and water and vapor different again. The formula H_2O , does not exist for me outside the laboratory. In its place is a welter of substances dispersed and hidden throughout the world, a whole unruly race of different creatures that only science claims are a single docile formula H_2O .⁵⁵⁶

Can the chemical formula " H_2O " alone account for different ices and for different waters? Of course, not. The world is more complex than abstract formulas. Re-enchanted science curriculum welcomes and celebrates the irreducible complexity of the world, providing enough space for quantitative as well as qualitative knowing.

Writes Sheldrake:

Of course, actual experience, not the limited abstractions of science, including our cultural heritage, that links us to the world which we live, not just the artificially limited aspects of experience that constitute an experiment or scientific observation. If we are not to live double lives, split between and 'objective' impersonal, mechanistic reality and 'the subjective' world of personal experience, we need to find a way of bridging these two realms. Mechanistic science cannot guide us in this endeavor, because it depends on creating a split in the first place. By contrast, an evolutionary, holistic science of the future should be able to help us in this process of integration.⁵⁵⁷

⁵⁵⁶ Elkins, 1999: 25.

⁵⁵⁷ Sheldrake, 1990: 138.

How do we know the air? Open any science textbook and you may read something like:

The air that surrounds the earth is a mixture of gases. The air at sea level is 78 percent nitrogen and 21 percent oxygen. The remaining 1 percent is composed mostly of argon, other rare gases, and water vapor. Air is a mixture of gases that do not chemically combine with one another and therefore maintain their individual characteristics.

This information about the air is undoubtedly useful, but...is it the only way we know the air? Writes David Abram:

What a mystery is the air, what an enigma to these human senses! On the other hand, the air is the most pervasive presence I can name, enveloping, embracing, and caressing me both inside and out, moving in ripples along my skin, flowing between my fingers, swirling around my arms and thighs, rolling in eddies along the roof of my mouth, slipping ceaselessly through throat and trachea to fill the lungs, to feed my blood, my heart, myself, I cannot act, cannot speak, cannot think a single thought without participation of this fluid element. I am immersed in its depth as surely as fish are immersed in the sea."⁵⁵⁸

Minutes from my work with the science video club "Gaia"

While writing the script for our video about Gaia, I asked Kim, a 12th-grader, to read aloud the forgoing excerpt from Abram's book. "Gross," said Kim after finishing reading. "Why?" "Because it is something about the body!"

Kim, do not believe textbooks that compare your body with the machine⁵⁵⁹ and do not discard your bodily knowledge as something "gross." In the complex living holographic universe, your body is the body of the Cosmos. Re-enchanted science curriculum celebrates your bodily knowing as cosmic knowing!

⁵⁵⁸ Elkins, 1999: 225.

⁵⁵⁹ Science Probe, 1995: 96.

Martha Heyneman states: "...because it is itself cosmos, the body gives us immediate, wordless experience of what cosmos is: *e pluribus unum*, a living, functioning unity..."⁵⁶⁰

Where this inner is waiting an outer?

*What part partake such lawn's alleviating?*⁵⁶¹

This place is our body, which bridges inner and outer cosmic dimensions....⁵⁶²

A soap opera "Days of Physical Science in an Elementary Schools Course"

The topic of the lesson was "Thermal (heat) Energy and Temperature." After several hands-on activities, we are about to conduct another scientific experiment,

"Rock-n-Rroll!" Research questions are:

- 1) how does our body feel thermal energy?*
- 2) what will happen with the temperature of our body after dancing?*

Teacher:

Your experimental design?

Chorus:

To measure the temperature before and after.

Teacher:

What will happen with the temperature of our body after dancing?

Chorus:

The temperature will increase.

Teacher:

Let's dance and see! So, how does our body feel thermal energy?

Chorus:

Flashes, pulsations, and perspiration...

⁵⁶⁰ Heyman, 1993.

⁵⁶¹ Rilke, 1984.

⁵⁶² Merleu-Ponty in Abram, 1996.

Teacher:

What happened with the temperature of our body after dancing?

Chorus:

It did not increase!

[Confusion...why did the temperature not increase?]

Discussion:

When we perspire, the particles of liquid evaporate, and the process of evaporation requires energy. This is how our body regulates its temperature.

The voice from the chorus:

-Isn't it how Gaia regulates the temperature of her body as well?

QUANTUM LEAP:

From our body-- to Gaia's body, what a nice connection.

Another quantum leap: living scientific knowledge, while growing rhythmically from the richness of our bodily, mental, and spiritual experiences, cannot be adequately expressed through disenchanted abstract mechanistic language. Re-enchanted knowledge requires a re-enchanted language.

Writes the philosopher of science Isabelle Stengers:

Scientific knowledge, drawn from the dreams of an inspired, that is, supernatural revelation, can today be discovered both as a "poetic listening" to nature and to natural processes in nature, open processes of production and invention, in an open, productive, and inventive world.⁵⁶³

⁵⁶³ Stengers, 1997: 58.

6. *the language is alive:*
"friend, I will send the voice so hear me"

*... the language of poetry may be more important than the language of science in interpreting the "one" or "the unitary principle behind phenomena."⁵⁶⁴
(Werner Heisenberg, quantum physicist)*

In the disenchanting flatland of the mechanistic universe, the only official language was the abstract, mechanistic, and sterile language of "its." Aesthetic, spiritual "I-language" and moral, ethical "we-language" were dismissed.⁵⁶⁵ But...the language of "its" is a dead language! No breath and no emotional explosions can survive in such a "monochromatic" desert of detachment and objectivity...

The art of conversing with stones is called physics. The question-and-answer periods of the conversations are called experiments. The actual talk is about sizes, temperatures, densities, motions, causes and effects, and the nature of space and time.⁵⁶⁶

What else, if not about movement, temperatures, and sizes, can you talk with stones and with the rest of the universe, this enormous collection of stones in space? Naturally, you will not say to them "hello" or "thank you." No one says "thanks" to a thing, writes Martha Heyneman.⁵⁶⁷ Who would be silly enough to say "thank you" to the sun, to the earth, to natural resources? The word "thank you" is not included in mechanistic scientific it-language.

Today "...new science develops a new dialogue with nature,"⁵⁶⁸ providing grounds for re-metaphorizing our metaphors. This step, suggests Chet Bowers, is a vital

⁵⁶⁴ Cited in Miller, 1996: 23.

⁵⁶⁵ Wilber, 1998.

⁵⁶⁶ Frazer, 1987: 222.

⁵⁶⁷ Heyneman, 1993.

⁵⁶⁸ Prigogine, cited in Doll, 1989: 244.

for educating an eco-centric culture.⁵⁶⁹ Metaphors of re-enchanted science education emphasize the inherent unity and organic nature of our reality, challenging Western assumptions of fragmented and individualized existence...

The metaphor “hologram” depicts our reality as an unbroken wholeness, where the boundaries of the individual ego are fuzzy. The modern cosmic story tells us that we all came from a singular “one.” If so, the stone, the eagle, the yellow wind, the angry ocean, you, and I, we are all close relatives. We are different knots of the same rope. Thinking about human and more-than-human⁵⁷⁰ experiencing beings as relatives, requires changing the mode of our communication with them. “A good way to start thinking about nature, is to talk to it. Talk to the rivers, to the lakes, to the winds, as to our relatives.”⁵⁷¹ For such conversations, the abstract prosaic it-language is not sufficient. The language of re-enchanted science curriculum integrates objective it-language, subjective I-language, and intersubjective we-language. Like in oral cultures, it talks not about the world, but to the world.

Oral people converse with the more-than-human cosmos and invoke kinship even with those entities which, to the civilized mind, are utterly insentient and inert. Here words speak not “about the world”; rather they speak “to the world.” Western civilization language seems to deaden that life.⁵⁷²

The shaman chanting song:

*Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

*In the West I call a black stone friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

⁵⁶⁹ Bowers, 1995.

⁵⁷⁰ Abram, 1996.

⁵⁷¹ Abram, 1996: 225.

⁵⁷² Abram, 1996: 71.

*In the North I call a red stone friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

*In the East I call a yellow stone friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

*In the South I call a white stone friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

*On earth, I will call a spider friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

*Above, I will call a spotted eagle friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.⁵⁷³*

Re-enchanted science curriculum and pedagogy speak a poetic and expressive cosmic Esperanto, which remembers the songs of the birds, sounds of the winds, and bubbling laughter of rivers as its primordial sources.⁵⁷⁴ This language enables students to converse with the more-than-human world, listen to it, and read its unwritten pages.

*Tired of all who come with words, words but no language
I went to the snow-covered island. The wild does not have words.
The unwritten pages spread themselves out in all directions!
I come across the marks of roe-deer's hooves in the snow.
Language, but no words.⁵⁷⁵*

Abstract scientific language cannot express the richness of my experiences. Speaking it-language, I can tell for instance, that water is a chemical substance, H₂O, a perfect cleaning, heating, and cooling agent, necessary for sustaining human life. I can measure the volume and temperature of the water. I can determine specific heat. Then I can describe all my inquiries using “it”- language, which is definitely useful and

⁵⁷³ Wolf, 1991: 50.

⁵⁷⁴ Abram, 1996.

⁵⁷⁵ Abram, 1996: 137.

necessary for communicating my knowing. However, how can such language account for my qualitative experiences of the beauty and complexity of water? To express these experiences, I certainly need the re-enchanted language which would articulate a broader scientific knowledge that grows out of explorations through “the eye of flesh”, “the eye of mind”, and “the eye of contemplation”.

*Isn't it amazing
that the simple combination of oxygen and hydrogen
produces the miracle of miracles: H₂O!*

Water...

*brilliance of a little diamond -- a drop of the rain in my palm
shining with a million colors and shades;*

*appeal of a cold and fresh sip
when dying of thirst on a hot day;*

*power of a giant, the ocean,
in anger casting its waves upon the shore;*

*purity of a snowflake
drifting onto the ground in silence;*

*complexity of a simple puddle
inhabited by millions of creatures
moving, sliding, and jumping in celebration of their little lives;*

*innocence of a playful creek
that has trickled its way among the stones
and is singing now its burbling song without end;*

*mystery of a shimmering trembling shadows
upon the surface of a lost forest lake;*

*illusion dripped through the fingers,
and nothing left;*

Water...

*nobility of blue Gaia's blood
running through her veins-rivers.*

Writes Heyneman:

The lost language of the whole, in which a whole worldview will have ultimately to be presented, is the language of poetry. By that I mean language that does not necessarily make use of rhyme and meter but embodies idea and feeling in sensory images (and sound, rhythm, relative speeds within sentences, and weights and textures of words are also sensory images, speaking to the inner ear and to the kinesthetic and architectonic senses of the body) and incarnates what is beyond opposites, and hence beyond words, in vivid sensory symbols.⁵⁷⁶

There is something else about the language of the emerging science curriculum.

Entering the 21st century, we have to take into consideration that the predominant contemporary mode of expression is not exclusively written or oral language, but a combination of written language, video, music, and sound. As Ricki Goldman-Segall writes, “emerging technologies not only enhance our learning and extend our abilities to see, hear, and to speak; they propose alternative ways for us to explore the world around us—ways that are not bound by conventions designed for a pencil-and-paper classroom headed by a solitary teacher.”⁵⁷⁷ I would add that emerging technologies give us additional re-enchanting advantages.

A soap opera “Days of Physical Science in Elementary Schools Course”

Teacher:

Today we have an outdoor lesson

Chorus:

Yes!!!

Teacher:

We are going hiking with a purpose to use our scientific skills of observation and to honour the world by producing a collective video. I invite you to look around and to capture the image that enchants you. It could be a cloud or a leaf or the branch of a tree or... Think about two words to associate with your image. It could be a literal description

⁵⁷⁶ Heyneman, 1993: 25.

⁵⁷⁷ Goldman-Segall, 1998: 8.

or a poetic metaphoric expression. Videotape your image and simultaneously speak your words. For instance, I see this dry broken branch from a tree lying on the ground. For me, this image is "broken memories..."

During next lesson, we watched not a video, but our collective poem that honoured the living, feeling, and poetic world with all its "dreaming clouds," "illusive hopes," "frozen tears," "forgotten flowers," and "lost suns."

From Duncan's reflective journal:

This class was the day we went outside to create metaphoric snapshots of the environment. I was reluctant to do this as it seemed pointless at the time. The activity seemed more suited to art than pure science. The idea that the environment, which I respect greatly, is inspirational is the domain of Romantic poetry rather than scientific inquiry. Looking back I realize that I was being close-minded and unimaginative. I did not do a snapshot because I did not think about anything, which was no doubt attributable to my narrow perspective. The idea of using video cameras is excellent because it provides students with an opportunity to explore the "synergy" of the environment and technology in a hands-on way. I regret not participating because I lost the opportunity to benefit from experience.

Duncan's comments made me think: was this activity scientific or was it exclusively artistic? Does my plea for re-enchantment ignore and distort *real* science? I find this question not easy to answer. Where was the science in this activity? Learning observational skills. What was the art? Making poetic, metaphorical associations. But...was not this activity altogether an expression of our deeper knowing of the world that embraces our inner and outer experiences? Perhaps it is time to re-think what the *real* science is...

...The topic of another lesson was "Chemical and Physical Processes." Rusting is a good example of a chemical reaction. You can conduct a scientific experiment, placing a steel wool in a test tube with water and then observe the process of rusting. You can explore rusty and non-rusty iron with a magnet. Rust is not magnetic. It has different properties than iron. You can go outside to collect rusty objects. You can also create a

magic video-story, where iron and oxygen decided to produce the new compound "rust" in the presence of water. If the teacher would take the role of "Rust", dressing accordingly, the video-story unites class and teacher into a holographic unity of teaching and learning science through fun and excitement.

NO ONE LIKES RUST

*No one likes Rust...
Rust is not an attractive compound at all...
It symbolizes aging and destruction,
and it ruins many useful things*

*Who is to blame for such an unpleasant event as rusting?
Oxygen is the guilty party!
Of course, I do not think
oxygen intentionally complicates our lives
by producing Rust.
Probably, it is just having fun,
flying around, searching for elements
which do not mind reacting with it.*

*While wandering about,
oxygen perhaps noticed
a piece of iron
and decided to make a deal with it.
Using all his charm, oxygen said:
"Hey, iron! How are you?
Aren't you bored being alone?
would you like to participate
in a neat chemical reaction with me?
We will produce a great new compound "iron oxide:
if you do not mind lending me just a few tiny electrons
to complete my electronic configuration!"*

*Iron, probably, replies:
"well...your deal sounds good...
A few little electrons are actually
not a very high price to pay,
but it is against my nature
to make hasty decisions.
I have to have some time to think!"*

*Here comes water:
"Come on, iron! There is nothing to think about!
Hurry up and react!"*

*Iron says:
"OK, I am convinced.
I will react with you, oxygen,
in the presence of water.
You can have my electrons if you wish."*

*The deal was done. The reaction was completed.
Rust, which is iron oxide was produced.
Elements make their own deals
and we make ours.
Sometimes their and our deals are not in agreement,
But... if we ever found a way
to contact the elements,
we could possibly negotiate...*

*From humans to elements:
"Please do not produce rust on our cars!"*

Voices from the chorus:

- I like using movie making as a tool for students to show that they have learned about a particular concept. Making your own video puts a person in the role of teaching. Teaching something enables a person to learn and remember something to a much higher degree.

-It is more fun and more thoughts. Children will remember and learn so much better via doing the video. Other benefits: writing scripts, acting, collaborative work, learning to film and to edit, integration with other subjects.

-The video describes what rust is and how it was formed. It explains how the element iron in presence of water reacts with oxygen creating a new substance. The video helps students visually "see" or understand the process of these elements reacting by dramatizing (acting out) this process. The effort required in making video helps lead to greater student engagement (interest), motivation which furthers deeper thought leading to greater understanding, retention, and learning.

Other "rusty" ideas from prospective teachers:

-Create video presentation where the audio is a variety of students' tunes and rhythms that incorporate the following "rust-prevention" chant...

We must, we must, we must

We must reduce rust!"

-Invite students to present mini-dramatizations of images in their lives, depicting where it may be useful to anticipate and prevent the oxidation of iron, the magic of rust! For example, protectively painting a bicycle and storing it inside or undercover (rather than outside in the rain and moist air), or cleaning, drying, and putting away garden tools, or putting a protective cover on the back yard barbecue...Investigate your neighborhood on your walk home, use your imagination for more ideas!!!

Rust through art:

"Images of Chemical Change:"

Brush a mixture of white glue and water over an entire sheet of construction paper (Black? Silver?) Place a found/fallen leaf or array of leaves onto the sticky paper (leaves change colour: chemical or physical change???). While paper is still damp with glue mixture, use steel wool or sandpaper with a set of "rusty" objects. Shave the rust onto the paper so that the page is covered thoroughly with rusty particles. Carefully peel off the leaves...they will leave clear silhouettes/shadows/memories of the leaves, surrounded by a sprinkled shower of rust!

Rusty fairy tale:

Role-play a tin man from "Wizard of Oz."

Rusty dancing:

How would rusty robots dance?

Rusty connections to language arts and technology:

Build fairy tale/story characters of everyday pieces of metals (safety pins, paper clips, tin foil, zippers, nails, nuts/bolts).

Set characters outside to oxidize.

Predict: which parts of your character will rust? Why?

Take pictures and make drawings of observed changes overtime.

Use photos and your drawing to accompany creative writing of a story fairytale or adventure story about our rusty characters...

Videotape a role-played story.

A voice from the chorus:

I would create a story that defends rust. Everyone seems to blame it, but actually it is doing a good job recycling metals. If there were no rust, our world would be even messier with old metallic things thrown everywhere.

Yes, it could be a great story, and the story must have a room within science education. If you give a story a freedom, if you turn it loose, it tends to write itself poetically and ethically, even if this story is about scientific observations. Poet Leggo described a project where he and a teacher invited elementary students to write stories while studying a unit on butterflies. When represented by the story, "their observations were no longer filled with scientific jargon and recitations of facts, but with human feelings and wonderment."⁵⁷⁸ With awakening human feelings, ethical questions about caring for butterflies emerged. "Then there is the science that asks the deeper questions, one that asks whether we should even be keeping butterflies in captivity."⁵⁷⁹

Butterfly

*Butterfly, butterfly,
Oh where are you butterfly fluttering through the wind?
You can see me but I can't see you when you're
Behind the tree.
Oh butterfly show me where you do travel; and where
Your life journey began.
I hope to see you again one day, oh butterfly, butterfly, butterfly.⁵⁸⁰*

7. imaginary senses are alive: "have you ridden the wind before?"

*Gaudior asked,
"Have you ridden the wind before?"
"No."⁵⁸¹
(Madeleine L'Engle)*

Every kid knows that we have five senses from which to explore our reality. We can see, smell, touch, hear and taste things. Mechanistic science curriculum is concerned

⁵⁷⁸ Leggo, 1997: 28.

⁵⁷⁹ Ibid: 28

⁵⁸⁰ This poem is written by one of the elementary students. In Leggo, 1997: 27.

⁵⁸¹ 1962: 48.

with developing these five senses. There are several other senses, however, that are lost in industrial education. These are the imaginary senses, which physicist Alan Wolf describes as self-healing, penetrating other realities, perceiving and understanding other worlds, a sense of revelation, a sense of oneness with Gaia and with the whole universe.⁵⁸² Martha Heyneman writes that “whole symphony of senses, the classical five plus all the subtler ones enables us to know the world as completely as possible.”⁵⁸³

A soap opera “Days of Physical Science in an Elementary Schools Course”

The topic of the lesson was "exploring the world through our senses." My purpose was to illustrate that our knowing the world extends beyond five senses. We went outside. Everyone was invited to find a little something to bring back to the classroom as a gift from the world and to describe it as fully as possible. As I expected, the descriptions of "gifts" were not limited to utilizing five senses; they grew into the stories coloured with emotions, memories, intuitions, humor, intentions, and imaginations. Alison did not bring anything. She did not want to "disturb" the universe by taking something without a real necessity. She brought an imaginary present, a little playful cloud from the sky.

QUANTUM LEAP:

*This is what re-enchanted science should be about.
Not disturbing the universe without necessity!
From now on, I shall ask my students to bring only imaginary gifts from the world.*

Since the universe of the re-enchanted science curriculum has physical dimensions of explicate order and imaginary dimensions of implicate order, imaginary

⁵⁸² Wolf, 1991.

⁵⁸³ Heyneman, 1993.

senses are as real as the physical ones. They enable our intuitive knowing, which is “seeing without glasses, hearing without filters, touching with an ungloved hand.”⁵⁸⁴

When I cross a busy road, I estimate my relative safety without any need to calculate the speed and time of automobile movement. If I want to skip a stone, my body knows what to do without calculating forces and trajectories. In his *Theory of Ecological Constraints* image psychologist Roger Shepard speculates that our physical intuition arises from the internalized, embodied constraints of our physical world, the world that appears three-dimensional, has certain gravity, air pressure, a 24-hour and 12-month cycles, and six degrees of freedom.⁵⁸⁵ We internalize the world through the embodied experiences of our ancestors and through our own experiences in the physical world. We hold the world within us. What could be more holographic? A re-enchanted science curriculum cultivates students' intuitive holographic knowing embodied a long before entering the science class.⁵⁸⁶

FLYING WITH THE WIND
OR...
HOW I LEARNED ABOUT GRAVITY⁵⁸⁷

*The spring was especially windy.
Strong, wild, but warm winds, almost every day.
They seemed to be ready to pick you up and carry you off
above mountains, oceans, and fields.
You may end up in an underground city of gnomes,
or in the Land of Oz,
or... somewhere else, not yet described
in a fairy tales' literature.
The spring winds were strong,
but they definitely needed some help
to carry me toward the magical "somewhat"*

⁵⁸⁴ Noddings & Shore, cited in Miller, 1996: 88.

⁵⁸⁵ Shepard, 1988.

⁵⁸⁶ Drake, 1992.

⁵⁸⁷ At that time, I knew nothing about Mary Poppin's more successful experiment.

that resides in magical "somewhere..."
The help I gave to the wind
was in the form of a little old umbrella
plus the roof of my grandmother's old house
created conveniently for jumping off.
So, jumping from the roof of the old house
using a flying device--an umbrella
when the Spring wind was especially strong
was to me a pretty clever idea.
How else could you travel to all of the places
that are described and yet not described
in fairy tales?
So, after thorough preparations
which included
packing some clothes and writing a "good-bye" letter,
I jumped from the roof of my grandmother's house,
clutching an umbrella and all my possessions...
That was how I painfully learned about the "gravity" concept
Or... maybe,
the spring wind was not quite strong enough
to carry me away to the magical "somewhere"
described and yet not described in fairy tales?

Tell a story or perform dramatically a real world situation. Imagine driving a car. Stop the car abruptly. What happens to your body? Within this space-moment, an unreal imaginary world becomes real. The implicit knowing becomes explicit. You suddenly realize that your body knew the "inertia" concept a long time before this science lesson. What matters? What if? So what? Performative inquiry explores variables, dancing on the edge between the unreal and the real. What if the car was to move at a different speed? What if your weight was twenty or a thousand kilograms?

A student imagines--*What if?*

and performance realizes
a possible universe into being.⁵⁸⁸

⁵⁸⁸ Fels, 1999: 112.

In the holographic universe, where the life of each of us relates to an ongoing cosmic drama, our performances are not limited to a dramatic play in the classroom but extended to the scale of an entire world. Open the doors of your science classroom. Is the topic of your lesson pendulum motion? A swing in a park can become a lab tool for recalling your intuitive knowing of “the center of mass” concept.⁵⁸⁹

The combination of intuitive explorations with traditional classroom experiments, guided by scientific method, is explosive. Aha! Eureka! Quantum leap. New meaning bursts into being. Your knowledge grows simultaneously with your embodied interactions with the rest of the universe. If you were born and raised on planet Mars, your body would know the world differently. Knowledge sprouts from fertile soil where intuitive insights merge with biological and social experiences into the ongoing process of the embodiment of the world.⁵⁹⁰

“Crunch! Crunch! I’m a goat out for lunch!”⁵⁹¹ This way of knowing is familiar to us from childhood. Bodily *architectonic* imagination enables us to turn temporarily into someone or something, helping us to develop an intuitive holographic sense of oneness with the world.

Without changing position, it [body] can sense itself in any size or any shape--curled up in a ball, or with an arm poking out there, a leg there, creating a pattern of wrinkles, stresses, and strains in the field of sensations --so long as there is some shape. This faculty of intentional bodily imagination underlies our capacity to put ourselves in the place of

⁵⁸⁹ From the science lessons of Dr. Karen Meyer at the University of British Columbia.

⁵⁹⁰ This is the essence of an enactivist approach to learning suggested by Varela et. al., 199, which perceives learning as an interactive, interrelational, and interdependent ongoing process of embodiment of the world. To me, enactivist approach comprises a holographic principle: *all in all*. Varela and others understand embodiment as follows: “By the term embodied we mean having a body with various sensorimotor capacities, and second, that these individual sensorimotor capacities are themselves embedded in more encompassing biological, psychological, and cultural contexts. The body “encompasses both the body as a lived experiential structure and the body as the context or milieu of cognitive mechanism.”

⁵⁹¹ Heyneman, 1993: 27.

another person or thing and know, not theoretically but in the sensation of our own bodies, what it Feels like to be that other.⁵⁹²

Physicist Nick Hebert speculates that future mind-link technology could acquaint us with the senses of other experiencing beings. It is easier for us to imagine how it might feel to be a dog or a cat because our bodily scheme is not dissimilar to theirs. But what about the sensations of an octopus? “What would it be like to experience the world via the sonar sense of a dolphin or a bat? Or sense electric fields as certain fishes do? How does a plant feel while it is gazing on photons of light? If you could directly experience the sizzling sensation of photosynthesis, how would you describe to someone else the taste and smell of sunlight?”⁵⁹³

Wouldn't it be exciting to plug yourself into a sophisticated apparatus and have the experience of a butterfly's flight! How wonderful it must be to ride the wind. *Have you ridden the wind before?* Since no such apparatus has been invented yet, we can use our bodily imagination to associate ourselves with the butterfly. Mechanistic science studies the butterfly's life functions, habits, or cycles. In addition to all of that, re-enchanted science invites students to imagine how it might feel to be a butterfly. Exploration of the butterfly's experiences by means of imaginary senses is a legitimate scientific inquiry of re-enchanted science curriculum. When we imagine a butterfly's experiences, a new caring science leaps into existence. If you were a butterfly, how would you feel if you had to exist in captivity?

I hope to see you again one day, oh butterfly, butterfly, butterfly

⁵⁹² Heyneman, 1993: 27.

⁵⁹³ Herbert, 1993: 74.

“Crunch! Crunch! I'm a goat out for lunch!” The inhabitants of the enchanted land of childhood are literate in the language of bodily imagination, a language, which was long ignored and uneducated in mechanistic science education.

DEATH OF BOB

Bob was an interesting fish. If someone told me, I would not believe it, but I witnessed myself that Bob definitely had a personality. He was perhaps lonely in his tiny fish tank. We wanted to buy him a friend, but procrastinated. Any time when I approached his tank, Bob followed me as if he were a dog. The language of his whole tiny golden body was screaming: "Hey, don't leave! Well...if you absolutely have to leave, give me at least a snack!" My daughter and I became attached to this sparkly little creature. Bob quickly became a member of our family.

One morning I found Yana crying. Bob had jumped out of his tank and died. It was terrible. I was surprised how much pain I felt over this tiny fish. I still miss him. However, there was something else to this event that made me take Bob's death even closer to my heart. Yana told me that she imagined how shocked and scared Bob felt in the huge unknown hostile dry floor. Following this imaginary picture, I had an acute bodily feeling of laying helplessly after being thrown into huge unknown world...dying. I do not remember myself ever being a fish. Why then was I able to imagine Bob's feelings so vividly? Isn't it because we are a holographic "one"?

YOU WILL BE OKAY

The park was beautiful and fresh. It was newborn after the rain. It shone in the sun with myriad tiny drops. My daughter Yana and I walked through this sparkling kingdom. Yana was eleven and we were holding hands. Suddenly, my child broke away from me. In an instant, she was hugging a little, half dry, seemingly ill tree. Hugging the tree, she was saying: "You will be Okay..." I asked her later why she had done that. She told that she imagined how lonely and ill this tree was. She felt that the tree desperately needed a hug.

If my daughter had not told me, I could not imagine how Bob might have felt dying on a dry floor, and I would have passed by the little tree without noticing it.

But...the little tree was screaming for a hug! The child heard it!

I did not. Is there something that I knew in my childhood and then forgot?
Teaching the chemistry of cellulose, I never imagined nor invited my students to imagine what a tree might experience. I know about the structure of the long-chain molecules of cellulose and about burning as a reaction of oxidation, but somewhere, in the flatland of mechanistic science education, I lost my knowing by heart how it might feel to be a tree.

Turn temporarily into something!

QUANTUM LEAP

*what do I teach
and
what do I unteach
when teaching science?
Is my teaching worth unteaching?*

Writes Heyneman:

We have today to gather our dismembered hearts, piece by piece from where we left the fragments deposited long ago, hidden in the forgotten particular sensations of childhood.⁵⁹⁴

Turn temporarily into something or someone, and you will be able to tune into “vibrations” from others at the level of your feelings, at the level of emotional intuition of your soul.⁵⁹⁵ Your vibrations and the vibrations of others, resonating, could harmonize themselves into a symphony of empathy, which is “*a truly social interchange at the holographic level*” since it “*stretches forth to objects and draws them into itself.*”⁵⁹⁶

⁵⁹⁴ Ibid: 24.

⁵⁹⁵ Miller, 1996.

⁵⁹⁶ Ahsen, 1991: 66.

How might it feel to be an unpretentious stone lying unnoticed on the ground? What memories are stored in its stony body? What desires and dreams lie within its stony spirit?⁵⁹⁷

*In the West I call a black stone friend
Friend, I will send a voice, so hear me.
Friend, I will send a voice, so hear me.*

A soap opera “Days of Physical Science in an Elementary Schools Course”

Teacher:

I invite you to participate in an imagery exercise. Imagine yourself being something or someone and describe your experience.

-Who are you?

-I am a stone. I enjoy laying by the creek and philosophically observing the world. I am happy that I do not need to worry about such vanities as work, money, new cars, clothes, and so on...I simply enjoy sun and spring.

-I am a tree. I feel so naked. I am anxious to put on my green dress again. I am so glad that summer is coming.

-I am a tiny helicopter flying off the maple tree. I enjoy the glory of the moment. I fly!

From Sarah’s reflective journal:

I enjoyed the activity of pretending we were some sort of object of the environment, and how this object felt. I was a weed and received a bit of laughter for my over the top emotional plea for acceptance for who I was (something that sucks up all the water and nutrients other seeds need for survival or they die). It would be a great exercise for a story starter to write a paragraph or more about your experience as that object.

Turn temporarily into someone and you may understand how it feels to be a little dog in an animal shelter or how it feels to be Gaia. What would Gaia’s life be about? What kind of news would she discuss with other planets? What would she think of a modern human civilization that makes her terribly ill? How would it feel to be an entire

⁵⁹⁷ Alchemists believed that all substances have spirits.

Cosmos? Imagination helps to understand the language of ancient harmony, to recall your spiritual intuitive knowing of being “the one” with the Cosmos.⁵⁹⁸

Developing spiritual intuition within the realm of science education? This is categorically radical re-enchantment! However, if we decided to step into the organic world, we inevitably enter the spiritual realm... I agree with Leggo who writes:

Perhaps I need to speak about organic without trying the word conceptions of high school biology. Perhaps I need to acknowledge the existence of spirits and angels and embodied winds and water and light.⁵⁹⁹

Warning!

At this point, we are entering the prohibited land of a spiritual “no-no”. If you are not comfortable, you may choose to go no further.

A soap opera “Days of Physical Science in an Elementary Schools Course”

From Vera’s reflective journal:

One thing I do have to mention is that by the end of the course, I was so amazed that I now have all the information I need to teach a basic physical science course. This class not only gave me ideas about teaching, it also gave me actual information--and the information was comprehensive enough that it covered all the different topics. It's amazing. I had a lot of fun with this course. I was very apprehensive in the beginning—especially since it seemed so “spiritual”, and because I know that my faith is definitely something different. I really didn't know how much was expected of me... As I mentioned before, the only thing that perhaps affected Lyubov's lessons were the way they were presented. The tone was always “spiritual” and I always felt like I was expected to be so “excited” and “energetic” and “engaged”. I was, but it feels weird when it seems like I'm expected to be—to “follow” the spiritual atmosphere.”

⁵⁹⁸ Miller, 1996.

⁵⁹⁹ Leggo, 1999: 117.

CIRCLET 4:

THE LAND OF SPIRITUAL "NO-NO" AS A STEP INTO
RADICAL
RE-ENCHANTMENT

*... What is the knocking?
What is the knocking at the door in the night?
It is somebody who wants to do us harm.
No, no, it is three strange angels.
Admit them, admit them.⁶⁰⁰*

⁶⁰⁰ Lawrence, cited in Nachmanovitch, 1990.

Admit them, Admit them

We likely see a reemergence of deliberation about how science [education] and sacred [spirituality] fit together.⁶⁰¹

(Lincoln & Denzin)

Welcome into radical re-enchantment, into the risky territory of spirits, goddesses, and angels. Such an otherworldly shadowy realm was a definite “no-no” for the mechanistic science curriculum. Today, however, it hesitates at the door opened by cutting edge science. Ken Wilber writes, we “may agree or disagree with new paradigms, one conclusion unmistakably emerges: at most new science demands spirit; at least, it makes room for ample spirit.”⁶⁰² Contemporary science, states Wilber, invites spirit from the very beginning: the Big Bang model triggers the “lethal blow of materialism.” Further, the insights of quantum theory brought the belief that “it looks more and more certain that the only way to explain the universe is to maintain that it *exists in the mind of some eternal spirit.*”⁶⁰³ Recall quantum randomness, quantum thinglessness, and quantum inseparability. These three principles of quantum theory suggest that our reality is mind-like rather than machine-like.⁶⁰⁴

Capra, in *The Tao of Physics*,⁶⁰⁵ found many striking similarities between Eastern spiritual philosophy and the insights of new physics. This is shaky ground, however. I am aware of skepticism around such parallels. Coming from a scientific background, I am

⁶⁰¹ Lincoln & Denzin, cited in Waltz-Michaels, 1996: 1.

⁶⁰² Wilber, 1985: 4. What is “spirit”? Ken Wilber synthesized cross-cultural and cross-temporal definitions of spirit as the “One”, the “Truth,” the “Higher Self,” “Godhead,” Higher Self,” “Universal Mind,” “State of states,” “Condition of conditions,” “Nature of natures,” “Superconsciousness”, “Transcendental summit of our being,” “Primordial emptiness,” “Chaos.”

⁶⁰³ Wilber, 1997: 2. Italic words belong to Sir James Jeans.

⁶⁰⁴ Herbert, 1993.

⁶⁰⁵ Capra, 1991.

not comfortable myself with incorporating Eastern cultural metaphorical language into science instruction. At the same time, I am enchanted with the idea that new visions in science might provide a conceptual ground for developing spirituality, which Wilber defines as goodness, affection, empathy, universal love, and feelings of belongingness, morality, and contemplation.⁶⁰⁶

After three years of teaching the science education course, I became acutely aware of the need for new metaphors and new understandings “justifying” spiritual dimensions in education. Chet Bowers⁶⁰⁷ and John Miller⁶⁰⁸ address this problem when they write about the necessity to ground contemporary education in the Ancient wisdom of perennial philosophy. They acknowledge that this philosophy comes from pre-modern spiritual traditions, which most people of the atomic age find difficult to accept and articulate. Wilber expresses a similar view:

Formless or Ancient Truth, we would agree, is a perfect union-identity with the entire manifest world; but our present day manifest world includes computers, global politics, the idea of evolution, molecular engineering human-machine interfacing, radical medical advances, and so on. In short, the form of Ancient Wisdom can no longer be ancient. The neo-perennial philosophy, with its adaptability to modern needs and desires, is and must now be God’s witness to the new and rising wisdom culture.⁶⁰⁹

True, there is no way for us to stop evolution and go back to pre-modern times. Pendulums do not swing back to the same position. We cannot erase the modern coil of the spiral of human civilization’s development. If we are to return to Ancient Wisdom, it needs to be a contemporary version. Quinn writes that we might learn to perceive ourselves as an unbroken wholeness with the world “owing its universal acceptance as a

⁶⁰⁶ Wilber, 1997.

⁶⁰⁷ Bowers, 1995.

⁶⁰⁸ Miller, 1996.

⁶⁰⁹ Wilber, 1997: 65.

scientific fact.”⁶¹⁰ This is why, while re-imagining a science curriculum, I follow postmodern constructive philosophy conceptualized by David Griffin and others⁶¹¹ and the neo-perennial philosophy of Ken Wilber.⁶¹² Both philosophical approaches recover ancient spirituality through visions of the state-of-the-art science.

The challenging task is to understand how science curriculum can obtain a comfortable space in the land of spiritual “no-no”, where Gaia is not a living system, but the Goddess, and where I am Gaia, and therefore a Goddess. What kind of pedagogical techniques and theoretical approaches can invite my students to enter the spiritual realm, without their feeling “pushed?” William Doll writes that to be alive, curriculum has to be “spirit-full.”⁶¹³ Considering, however, my students’ reflections, I wonder: *how much of “the spiritual” is not too much and how to approach it within science curriculum and pedagogy?*

A soap opera “Days of Physical Science in an Elementary Schools Course”

*The two-hour lesson was an ongoing parade of hands-on experiments with echoes, singing bottles, tuning forks, tape recorders, and self-made musical instruments... At the end of the lesson the meaning of the concept “sound” started to emerge. Sound is a form of energy. It travels as a mechanical wave. It is produced by fast back and forth movement called vibrations... And then time came for the **holonomic inquiry**.*

⁶¹⁰ Quinn, 1997.

⁶¹¹ Griffin, 1988; Griffin, Cobb, Ford, Gunter, & Ochs, 1993.

⁶¹² Wilber, 1997. To me, constructive postmodern and neo-perennial philosophies express similar systems of thought.

⁶¹³ Doll, in press. He understands “spirit” as a “vital integrity.”⁶¹³

Teacher:

Listen to this song.⁶¹⁴ Be mindful of your emotions and bodily response.⁶¹⁵ To concentrate better, close your eyes...

Chorus:

The body resonates with sounds; it responds to rhythms.

Teacher:

What kind of emotions arose?

Chorus:

Enjoyment, sense of intrigue, lightness, elevated spirit.

Teacher:

Is our knowing of sound limited to defining it as a form of energy that travels as a mechanical wave?

Chorus:

No...

Teacher:

Sound is not just mechanical waves. It is also our music and our poetry. The mechanistic universe was deaf to these human realms. In the re-enchanted holographic organic world, you are the Cosmos; therefore, your experiences, your music, your poetry, your dances, your emotions have status of cosmic experiences. Now re-direct your mindfulness into an imaginary dimension. Listen to the music. Respond to it with your body and with your soul. Try to imagine an incredible cosmic symphony of rhythms, which you perhaps cannot grasp with your ears, but your heart may be able to hear it. Look deeply into your inner dimension, look inside yourself, and you might see unimaginable cosmic flowers, colors, forms, and shapes dancing in an ocean of unthinkable cosmic music. Then please draw what you just have seen in your inner cosmic dimension when listening to this music.

Thirty-four different inner cosmic appearances leaped into artistic expressions.

Among them were:

abstract shapes and forms
a sun and planets

⁶¹⁴ *The Spell of Uma Sumak.*

⁶¹⁵ In *The Embodied Mind*, Varela, Thompson, & Rosh, while drawing from Eastern philosophy, define mindfulness as an awareness which is arisen from presence of mind in embodied everyday experience. "Mindfulness techniques are designed to lead the mind back from its theories and preoccupations, back from the abstract attitude, to the situation of one's experience itself." (p. 22)

stars
strange creatures
a medieval lady on balcony
blue flowers
colorful cosmic butterflies

-What about angels?

-What about them?

-There were no angels in the students' drawings. Do they really exist?

-To be honest, I do not know. Personally, I have never met one, although I wish they existed because our world would be cozier if angels lived in it.

-In a century or two advances of genetic engineering perhaps will enable humans to splice "the genes for wings onto a human back. That means, humans could become angels if they want to. " ⁶¹⁶

-Angels are not about wings, but about souls. In the holotropic state of consciousness, people sometimes identify themselves with non-material beings made from pure energy. These beings emit love, warmth, and compassion, and this is what angels are supposed to be all about. The holographic model of the universe can account for the existence of such beings. They might exist at a different, higher frequency level of holographic reality.⁶¹⁷

This issue was more or less settled in medieval times. Angels existed, period. If humans purified their souls, they could become closer to angels. It was something to look forward to. I do not know anything about life of angels, but the thought that holographic model provides a space for their existence is appealing to me.

If angels do not exist right now, they may evolve later since the evolution of the universe perhaps is not limited to the evolution of matter. It might be that the highest stage of evolution is spiritual evolution.

Am I realistic here? Is spiritual evolution possible in the world where all life feeds on other life? And what about the dark and destructive aspects of the unconscious human

⁶¹⁶ Kaku, 1997: 239.

⁶¹⁷ Talbot, 1991; Sheldrake, 1990.

psyche, which Carl Jung called the Shadow? The world is overflowing with violence and tragedies. Just turn on the television. Does it not indicate that the universe has an inherent dimension of “evil?” As Stanslav Grof writes, it may be that evil and goodness complement each other just as light and darkness. But, what if the universal Spirit still evolves, and existence of the evil is due to Spirit’s immaturity? What if this Spirit “grows up” in the direction of eternal goodness, love, fairness, and beauty? I would definitely like to think so. Ken Wilber, following the philosopher Hegel and the ideas of the theosophical movement,⁶¹⁸ believes that the evolution of the world is not limited to an increasing complexity of the material physical world, but extends into spiritual evolution, which he calls Spirit-in-Action. From the vantage point of the science of complexity, I translate this process as an autopoietic self-organization of living Spirit.

We are part and parcel of a single and all-encompassing evolutionary current that is itself Spirit-in-action, the mode and manner of Spirit's creation, and thus is always going beyond what went before--that leaps, not crawls, to new plateaus of truth, only to leap again, dying and being reborn with each quantum lurch, and often stumbling and bruising its metaphysical knees, yet always getting right back up and jumping yet again.⁶¹⁹

There are no clear outcomes, nor guarantees. The spiritual evolution is a creative process filled with spontaneity and unpredictability, trials and errors, pinnacles and chasms, deaths and re-births. Perhaps today, writes Wilber, we are witnessing a new qualitative leap of Spirit toward developing a new consciousness.

The human race is in the process of developing a new kind of consciousness, far in advance of the ordinary human self-consciousness, which will eventually lift the race above and beyond all the fears and ignorances, the brutalities and bestialities which beset it today.⁶²⁰

⁶¹⁸ Theosophical movement was born at the end of 19th century.

⁶¹⁹ Wilber, 1997: 79.

⁶²⁰ This is the vision of theosophists, described in Hardy, 1987: 164.

Perhaps today, from within modern despair, disaster, depression, nihilism, and antagonism, a re-enchanted mode of thinking emerges, a consciousness that cares deeply for other human and *more-than-human*⁶²¹ beings:

how will our lovely blue planet Earth feel and look

when all her planetary sources are exhausted?

Rupert Sheldrake writes that “the public attitudes are greening...the climate is changing, both literally and metaphorically...Nothing less than a revolution is at hand.”⁶²² Science, human society, and the rest of the world are in the process of entering into re-enchantment.⁶²³

According to Michael Talbot, we probably are witnessing the exponential leap from one human species to another. This leap reflects “an evolutionary thrust toward higher consciousness for all humanity.”

Evolutionary fires that are beginning to flicker and dance though our collective psyche may be our wake-up call, a trumpet note informing us that our home is cosmic wholeness, our birth to non-physical world. The physical world is only a small instant in a much larger context and that reality is primarily in the original source of being. I think that being, as consciousness, probably predates the physical.⁶²⁴

That makes me wonder why I have chosen to explore this particular path? Why does it feel so right? Why do I have a passion to follow it? Could it be that universal consciousness, while evolving toward a higher plane, is trying to understand itself through me? Such a thought is very flattering and very holographic...

⁶²¹ The term of David Abram, 1996.

⁶²² Sheldrake, 1990: 58.

⁶²³ As I mentioned in the introduction, increasing number of authors talk about contemporary process of re-enchantment of science, art, and the world. See Berman, 1987; Griffin, 1988; Stengers, 1997; Gablik, 1991.

⁶²⁴ Talbot, 1991.

Why what happens would happen, we can only guess. After years of mechanistic certainty and causality, we are back to the mysteries and miracles of an ambiguous and cunning reality, which likes to play “hide and seek” games with us and with itself. Catch me if you can! “Miracles happen not in opposition to Nature, but in opposition to what we know of Nature,” said St. Augustine. Will we ever know Nature? Will we ever know ourselves? Perhaps, our reality is ultimately magical, and we need re-enchanted science to explore it in all its richness, mystery, and complexity.

According to Wilber, re-enchanted science is deep and broad. It encompasses and transcends limited and narrow mechanistic science, which “massively rejected Spirit, God, and Goddess, sacred nature and an immortal soul--and left us with the modern wasteland.”⁶²⁵ Deep science explores the world not only through sensory or mental experiences, but also through spiritual experiences, which include contemplation, art, meditation, myth, intuition, and imagination. Deep science does not reject such experiences on the grounds that it “cannot be objectified and thus nailed with a sensorimotor hammer, whether this hammer be a telescope, microscope, photographic plate, or whatnot.”⁶²⁶

For re-enchanted science, qualitative anecdotal spiritual data are scientific. These data were collected in the East and West, North and South for at least three thousand years, and they are repeatable and verifiable. Contemplative knowledge can be publicly shared. “Mathematical knowledge is public knowledge to all equally trained mathematicians; just so, contemplative knowledge is public knowledge to all equally

⁶²⁵ Wilber, 1998: 188.

⁶²⁶ Ibid: 151.

trained contemplatives.”⁶²⁷ On these grounds, Wilber envisions possibilities for developing spiritual empiricism as a legitimate dimension of broader re-enchanted science.

An increasing number of scientists recognize the need for post-mechanistic science to broaden the definition of what is, and is not, scientific evidence or scientific inquiry and to elevate anecdotes about psychic and spiritual experiences into the status of scientific data. As David Griffin writes, the layer of these experiences is too overwhelming to be ignored.⁶²⁸

In *Magical Child. Rediscovering Nature's Plan for Our Children*, Pierce writes that very young age is the most appropriate threshold for developing spiritual knowing, since the bodymind of the elementary child remains bonded to the holographic matrix of the earth.

When we speak of the brain as a hologram, we mean that any part of the brain, even a single thinking cell, reflects or encompasses the workings of the total brain. An even more intriguing implication is that the brain may be a hologram of the entire planet earth. That is, just as you can divide a holographic plate and find the whole picture in any piece, so the brain can be considered just such a piece of the earth, reflecting within the picture or workings of the whole life system. The human brain may be a kind of microminiature replica of the living planet itself, just rather fuzzy at the edges, needed clarification...Each bit of the hologram system interacts with the total for precise functions; every creature fits into the balance with meaning, purpose, and design.⁶²⁹

Young children remember their holographic unity with the world until modern education makes them forget it. For Pierce, education should follow a natural biological plan by not forcing earlier abstract thinking, but rather providing “full-dimensional interaction with the living earth.” While the “mysterious or spiritual experiences of

⁶²⁷ Wilber cited in Heyneman, 1993: 31.

⁶²⁸ Griffin, 1997; Talbot, 1991.

⁶²⁹ Pierce, 1977: 7.

oneness,” which are “unity experiences of the hologram” are not predominant in the abstract world of adults, they are natural for a child, who “is not exactly aware of them, which rather like a fish not being aware of water because there is no other world.”⁶³⁰

Pierce believes that holographic bonding with the world explains the considerable literature that claims ESP (extrasensory perception) and psychic phenomena are more pronounced among children than adults.⁶³¹

I imagine science lessons with the following topics: “Skills of self-healing”, “Communicating telepathically”, “Out-of-Body explorations of other worlds”, “Basics of psychokinethis,” “Power of prayer”, or “Entering holotropic consciousness”.

Radically re-enchanted science curriculum would provide space for educating psychic and spiritual skills. Some scientists illustrated that these skills can indeed, be developed.⁶³² Could such developments be harbingers of the future, foreshadowing time when not astronauts, but “psychonauts” become the heroes we watch on the evening news?⁶³³ Should science education aim at developing these abilities? I am brave enough to say: why not? Since we all are “quanta” existing in material and wavelike modes, time perhaps has come to attend our imaginary, wavelike, mystical dimension of existence, and elementary years appear to be the optimal starting point for that.

⁶³⁰ Pierce, 1977: 124.

⁶³¹ In *Magical Child. Rediscovering Nature's Plan for Our Children (1977)*, Joseph Pierce provides many anecdotal stories as well as descriptions of experiments that illustrate children's capability of psychokinesis, telepathy, and other so-called paranormal phenomena.

⁶³² Grof, 1998.

⁶³³ Talbot, 1991.

A soap opera “Days of Physical Science in an Elementary Schools Course”

From Stacy’s reflective journal:

*I think children are especially more in tune with the environment and that we are robbing them of something if we choose to talk about their world within impersonal and unconnected framework of beliefs.*⁶³⁴

Quantum Nonlocality and Psychosynthesis in Science Education

*As the ocean waves, the universe "peoples." Every individual is an expression of the whole realm in nature, a unique action of the total universe. This fact is rarely, if ever, experienced by most individuals.*⁶³⁵
(Allan Watts)

For physicists Peat, Bohm, and Hiley, the quantum nonlocality principle has a pivotal philosophical component since it illustrates the unbroken wholeness of the entire world.⁶³⁶ Waltz-Michaels writes that quantum nonlocality principle as well as other insights of new physics such as a wave/particle duality, open possibilities for introduction of spiritual dimensions into education. They provide a framework for re-thinking major concepts such as “thought and practice, quantitative and qualitative research, the general and the special, the self and others and /or the one and the many.”⁶³⁷

Since the main purpose of re-enchanting science education is to develop the spiritual sense of oneness with the rest of the universe, the quantum nonlocality principle should be included in the science curriculum. Unfortunately, there is no way to reproduce Aspect's experiment in a classroom, due to cost and sophistication. However, there is something we can do....

⁶³⁴ Stacy’s final reflections on the science education course.

⁶³⁵ Watts, 1966: 6.

⁶³⁶ Peat, 1991; Bohm & Hiley, 1992.

⁶³⁷ Waltz-Michaels, 1996: 8.

While writing this, I hear the strident inner voice of a “realistic” teacher inviting me to come back down to earth. The quantum nonlocality principle and say, elementary science curriculum... Does it not sound a little...far fetched?

SCENARIO FOR AN UNFINISHED VIDEO

Once upon a time, the local youth science video club "Gaia" and I, as director, decided to produce a video that would illustrate the quantum nonlocality principle. We role-played the Allen Aspect's experiment in a simple scenario where two partner-electrons spun in different directions, in order to avoid unnecessary tension. One partner was spinning clockwise and the other-- counterclockwise. Suddenly, two scientists came and separated the electron partners with a huge (cardboard) magnet. Next, they forced one of the electrons to change the direction of its spin. The second electron partner simultaneously changed its direction. How did that electron know about the affairs of its partner?

The participants, 5th -7th graders, were fascinated: what a magical world! Did they grasp the concept of quantum inseparability? It seems to me they understood the principle: particles are interconnected! They communicate!

What else can we do to develop a spiritual sense of oneness? We can invite students to become holonomic inquirers, which means imagining the unified organic universe through self-explorations as guided by the question: *when, how, and where do I feel as an unbroken wholeness with the world?* For this purpose, we can organize “experimental settings” to evoke *unitive* states of consciousness. Majestic mountains, a

playful ocean, a hospital, art gallery, symphony, or animal shelter can become a “scientific lab” for conducting holonomic inquiry.

Meditation, breathing exercises, and rhythmic movement can become research “techniques.”⁶³⁸ Experiences of empathy, love, and awe, contemplation of radiant beauty, and other “glorious enchantments,” can become scientific data for grasping the manifestation of quantum nonlocality principle within the human realm.

Candace’s poem:⁶³⁹

*Misty skies fleeting
Kissing my face softly
Blooms beginning sunset
Sun filled days
Of laughter
Waves crashing salty-tasting air
Fragrant
Endless skies
Pale-green shoots
Turning emerald
Like jewels
Red rubies set in bright gold
Crunching beneath my feet
Long days going to sleep
Diamonds falling from the sky
Kissing my face softly*

Principles of re-enchanted science education resonate with those of holistic education, whose main objective is to re-connect individual selves with higher universal transpersonal “Self.” For Carl Jung, the “Self” lies at the center of the psyche and is closely connected with what he called the “collective unconsciousness.”⁶⁴⁰

Following Jung, Roberto Assagioli developed the concept of psychosynthesis, a branch of transpersonal psychology that offers a range of practical techniques such as

⁶³⁸John Miller in *The Holistic Curriculum* provides an outstanding overview of such “techniques” and approaches. See Miller, 1996

⁶³⁹Candice was enrolled in my science education course.

⁶⁴⁰Jung, 1968.

meditation, visualization, dancing, drawing, and guided imagery for connecting the personal “self” with transpersonal “Self.” What is psychosynthesis about? Writes

Assagioli:

Psychosynthesis is an inclusive and positive conception of man that considers him dynamically as being in process, of personal growth within an evolving universe. It actively fosters the harmonious development of the emerging qualities within a human being, and their integration and synthesis around a higher unifying center. The scope of the psychosynthetic approach ranges from the personal, through the inter-personal to the universal and includes the transpersonal dimensions...⁶⁴¹

The aim of psychosynthesis, as William Parfitt puts it, is to bring an awareness of wholeness and connection to evolution happening to each of us.⁶⁴² I am attracted to the vision of Diana Whitemore who writes about educational features of psychosynthesis:

Imagine a child who perceives the world as a wonderfully exciting life-affirming place and who experiences adults as welcoming, guiding and supportive-as his [her] best friends. Imagine a child who feels appreciated; who feels worthwhile simply because he [she] exists. Such a child would soon discover the wonder of life, the joy of exploring and learning and the beauty of understanding.⁶⁴³

So far, I have not found literature on the applications of psychosynthesis in science education; however, its potential for teaching re-enchanted science seems obvious to me because it offers a practical means for fertilizing *the great holarchy of becoming unified with the universe*. Inspired by possibilities, I imagined and then conducted a lesson....

⁶⁴¹ Assagioli, cited in Whitehead, 1986: 23

⁶⁴² Parfitt, 1994

⁶⁴³ Whitemore, 1986: 1

A soap opera “Days of Physical Science in an Elementary Schools Course”

The topic of the lesson was “States of Matter.” Hands-on experiments were completed. Ice was melted in crucibles and its melting curve graphed. Molecular-kinetic theory was discussed and role-played through dramatic explorations. And then...

There are four states of matter: gases, solids, liquids, and plasmas and there are four ancient elements: fire, air, earth, and water. These four elements are not only the foundation of astrology and alchemy, but they comprise everything we can normally perceive and experience. “These elements are interwoven into the fabric of nature and of the human experience,” writes Ruth Eichler in the Twelve Songs of the Soul.⁶⁴⁴

We human beings are born at a particular time and in a particular location because the all-encompassing harmony of the universe that dictated such a solution to a particular need in the three-dimensional world of physical existence, should take form as a human organism. This archetypal solution is “coded” in the language of the sky as the birth-chart of a particular person. Each person has a predominant element; there are fire people, air people, water people, and earth people. We literally can be nourished by our predominant element (sunshine for the fire person, time beside water for the water person, a beautiful garden for the earth person, or windy day or flight for the air person...⁶⁴⁵

Carl Jung distinguished four human temperaments:

<u>Elements</u>	<u>Jung's Temperaments</u>	<u>Astrological Signs</u>
<i>FIRE (plasma)</i>	<i>INTUITIVE</i>	<i>Aries, Leo, and Sagittarius</i>
<i>EARTH (solid)</i>	<i>SENSATION</i>	<i>Taurus, Virgo, and Capricorn</i>

⁶⁴⁴ Eichler, 1995: 22. In *Twelve Songs of the Soul*, the author synthesizes psychosynthesis and healing.

⁶⁴⁵ Eishler, 1995: 27.


AIR (gas)
WATER (liquid)

THINKING
FEELING

Gemini, Libra, and Aquarius
Cancer, Scorpio, and Pisces

PEOPLE OF FIRE

The element fire refers to a universal radiant energy, an energy which is excitable, enthusiastic, and which through its light brings color into the world.

Signs: Aries, Leo, Sagittarius.

Ruling Planets: Mars, Sun, Jupiter

People of Fire are:

Creative and expressive
Courageous and self-assertive
Direct and honest
Ardent and strong
Generous and warm
Freedom oriented
Intuitive

PEOPLE OF EARTH

An attunement to this element indicates that the individual is in touch with the physical senses and there-and-now reality of the material world.

Affiliated Signs: Taurus, Virgo, Capricorn

Ruling planets: Venus, Mercury, Saturn

Several salient qualities hallmark Earth's expression at the personality level:

Sensing;
Practical and realistic
Stable and dependable
Self-disciplined
Preserving and protective
Productive

PEOPLE OF AIR

We refer to air as the "collective element, for all men and women of this planet are connected to each other through the air we breathe. The sparkling wind, filled with divine spirit, carries the essence of the air.

Affiliated Signs: Gemini, Libra, Aquarius

Ruling Planets: Mercury, Venus, Uranus

Light and free, Air persons primarily identify with mental and interactive qualities. The following attributes comprise qualities of air people:

Thinking

Intelligent and alert

Detached and objective

Fair and just

Cultured [having interests in education, arts, sciences]

PEOPLE of WATER

Water can dissolve more substances than any other liquid known to humans.

Affiliated Signs: Cancer, Scorpio, Pisces

Ruling Planets: Moon, Pluto, Neptune

Like the ocean, the element of water cleanses and heals. Besides being feeling and emotional, water possesses the following qualities:

Cleansing and healing

Sensitive and compassionate

Dependent and vulnerable

Protective and private

Perceptive and absorptive

Teacher:

I am Leo. What about you? Do your personality and preferences for one of the elements correlate with Jung's chart? [Almost 80% of the students found some correlations]. Of course, since we all are children of the Earth with all its elements, there could be much overlap. This exercise, from the point of view of modern science, does not appear to be very scientific; however, we could use it as a metaphorical expression of our holographic oneness with the world and as a way to honor holistic visions of medieval

alchemists and astrologers. While studying the structures and properties of states of matter, we should not forget to celebrate the Earth, Fire, Water, and Air, the four elements that give us life. David Abram writes:

*How did the psyche withdraw so thoroughly from the world around us, leaving the cedar trees, the spiders, the stones, and the storm clouds without that psychological depth in which they used to dwell (without, indeed, any psychological resonance or even relevance)? How did the psyche, the spirit, or the mind retreat so thoroughly into the human skull, leaving the air itself a thin and taken-for granted presence, commonly equated, today, with mere empty space?*⁶⁴⁶

*The words "breath" and "wind," are related to the Latin word "spiritus."*⁶⁴⁷

*When teaching respiration, do we give students a chance to know that the word respiration comes from the word " spirit," a playful Spirit that unifies the whole world through breathing? When teaching air pressure, do we give students a chance to know that according to ancient oral cultures, there exists White Wind, Blue Wind, Yellow Wind, Dark Wind, Little Wind, and Holy Wind?*⁶⁴⁸

*What are you, wind? Only air
Winging in and out of everywhere? If only air,
And thinner than all gauze,
How do you know when to bluster and to pause?
Or where to go?
How to drift and settle
Each star-flake of snow,
To crest a wave,
Ripple stands of grain...*⁶⁴⁹

The book " Song of the Earth" of Mary Hoffman and Jane Ray, written for elementary and middle school children explores the magic of the earth elements through

⁶⁴⁶ Abram, 1996: 238.

⁶⁴⁷ Abram, 1996: 239.

⁶⁴⁸ Abram, 1996.

⁶⁴⁹ This poem is a gift from a prospective teacher, Jeannette. Unfortunately, I do not know who is the author of this poem.

myth, legends, images, and ideas from round the earth. Celebrating the four elements, it invites us to listen to the songs of the Earth.

The song of the Earth has been sung from the beginning of time, but we can no longer hear it. Through exploring the magic of the earth, fire, water, and air, the words of that song may return us and perhaps we can learn to tune again. Most of us, living in our centrally-heated homes with their modern kitchens and bathrooms, are out of touch with four elements and never see their links with nature. Yet, earth, fire, water, and air still hold strong magic and are the key to a rich world of stories, legends, pictures, and music.⁶⁵⁰

If we listen to the songs of the Earth, we can have a closer and more harmonious relationships with the elements. We can remember how vital earth, fire, water, and air are to human life. We can acknowledge what powerful influences they have been on people in the past and what great art they have inspired. And with every small step to help one of the four elements a little is put back of the magic they have lost. One day, if we learn to treat them as friends, not enemies, Earth, Fire, Water, and Air may regain the natural power they had when the world began.⁶⁵¹

Now we have a mission. Let us form four groups: people of the fire, people of the earth, people of the water, and people of the air. We will go down to the ocean, look around and find a way to celebrate the earth, fire, water, and air. You are free to express yourselves as you wish. Write a poem, create dance, make a picture, or invent a ritual honoring your state. Another assignment is to describe all possible ways of our knowing of four elements. Before we go, though, let us chant the poem Madeleine L'Engle's "A Swiftly Tilting Planet":

*in this fateful hour
all Heaven with its power
the sun with its brightness
the snow with its whiteness
the fire with all the strength it hath
the lightning with its rapid wrath
the winds with their swiftness
the sea with its deepness*

⁶⁵⁰ Hoffman & Ray, 1995: 1.

⁶⁵¹ Hoffman & Ray, 1995: 9.

*the rocks with their steepness
the earth with its starkness
all these I place
between myself
and
the power of darkness.⁶⁵²*

One of the student teachers, Sara, wrote and then conducted on the beach imagery exercises for people of the earth, the air, the fire, and the water. These are the segments of Sara's beautiful poems:

Earth

*...Take a handful of fir needles and cedar
Rub them between your hands
Hold them up to your nose and breathe their sent
Now you are lava
Thick and hot
Slow moving and deliberate
A lizard made of fiery Earth
You are as solid and as strong as granite
As brilliant as diamonds and emerald
You carry the imprint of layers of sandstone
You have a memory as old as time.*

Air

*...Trees and plant take in the CO₂ and give us oxygen back
Say a silent "thank you" to those trees!
Now imagine yourself to be the wind
What kind of wind are you?
A Chinook or a sirocco
A humid tropical wind
An icy wind from the northeast
A gale force or a gentle breeze carrying the scent of flowers
Are you a tornado lifting up whole houses and carrying them to Oz?*

Fire

*...Imagine that you are a snake
Coiled and sleeping on a sun warmed rock
Muscles relaxed*

⁶⁵² L'Engle, 1978.

Feel a cold spot and shift so that the sun can touch it...

Water

*...You are rain on the upturned face of a child
You're a river carving its way to the sea
You are the water swallowed by a thirsty farmer on a hot day...*

Jeannette:

THE WAYS WE KNOW THE ELEMENT "AIR"

*breathing
wind
movement of trees
cold days: seeing air of your breath
to blow the candle...or help a fire the burn!
making waves
moving clouds above us and around us
leaves floating from the trees
carrying smells and sounds*

Melannie:

*Dancing with the wind
Burning those who get too lose
Beauty from afar
An evening at the beach
The sun-setting glow
Its beams attempt to reach
for something we don't know...*

Shannon:

SOULCLEANSING

*My soul is hollowed out
Filled with something new
The dirt and confusion of busy city life
Are gone
Impurities flushed
A new brilliance
Dawn in their place*

*Solitary I am
But not alone
My soul aches
But not with pain*

*Inspiration
All around me
I am awed
Filled with reverence*

*Glorious nature
Omnipotent peaks
I am as a single drop
In this ocean of mountains*

*What matter my suffering, my joys
In view of this magnificence?*

*I am at one
With nature
At peace
With myself...*

From the reflective journal of Phillip:

*That by far and away is the most wonderful and valuable thing that I learned in your class—I have long been fascinated by science as a magical door to the discovery of the universe, but I had never developed any real sense that such an approach could be practically introduced in a “regular” science class in school. Your approach is very natural to me, and I hope to build on it and find ways to both stimulate interest in the study of our world and at a deeper level, to contribute to an understanding that we need a revolutionary change in the way we understand our place and role in the universe. While Industrial Age Science had resulted in many fantastic/incredible changes, it has come at a devastating cost—there is a terrible imbalance in the world, and hopefully, new science will help to restore this balance we need to keep our little planet alive and thriving... The energy of love pulsates through Gaia?!...that Rhythm has meaning, that Particles might have “memory”, and maybe even personality...these are all exciting concepts that are worthy of inclusion in our elementary school curriculum...
The Gaia/Psychoanalytic/Interconnected/Moral nature of new science is a sign for the next millennium.*

From the reflective journal of Duncan:

The primary benefit that I have derived from this course is that my “mechanistic” outlook from the beginning of the term has been superseded by an “organic”, holistic and enchanted perspective. Therein lies the difficulty of such a shift in philosophy. I still refuse to teach astrology or psychosynthesis with what I know to be science. Thus, my only suggestion for this course is that instructor continues to teach the way she is, but make it more gradual and palatable for the mechanistically inclined, such as myself. It was a shock for me at the beginning of the term and there was a great deal of resistance and unreceptiveness on my part. A smooth transition from mechanistic science to the empowered version would probably ameliorate the initial skepticism that students, like myself, have...

Overall, the majority of prospective teachers were disappointed with the “psychosynthesis” lesson because they did not see the relevance to “true” science. It gave me much food for thought. Ken Wilber proposes that broader, re-enchanted science should embrace story and spirituality.⁶⁵³ William Doll suggests that curriculum should incorporate three “S”s—science, story, and spirit. From Doll’s perspective, science should overlap with the story, while flowing into the spiritual dimension.⁶⁵⁴ The challenge is to create a chaotic butterfly that will provide freedom for story and spirituality, yet maintain the framework of science. For me, the black box is widely open: *how can story and spirit overlap with scientific inquiry?* This question begs for developing interdisciplinarity connections.

I wonder if I started my “psychosynthesis” lesson not from astrology and alchemy, but from the dimension of contemporary science, would my invitation to celebrate four elements be accepted more enthusiastically? I envision vast opportunities for educational research related to the question: *how to re-animate our vision of the world and how to develop our spiritual sense of gratitude to it through science education?* I agree with

⁶⁵³ Wilber, 1998.

⁶⁵⁴ Doll, in press.

biologist Rupert Sheldrake who emphasizes the need for “inventing” new festivals, traditions, ceremonies and other ways to celebrate the world. He writes:

It is hard to feel a sense of gratitude for an inanimate, mechanical world proceeding inexorably in accordance with eternal laws of nature and blind chance. And this is a great spiritual loss, for it is through gratitude that we acknowledge the living powers on which our own lives depend; through gratitude we enter into a conscious relationship to them; and through gratitude we can find ourselves in a state of grace...⁶⁵⁵

While inventing new traditions, however, we shall not forget an ancient heritage.

“*The fact that it involved astrology and alchemy was a little disturbing,*” wrote Duncan in his reflective journal. His hesitation was not surprising since mechanistic science education exists in a timeless, reversible world, beyond honoring history and looking into the future. It ignores the “arrow of time,” which, according to Illia Prigogine and Isabelle Stengers, is a serious disenchantment.⁶⁵⁶

The Arrow of Time Points Toward Utopia

*I have come to realize that the science education I have provided
has been based on a Newtonian view of curriculum and
as such has ignored the temporal dimensions.⁶⁵⁷
(David Lloyd)*

Writes Whitmore:

Is it just the mystical dream of an eternal optimist? Is our responsibility as parents and educators limited to giving a child merely the practical tools to cope with life on a seemingly confused planet? Can we only educate them to get by? I do not think so. We have a responsibility, a heartfelt duty, to offer a vision for the future which includes both a realistic perception and assessment of troubled times, and an awareness of the incredible poignancy of life.⁶⁵⁸

⁶⁵⁵ Sheldrake, 1990: 187.

⁶⁵⁶ in Stengers, 1997.

⁶⁵⁷ Lloyd, 1999: 1.

⁶⁵⁸ Whitmore, 1986.

While re-imagining science education, I realize importance of the interplay of history and future that is, according to Prigogine, the necessary aspect for self-organization and creation. Arguing for incorporating temporal dimensions into science education, David Lloyd writes that when “acquiring scientific knowledge in isolation we will inevitably force the development of a limited, one-sided, conscious mind and repress the intuitive “other.”⁶⁵⁹

I envision science curriculum traveling in a time machine into the history of science and into the possible paths of the future. We cannot change the past, but we can change its interpretation. Today alchemy and astrology are reduced to naïve magic or to commercialized promises of money, success, and love for \$1.99 per minute. Mechanistic science curriculum does not permit time to re-interpret the history of science, nor to honor the integrity and true spiritual intentions of medieval astrologists and alchemists. Physicist Roger Johnes calls the holistic mode of thinking “alchemical consciousness.” I am curious how our world and our science would look today, if disenchanted mechanical thinking did not collapse “alchemical consciousness.”

While honouring the past, re-enchanted science curriculum would invite and develop students’ visions of the future, stressing human power and responsibility in creation of own reality. We must teach to dream and to celebrate the dream. Otherwise, our dreams of a better future will never come.

I asked the adolescent friends of my daughter about their images of the world in a hundred years. “Your generation is so lucky,” said one of them. “You are not the one who will live without water and forest. I am afraid I will never have children because

⁶⁵⁹ Lloyd, 1999: 6.

they simply will not be able to live on the Earth. My vision of future is very pessimistic. I try not to think about the future...”

...the future in schools remains a missing dimension, a blank and largely empty space. This helps to explain why many young people feel anger and despair. At some level they instinctively know that future is important. But on the whole, the messages they get from school, commerce, and media are not helpful.⁶⁶⁰

Lloyd’s research indicated that while some students have utopian visions of fairness, beauty, a safe environment, eliminating of poverty and disease, most have dystopian pessimistic visions of a technocratic society and a destroyed environment. However, an optimistic view of the future is necessary for healthy human psychology.⁶⁶¹ The vision “*I am afraid I will not have children because they simply will not be able to live on the Earth*” is definitely not optimistic and therefore not healthy.

PRAYER OF THE UNBORN

*Men and Women who are on the Earth
You are our creators.
We, unborn, beseech you:
Let us have living bread
The builder of our new body.
Let us have pure water
The vitalizer of our blood.
Let us have clean air
So that every breath is caress.
Let us feel the petals of jasmine and roses
Which are as tender as our skin...⁶⁶²*

I imagine a science education that turns the “arrow of time” toward a “scientific utopia”, exploring issues of both material and spiritual evolution. Re-enchanted science curriculum should provide room for research, discussions, and projects that imagine realistic, scientific ways for creating fair, nonviolent, ecologically friendly, and

⁶⁶⁰ Slaughter, cited in Llyod, 1999: 18.

⁶⁶¹ Taylor, cited in Llyod, 1999.

⁶⁶² Huxley cited in Whitmore, 1986.

harmonious human society. Visions of the future can provide a fertile ground for science and humanities to merge. The world of stars without wars...⁶⁶³ This is something to look forward to and to be educated for.

Writes Boulding:

As long as we can imagine a better world with minds adequately equipped for the complexities of the twenty first century, we will be able to work towards better futures.⁶⁶⁴

Thinking about utopias, I hear the inner voice of a “realistic” teacher. How would I assess such projects in science class? Hmm...I could assess them for comprehensive literature research, for the flight of fantasy, and for scientific and technological inventiveness and originality. Or, I could not assess them at all. It raises the question of whether we absolutely have to assess everything quantitatively. But this is (*is this?*) a different story.

QUANTUM LEAP

*next year, I will start
my science education course
from the “red filter” activity;
from discussing different worldviews;
from fantasizing about a better future
and how to get there...*

Such a beginning could become a softer and less shocking entrance point into a spiritual dimension, into an understanding that “...at most new science demands spirit; at least, it makes room for ample spirit,” into the new story of science education on the edge

⁶⁶³ I envision a scientific project where students imagine ecocities of the future. Lewis Mumford, describes what the city of the future and the society of the future could look like. In Mumford, 1961.

⁶⁶⁴ Boulding, cited in Lloyd, 1999: 3.

of chaos, into the magical space of possibilities from where a better world might leap into existence.

Admit them, admit them...

*MatterEnergySpaceTimeSpirit is Alive:
The Story of Radically Re-Enchanted Science
Education*

Reducing the entire world to inanimate matter that occupies space, mechanistic science focused its explorations on the material mode of the manifested world, excluding our spiritual wavelike nature from consideration. Could this incompleteness, this craving for wavelike existence, be the reason behind the modern obsession with drugs that suppress our material mode and unleash us as waves?

Exploring not only the outer, but also the inner spiritual dimensions, radically re-enchanted science re-unites the “Truth”, the “God”, and the “Beautiful”. It embraces meaning, value, and intrinsic morality, recognizing that they are “integral aspects of the world as they are for us.”⁶⁶⁵

Re-enchanted science recovers “the deeper meaning and spiritual dimensions of Nature in the light of the astonishing discoveries we have about cosmic evolution, about biological evolution, about the levels and layers of structure that we find in cells, tissues, organisms, and atoms.”⁶⁶⁶ It re-conceptualizes the world from inanimate, soulless, and deaf fragments of matter into unbroken wholeness, where matter, energy, time, space,

⁶⁶⁵ Bohm, 1988: 67.

⁶⁶⁶ Sheldrake, cited in Green, 1998: 300.

and spirit comprise a single evolving Cosmic Organism. It returns a Cosmic Grand Meaning to human life, fertilizing a great holarchy of becoming unified with the living *MatterEnergySpaceTimeSpirit*. This could be a story of radically re-enchanted science education that stepped into the land of spiritual “no-no”. To create this story, not only traditional scientific skills need to be developed, but also re-enchanted.

traditional scientific skills

observing
measuring
classifying
inferring
predicting
communicating
hypothesizing
designing experiments
controlling variables
interpreting data
*formulating models*⁶⁶⁷

plus re-enchanted scientific skills

listening
looking and seeing
speaking Cosmic Esperanto
loving
feeling
healing
emphasizing
transcending
contemplating
integrating
imagining
*intuiting*⁶⁶⁸
creating

equals

⁶⁶⁷ BC K-7 Science IRP, 1995: 3.

⁶⁶⁸ From conversation with Karen Meyer.

Re-Enchanted Science

From Jeannette's final reflections: ⁶⁶⁹

Re-enchanted science is:

inquiring

laughing

appreciating

experiencing

magical

liking mysteries

imagining

speaking expressive language

thinking

empathizing

wondering

connecting.

From Johneen's final reflections:

Re-enchanted science has a human element.

From Nadine's final reflections:

Teaching re-enchanted science, all you need is:

A little bit of passion

A drop of compassion

A drizzle of magic

A smidgen of fantasy

A cup full of creativity

A fist full of imagination

A pinch of unpredictability

A twist of intelligence

An appreciation of the unexplainable

An understanding of explainable

A whole lot of energy!!!

From Garry's final reflections:

*Re-enchanted science
learns from a new perspective*

⁶⁶⁹ Jeannete, Johneen, Nadine, and Gary were student teachers enrolled in my science education course.

expands our senses.

LET IT BE!

CIRCLET 5

WHERE MAGIC AND SCIENCE SHAKE HANDS:
A STEP INTO EXTREME
RE-ENCHANTMENT

Now it is systematic of our rusty-beer-can type of sanity that our culture produces very few magical objects...the reason is that we have scrubbed the world clean of magic⁶⁷⁰

There may be no such thing as the glittering central mechanism of the universe to be seen behind a glass wall at the end of the trail. Not machinery but magic may be the better description of the treasure that is waiting.⁶⁷¹

⁶⁷⁰ Watts, 1967: 106-107.

⁶⁷¹ Kirk, 1991: 3.

*What does magic and alchemy have
to do in helping to create
global civilization?⁶⁷²*

The Little Martians or the Pinhole Effect

*Where has my childhood gone?
In what cities and countries?
It left without trace.
It never called me, never wrote me
And did not even tell me "good-bye" ...
But I am happy to know
That somewhere, on the other side of the Earth,
My childhood gives magic to someone else
Although not to me anymore...*

The path of the morning light shining on the wall in my grandmother's house was narrow...Of course, everything is relative, as we know. It would be narrow for me or for you if we decided to walk along the morning light on the wall. Walking on the wall is not very convenient anyhow. However, for the little Martians, it was just right. For these little creatures, this narrow path of morning light was as wide as a new highway. They preferred to walk upside down. A strange habit, but what else can you expect from Martians? If they looked exactly as we look, and if they did exactly what we do, then they would not be Martians, would they? So this habit: walking upside down, was understandable. Martians are Martians, that is why they are what they are. The question, however was, how did these Martians reach the wall of my room when the

⁶⁷² Neutopia, 1994: 20.

windows were shielded with wooden shutters? My room was so far away from Mars...

The only reasonable explanation was "magic"!

This story about magical Martians emerged from my early childhood memories. I still remember these little creatures like I saw them yesterday. From a scientific viewpoint, I likely observed a pinhole effect. Light passed through tiny holes and shined on the wall. It traveled in straight lines, so the images were inverted. My little Martians were probably the inverted images of pedestrians walking on the street. But, how can I be sure that what I saw in the morning light was explainable exclusively from the scientific but not magical point of view?

Fairy Tales from the Scientific Point of View

As Jung and other our researchers insist, mythic forms of knowledge and experience resonate with the deepest levels of our nature as human beings, because they reflect the archetypal or fundamental forces within us. As we teachers and our students learn to access these inner resources, we may develop in the process a greater understanding and sense of our oneness with other cultures and with the universe as a whole.⁶⁷³

(Richard Steward)

Whitehead, Piaget, and Pierce⁶⁷⁴ emphasize that a child resides in a magical world and learns through fantasy and play.⁶⁷⁵ Lev Vygotsky says that play is the "pivot between the real and the imaginary." Existing in this space in between, the magical land of childhood resembles the most widely accepted Copenhagen interpretation of quantum reality, according to which our world dances forever at the edge of actuality and

⁶⁷³ Steward, 1996: 3.

⁶⁷⁴ Pierce, 1977.

⁶⁷⁵ Pierce, 1977.

potentiality. "Childhood space, viewed without idolatry, can open vistas for us," writes physicist Johnes.⁶⁷⁶

In the universe of childhood, *enchantment* is the dominant way of knowing, which makes a child a natural *holonomic* inquirer. According to Pierce, the child, being naturally tuned to the world's hologram (quantum vacuum holographic field?), is tuned to Carl Jung's realm of collective unconsciousness that provides a basis for worldwide fairy tales, myths, images, and symbols. Nancy King writes that fairy tales and myths can stimulate students' imagery and expressions of inner experiences.⁶⁷⁷ Emphasizing the importance of myth and fairy tales for education, Richard Steward says: "By using cross-cultural myth, fairy tales, and folklore, a teacher can help his or her students bring their personal mythologies into clearer focus...In this way, students can gain a more global perspective on their lives and expand sense of their place in the universe."⁶⁷⁸

For Bettelheim, fairy tales provide a means for the elementary child to bring order out of chaos and to understand his or her place within an interrelated community. "It is here that fairy tales have unequaled value, because they offer new dimensions to the child's imagination."⁶⁷⁹ In light of this, fairy tales appear to be the child's first steps into the science of complexity: new order out of chaos. Pierce invites fairy tales into a holographic worldview. He suggests that to fertilize natural, "holographic" development of a child, we need to read him or her, "nothing but fantasies, fairy tales, wild imaginative stories":

Throw in all the talking animals, cloud castles, little people, magic and mystery, signs and miracles, Santa Claus and angels, fairy godmothers and

⁶⁷⁶ Johnes, 1982: 229.

⁶⁷⁷ King, 1990.

⁶⁷⁸ Steward, 1996: 1.

⁶⁷⁹ Bettelheim, 1989: 23.

wonderful wizards. Saturate him with the unreal and improbable. Make up stories for him, and enter into fantasies with him. Talk the flowers with him, converse with the trees and wind, animate every nook and cranny of his life with imaginary beings.⁶⁸⁰

In my opinion, the resonance between the realm of fairy tales and the concepts of chaos and a holographic field makes fairy tales a scientifically valuable “instructional tool”⁶⁸¹ for re-enchanted science education...

A soap opera “Days of Physical Science in an Elementary Schools Course”

The topic of the lesson: Mixtures.

Activity: Cinderella’s contest.

Teacher:

In the Russian version of the fairy tale “Cinderella”, the evil stepmother made Cinderella to separate a mixture of various seeds and grains before she can go to the ball. If birds did not help her, Cinderella would be late. I do not really want you to see me as an evil stepmother, but today I will make you all Cinderellas. Each group of five has an assignment to design and conduct experiments for separating salt and paper, sand and water, oil and water, green and yellow peas, and iron and sand. Hurry, the ball begins soon!

Teams-Cinderellas worked hard, and all of them came up with scientific procedures for separating mixtures. After that, the real fun began: how could we utilize fairy tales for teaching science?

We can teach the concept “air pressure” by role-playing “Three Little Pigs.”

How did the Wolf destroy little pigs’ houses? By blowing!

Other tales, such as “The Queen Bee,” “ Sindbad”, “Goldilocs and the Three bears,” “ Wizard of Oz,” “ The Ugly Duckling,” and “Little Red Riding Hood” quickly found their space in re-enchanted science instruction.

⁶⁸⁰ Pierce, 1977: 118.

⁶⁸¹ Instructional tools...techniques...how to escape the mechanistic language?

From Jeannette's reflective journal:

Cinderella's context, ahh...I realized I did not know the Cinderella version where the evil stepmother tries to delay Cinderella from attending to the ball by making her separate mixtures. A nice connection to let kids to see there are other versions of similar stories and cross-culturally (fairy tales especially!) I also wondered if trying to separate these mixtures could be analogous to the prince requesting his stuff to sort through the "mixture" of women in the town...in hope of separating the magical Cinderella from numerous imposters...The method of separation in this case is the finding of the glass slipper!

Another possibility for utilizing fairy tales emerged from my reading of *Harry*

Potter and the Philosopher's stone:

It was sweltering hot, especially in the large classroom where they did their written papers. They had been given special, new quills for the exams, which had been bewitched with Anti-Cheating spell.⁶⁸²

Teacher:

Why don't we use fairy tales, fiction, and fantasy stories as a context for the assessment? It makes sense in teaching and learning re-enchanted science. We can invite the students to incorporate scientific concepts into the magic story and then to explain the meaning of the concept in the footnotes. Would you like to try this kind of assignment yourself?

Chorus:

Yes! (surprisingly enthusiastically)

Note:

Not often can you unite enthusiasm with assignment. It must be the magic of fairy tales.

The segment from Stephanie's story:

The Three Bears Revisited

*Once upon a time, there were 3 bears. A Papa bear, a Momma bear, and a Baby bear. One day, the Momma bear made porridge. She put oats in a pot and added water and turned the stove. The **thermal energy, radiated** from the element, moved through the **aluminum** pot, a great **conductor** of the heat...*

The segment from Melanie's story:

⁶⁸² Rowling, 1997: 191.

Scientific Cinderella

The temperature was 35°C and Cinderella was so hot that she had to have something cold to drink, so she made herself a mixture of lemon juice, water, and ice to cool her down...

The segment from Angela's story:

A Scientific Retelling of the brothers Grimm tale of Hansel and Gretel

*Hansel and Gretel, who were so hungry they couldn't sleep, overheard the whole conversation. Both of them were very sad. They sat up and talked about their mother and what she was like when she was still alive. She was a scientist and would delight the children for hours with science explorations. She was kind and loving, everything what their stepmother wasn't. The children thought their stepmother was something like an anti-mom—the opposite of their mother. This idea occurred to children because they were familiar with the concept **anti-matter** (Anti-matter is composed of atoms with negative nuclei and positive electrons). If their stepmother was a scientist, she would teach **disenchanted science** (Disenchanted science: cold, emotionless, no ideals, no norms, no morals, humans are machines, everything is ultimately meaningless, including human life).*

Browsing through the stories of prospective teachers, I found that they definitely provide the means to assess whether the concept is understood or not. For instance, when a person writes that Little Red Ridding Hood had stored kinetic energy, there is obviously no understanding of the concept “kinetic energy”, since it is energy in motion. You can store potential energy, but not kinetic. At the same time, the argument can be made that in fairy tales everything is possible; therefore, kinetic energy can be stored just as easy as potential...Magic is magic. This is something to think about.

Scientific Laws of Magicality

A magic beyond all we do here!⁶⁸³

Other Equipment:

⁶⁸³ From Rowling's *Henry Potter and the Philosopher Stone*, 1997.

- 1 wand
- 1 cauldron (pewter, standard size 2)
- 1 ser glass or crystal phials
- 1 telescope
- 1 set brass scales⁶⁸⁴

I have also been asked by Mr. Filch, the caretaker,
to remind you all that no magic should be used between classes in the corridors.⁶⁸⁵

Writes Bettelheim:

As Piaget had shown, the child's thinking remains animistic until the age of puberty... To the eight-year-old child (to quote Piaget's examples), the sun is alive because it gives light (and, one may add, it does that because it wants to). To the child's animistic mind, the stone is alive because it can move, as it rolls down the hill, Even a twelve-year-old is convinced that a stream is alive and has a will, because its water is flowing. The sun, the stone, and the water are believed to be inhabited by spirits very much like people, so they feel and act like people.⁶⁸⁶

"The child's mind, remains profoundly and frankly magical," states Ahsen.⁶⁸⁷ The universe of childhood is enchanted and organic: every entity there is alive and experiencing. The philosophy of childhood therefore fully supports panexperientialism of postmodern constructive philosophy.

My daughter Yana (13 y.o.):
Listen... all buses on the streets sing songs!
I:
What are their songs about?
Yana:
About...hmm...people have gotten fatter nowadays!

⁶⁸⁴ Ibid.

⁶⁸⁵ Ibid.

⁶⁸⁶ Bettelheim, 1989: 46.

⁶⁸⁷ Ahsen, 1965: 70.

THE PROJECT "STATES OF MATTER"⁶⁸⁸

Once upon a time three elementary teachers and I decided to conduct a project "States of Matter" with 75 fifth-graders. The purpose of this project was to explore the experiences of students when teaching science using anthropomorphic metaphors, a poetic mini-drama genre, and video production. We intended to introduce scientific concepts through the enchanting organic "red filter" of childhood. The first step was discussing student's a-priori knowledge. Our discussion started with a noticeable lack of enthusiasm. Well...states of matter are gases, liquids, solids...their properties are... The young people were yawning. They were bored, until we invited them to imagine...

GASES

*Gases do not have a very reliable character;
they use every opportunity to escape and expand.
Molecules of gases are not friendly with each other.
They do not want to make strong bonds and connections.
They are very independent,
and all their behavior shows
that they have very little interest in their neighbors.
Molecules of gases prefer to travel
in different directions by themselves
and have no desire for socialization.*

LIQUIDS

*Liquids are not very reliable substances either.
If they find a little hole or crack,
they immediately tell you "good-bye" and drip away.
Particles of liquids do not have a very strong passion
toward each other as well.
They make some friendly connections
and build some bonds, but...
everything is temporary in their lives.*

⁶⁸⁸ I describe this project in more details in Laroche, 2000 (a).

*They are surrounded by a group of peers
in one moment,
discussing some events which happened in their micro-world,
but next moment they are already in the midst of
a different group of peers.
Particles of liquids are probably curious,
and maybe even nosy.
They do not want to stay in one place for very long;
they have to know what's going on everywhere, all the time.*

SOLIDS

*If you are looking for reliability
take a solid, because a solid will not be in a hurry
to escape from you.
Particles of solids have the opinion
that staying together is much better than being apart.
They make strong and constant bonds
which they do not really like to break.
If the communication between micro-and macro-worlds
was more advanced,
they probably can teach humans
how to have real friendships without breaking apart,
and how to have marriages without divorces.
But, even though particles of solids are strongly connected
and do not like to change places and friends,
they still do not stay still.
They think, it is boring and not very healthy to be lazy.
That is why they are constantly doing exercises:
Vibrations, rotations, and stretching.*

*The difference between states of matter
is evident and apparent,
But they do not mind at all
being converted from one to another
under a change of conditions...
They understand that it is not a bad idea
to be flexible!*

*We invited students to produce video clips illustrating the poem. With explosive
enthusiasm, students later presented their ideas for video clips:*

- ⊙ *molecules of gases, doing cartwheels, dancing, swirling, moving in different directions by themselves, without any signs of friendliness toward each other;*
- ⊙ *an interview with helium gas inside of a balloon during a birthday party [wasn't that a creative idea?];*
- ⊙ *funny people with signs on their chests: "will work for water";*
- ⊙ *particles of liquids, gathering to dance together in small groups and constantly changing their partners;*
- ⊙ *particles of solids holding hands and doing exercises by dancing the "Macarena";*
- ⊙ *a particles' band playing music;*
- ⊙ *ideas about creating "home-made" animations, which would illustrate structures and properties of states of matter;*
- ⊙ *images from the natural world.*

There was a definite excitement and enjoyment throughout the entire project. From students' written reflections, they wanted more of such projects; they learned a lot about states of matter; they would absolutely love science if it were always taught this way.

Describing states of matter, they readily humanized them into the experiencing beings.

"Particles of gas like to run to each other or bump apart, they do not like each other too much, they like to be by themselves, apart, far away. Particles of liquid like to get together into groups and then break groups apart by forming new ones. They are nosy. Particles of solids like to get and stay together. They like each other, and they exercise together."⁶⁸⁹

In this project, I did not measure the "constructed" knowledge; therefore, I have nothing to "report." However, it was apparent that playful environment, the fairy tale-like context, and anthropomorphic metaphors resonated with childhood's magical organic approach to reality.

Angela's story:⁶⁹⁰

⁶⁸⁹ From the 5th-grader's essay.

When I was a little girl, our family lived in Winnipeg, Manitoba. We had a very large garden. At the end of the garden was a row of giant sunflowers that formed a "wall." These sunflowers were large but to a small child they were gigantic. I always thought they were human-like. The leaves were like arms and the flower was like a face with yellow hair. Sometimes when I was playing in the garden, I thought they could reach out and grab me with their giant leaves. I was not afraid of them, quite the opposite, I was in awe of them. They were beautiful...and magical! Yes, magical because they could move. I'm not talking about moving with the wind, no, these flowers would follow the sun! It was no wonder these flowers had such thick necks...they were in love with the sun and followed it around the sky. To this day the sunflower is still my favorite. The science behind the magic: Phototropism--growth of movement of a sessile organism toward or away from a source of light.

The science behind magic, and the magic behind science: this is a core of an "extremely" re-enchanted science curriculum. According to image psychologist Ahsen, "in fact, there is no basic difference between magical and scientific."⁶⁹¹

Scientific training comes hard to the mind, which entirely detests objectivity as it tends to put shackles on its freedom of involvement. The scientific thinking is torturous, the magical easy and spontaneous. At the same time the scientific in man is too small in comparison to magical, which represents the greater side of him. The savage has a view of the world which psychologically prior and chronologically older than scientific. He does not merely believe in world permeated by spirits, he also believes and follows a law which is contrary to objective laws as conceived and developed by science. He believes in an image universe hypothetically projected through a system of controls and predictions against objective laws.

Ahsen formulated four *laws of magicality*, which were evolved from his exploration of the magical lands of children, poets, and ancient mystic cultures.

1. *The Part is the Whole*
2. *Contact is Unification*
3. *Imitation is Reality*
4. *Wish is Action*

⁶⁹⁰ Angela was a student teacher enrolled in my science education course.

⁶⁹¹ Ahsen, 1965: 59.

“Nowhere in the material universe,” writes Ahsen, “are those laws valid: part is certainly not a whole, contact not unification, imitation is not reality, and wish is not an action.”⁶⁹² In the re-enchanted universe, the laws of magicality have the status of scientific laws. I wish to extend Ahsen’s magical laws:

5. *Something from Nothing*

This fifth law is one of the most persistent themes of fairy tales: one swing of magic wand and something desirable occurs in front of your eyes. Looking at five laws of magicality, I am fascinated by how much they resonate with the advances and insights of cutting edge science. .

1. *The Part is the Whole*

The holographic model of the universe: the essence of a holographic principle is that each part contains the information of the whole.

2. *Contact is Unification*

Quantum unseparability (nonlocality) principle: once two entities contacted, they always “feel” each other, no matter where or when.

3. *Imitation is Reality*

Quantum mechanical experiments indicate that our reality just pretends to be solid and material. At a mysterious subatomic level, it dissolves into probability waves. According to a holographic model, our world might be just an image of a deeper hidden order. Also, with development of holographic technologies, virtual reality becomes another level of “real” reality.

From the article “The Future. Will it work?” published by Chris Wood in Maclean’s magazine:

“In a testament to the company’s skills, it takes a moment to realize when live action ends and fantasy begins. By only a moment. Dr. John wants to make it a lot harder. By 2005, when you see somebody playing Electronic Arts hockey game”, he says, “I want you to have to look at it for at least a full minute before you know it’s not a broadcast.”

⁶⁹² Ahsen, 1965: 68.

“Blurring the lines between what is real and imagined, between who is living, dead, and merely synthetic, technology’s gifts have never offered humanity more god-like powers—nor confronted us with more haunting questions.”⁶⁹³

4. Wish is Action

We increasingly understand our power and role in the creation of reality and ourselves.

5. Something from Nothing

Chaos comprises hidden order. Vacuum is plenum. Nanomachines, devices as small as a molecule, are expected to produce unimaginable materials, cheap food, and new effective drugs to cure any disease. From the article *The Incredible Shrinking Future* by Tom Barret, published in the Vancouver Sun: “Proponents of nanotechnology say it will allow us to manufacture just about anything for next to nothing.”

It looks like state-of-the-art science, with all its sophisticated experiments, is currently moving into a magical universe, intuitively known to everyone from childhood. Young children do not have to put on magic glasses to see an enchanted world. They naturally reside there.⁶⁹⁴

THE MAGIC LAND OF MY CHILDHOOD

Always darkness, twilight...
Even when the sun shone brightly,
reflected on the blinding white snow...
Half the windows were covered by nailed wooden boards.
The corners of these boards, without any doubt,
were very cozy in many spiders' opinion.
They put enormous effort into their architecture.
Dust gathered over decades
on window surfaces,
translucent and gloomy.
This was the Magic Land of my childhood.
Shadows...

⁶⁹³ Wood, 2000: 13.

⁶⁹⁴ According to Piaget (1929, 1930) young children are especially susceptible to magical thought; they believe that humans can control the destiny of things and influence events through wishes and actions. Children exhibit qualitatively different understanding of various events and forces than adults.

intricate and intriguing Shadows
balancing and jumping
around old household items, clothes, pictures, and books.

Shadows of Who?

Sounds....

scary Sounds as from movies about Spooks and Ghosts...

Something (or Someone?)

was flapping, clapping, slamming, howling, and wailing...

Who?

Who made these scary noises?

finally...there She was.

Sitting on a bench, a stick in her hand.

A hat with feathers and a fur coat.

Long hair and eyes dark brown.

A portrait of a woman from a different century.

It was just a portrait,

but...why were her eyes so shiny and alive?

And...why were these eyes following me everywhere?

I looked at her, and my heart sank. She looked back.

She always, always looked at me...

Sometimes she squinted her eyes,

her red lips about to say something...

To say ...what? Some horrible secret?

This was not just a simple portrait.

It was mystery. It was magic.

After many years

I know that my Magic Land

was just the dusty attic of my grandmother's house,
and its mysteries could be explained by the interplay
of physical laws related to light, shadow, and sound.

But...I would pay any price for a ticket

bought in some old bus station,

to visit the Land of my childhood

that was governed not only by physical laws,
but also by the laws of magic and mystery...

Contemporary post-mechanistic science provides a conceptual comfort to imagine an “extremely” re-enchanted science curriculum that teaches physical laws as laws of magic and mystery, which makes them compatible with childhood’s laws. And...not only with childhood’s...

Ahsen writes about “essential magicality” of the human nature. When carrying little gifts of our beloved, we feel his or her physical presence. In our everyday routine, we often “make realistic attempts to dominate reality.” Adults’ worldview is a magical story: “He creates a new experiential universe out of bric-a-brac of solid existence and he goes to live in this experiential universe like a bird in his nest.”⁶⁹⁵ From Ahsen’s *The Magical Laws of Mind*:

*The child’s mentality is akin to the scientists and the magicians.
The adult also is like child in his more spontaneous and honest moods,
though mundane reality comes to teach him a sense of shame in regard to this.
Below this shame he continues to be magical.
He only does not accept this magicality outwardly
though he extensively includes it in the normal discharge of his routine.*⁶⁹⁶

From Rowling’s *Henry Patter and Philosopher’s Stone*:

They passed bookshops and music stores, hamburger bars and cinemas,
but nowhere that looked as if it could sell you a magic wand.
This was just an ordinary street full of ordinary people.
Could there really be piles of wizard gold buried miles beneath them?⁶⁹⁷

⁶⁹⁵ Ahsen, 1965: 72.

⁶⁹⁶ Ahsen, 1965: 69.

⁶⁹⁷ Rowlings, 1997: 53.

It may be, that humans hide magic beneath them, just as mysterious chaos hides ordered patterns. If so, learning science magically could mean learning science naturally, without trying to be someone we are not.

Without Trying to be Someone I am not

A soap opera "Days of Physical Science in Elementary Schools Course"

A segment from Tonya's story:

The Birth of a Sound

"Wa wa waa," it began to sing.

"Wa wa waaaa," it called.

...and sure enough, the Sound was born way way down in the depth of a cave who didn't know that nothing was supposed to happen in a perfect world. Well, like all things that are born, the Sound soon began a journey which is often called life, and it traveled through the cave in beautiful, long waves. "Wa Wa Waaa," it sang as it danced along. "Wa wa waaa," it called out still to the still and perfect world...

From Tonya's reflections on what she learned in the course:

Interesting. My experiments with sound also led me to realize something about the way we study Science. Because the scientific method states that we must perform experiments under a very controlled environment, when we teach science to children, we forget that not all of science is an official experiment. The information which might later inspire us to perform a controlled experiment often comes from unstructured play or exploration. I found that when I was exploring the relationship of volume to pitch, I was having fun because I was just playing. Later, with the discoveries that I was making through play, I began to modify my experiments and make them more controlled. But this came as a result of my own interest. I was making experiments rather than just following

them. I never had fun in high school with all of the controlled experiments they had us do. It was more about following the instructions accurately than about thinking scientifically. Science Education, I think, should be about play. It should increase our curiosity rather than demystify the world. With each new discovery made through play or through simple observation of the world, it is only natural that a child's sense of mystery should increase. And yet this often does not happen in our instruction of science. I think that too often, the way we teach science encourages children to trade their sense of wonder for a false sense of absolute knowledge. What a rip-off.

Finally, I learned something about myself in this course. I learned that I could enjoy science, and that I could think scientifically without separating from my creative side. As I mentioned earlier, I used to feel that science was about following sequential directions, which I have never been good at. Now I realize (as I suspected deep down) that it can be about far more than that. How absurd it is to assume that just because a person thinks more sequentially than tangentially, more logically than spiritually, that they should have more right to talk about nature or energy or mixtures. Indeed these are realities that we all experience and can come to be known in many different ways to the greater benefit of humankind. When I wrote my story about sound, I was not only communicating what I already knew, but in a way, I was discovering what I had observed through my own creative writing. How often do we use these devices in a science class! I am grateful that through the course of this class I have learned that I can approach scientific understanding without trying to be someone I am not.

A nonlinear thought:

Yesterday, I passed by the school--rectangular box looking like a prison. It is located on 41st avenue: the face of industrial culture that is clean of magic. I imagined a castle-like, magical school instead of a prosaic, prison-like one, and I imagined its being located on the Avenue of Stars instead of the 41st Avenue. I thought that such a re-arrangement could help children (and adults) not to be who they are not...

Inconclusive Conclusion: The Chaotic Butterfly Continues its Flight

My mechanistic realistic "self" craves a conclusion, but my re-enchanted "self" avoids rigid conclusions as attributes of a static and idealized world. In the real, complex, and dynamic universe, "truth keeps happening."⁶⁹⁸ The trick is to balance on the edge of chaos, to capture a place of junction between "stillness and motion," flux and permanence, "time arrested and time passing."⁶⁹⁹ In this essay, I stepped nonlinearly into a possibility of a new story of re-enchanted science education, yet to be inscribed onto the resonance patterns of reality. I envisioned this story as a *great holarchy of becoming unified with our fascinating--complex--holographic-- organic--spiritual-- magical world.*

In the science fiction film, "*The Sphere*," there was a pulsing and shining Sphere inside a spaceship that had accidentally "dropped" in from the future. If you went through this Sphere, your wishes, dreams, fears, and thoughts materialized into reality. The people who first found this magical apparatus nearly destroyed themselves, since the Sphere materialized their destructive images. They were not ready for the Sphere.

A fantastic time is approaching, a time when science might become such a "Sphere."

⁶⁹⁸ Joel Weinsheimer's motto of hermeneutics. In Davis, 1996: 19.

⁶⁹⁹ Prigogine, cited in Capra, 1996: 180.

...in front of us lies a new ocean, the ocean of endless scientific possibilities and applications, giving us the potential to manipulate and mould the forces of Nature to our wishes.⁷⁰⁰

Are humans and the Sphere (science) ready for each other? If humans have a magical Sphere, they must outgrow their destructive images, thoughts, and actions. If the Sphere (science) is powerful enough to make humans' desires come true, it must outgrow its "objective" detachment from "the God" (morals) and "the Beautiful" (art and spirituality).

Whether we like it or not, some form of global civilization will emerge, writes Kauffman in *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*. "We are at that particular time in history when population, technology, economics, and knowledge spin us together."⁷⁰¹ Since unpredictability appears to be embedded in nature, we perhaps will never be certain of the consequences of our best actions. All we can do is,

...be locally wise, even though our own best efforts will ultimately create conditions that lead to our transformations to utterly unforeseeable ways of being. We can only strut and fret our hour, yet this is our own and only role to play. We ought, then, play it proudly and humbly. Why try if our best efforts ultimately transform to the unforeseeable? Because that is the way the world is, and we are part of this world. That is the way life is, and we are part of life. We latter-day players are heritors of almost 4 billion years of biological unfolding. If profound participation in such process is not worthy of awe and respect, if it is not sacred, then what might be?⁷⁰²

"Once upon a time there was a milkmaid who loved to daydream about what could be." This is how a student teacher began her "scientific" retelling of a magical story. "One upon a time there was a teacher who loved to daydream about what science

⁷⁰⁰ Kaku, 1997: 5.

⁷⁰¹ Kauffman, 1995: 298.

⁷⁰² Ibid.

education could be.” This is how I began my ongoing story that is my part in the universal creative process.

My dream is about re-enchanted curriculum that prepares humans and their powerful science for each other, through growing the entire universe out of each young being. All in all. *Omnia omnibus*. Unbroken wholeness. As above so below. Unity in multiplicity. Uniqueness in oneness. Non-destructive magical consciousness.

Writes prospective teacher Nadine:

When one enters the doors of a re-enchanted lab, they will quickly discover that the lab is a creation of our imagination. In our Science Education class, I had the opportunity to explore Science in ways that I never looked before. I found myself in a science room where any approach is possible and the imagination has no barriers. I with my classmates explored science through nature, fantasy, poetry, magic, and self-discovery. Re-enchanted Science is...plays, mysteries, practice, laughs, magical, curious, expressive. Whatever you put into it!!!

What shall we put into it? I continue designing my science education course for three years, and along with an ever-increasing complexity of evolving meaning, I have an ever-increasing complexity of new questions... My ongoing search keeps opening the black box, instead of closing it.

This spring, a UBC professor passed on a “hello” from a former student. Sophia now teaches elementary kids. Her message to me was that her class adopted a tree. I was intrigued and decided to call Sophia. Yes, she told me, her class had adopted the tree. The children and the tree became a family and this idea was born under the influence of my science class. From Sophia’s new understanding, science education is not only about exploring scientific processes behind the functions of roots or leaves but also about adopting trees, talking to trees, and caring about them. Adopting a tree? What could be

more re-enchanting? I was exited. After our conversation, I found Sophia's final reflections on the course:

This science class has been an unforgettable journey. This journey will continue wherever I go. Thank you, Lyubov, for putting the "soul" of nature back into science and into my life.

And finally,

for the very open ending
of this manuscript,

I saved one message from
an anonymous course evaluation:

*This course was an inspiration and eye opener. I will happily and gratefully never see science as dry and purely formal, methodological etc. I know how to bring nature back into science, for myself, and my students. My class will reconnect with the world through poetry, drama, stories, experiments, and feelings.
That's science, science is life!!!*

Bingo. The Omega point. The heart of a chaotic butterfly. I hope for many, many more of such reflections. But, the challenge remains to reach those students of science who are lost, irritated, or silent. The challenge remains to find a meeting place for scientific inquiry, story, and spirit, the place that will be comfortable and transformational for everyone. The challenge remains to balance the flexibility of creativity and the firmness of organization, to dance between dream and reality, to fuse the possible and the existing. The challenge simply remains....

*imagining universe(s) into existence,
especially if they are re-enchanted,
is not a very easy task,*

but...the cosmic creative principle pulses in my heart

*this means the chaotic butterfly
continues its-dizzying flight
from one strange attractor to another
via the process of self-organization
along the spiral of the great holrarchy of becoming...
toward the new complex order*

of the re-enchanted world...

*Butterfly, butterfly,
Oh where are you butterfly fluttering through the wind?*

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APPENDIX

SCED 331 TEACHING RE-ENCHANTED

*Not I, not I but the wind that blows through me!
A fine wind is blowing the new direction of time.*
(D.H. Lawrence)

- To teach re-enchanted science means to introduce students to the amazing new visions of Nature that new developments in science has given us

"We need to rediscover a sense of the deeper meaning and spiritual dimensions in Nature in the light of astonishing discoveries we have about cosmic evolution, about biological evolution, about the levels and layers of structure that are found in cells, tissues, organisms, and atoms."

(Rupert Sheldrake)

- To teach re-enchanted science means to recognize that Nature is irreducibly complex, unpredictable, intelligent, creative, and beautiful

"When you understand all about the sun and all about the atmosphere and all about the rotation of the earth, you may still miss the radiance of the sunset."

(Alfred North Whitehead)

- To teach re-enchanted science means to foster development of a magical consciousness

"Magical consciousness is the awareness of the interrelatedness of all things in the world by means of a simple but refined sense of perception."

(K. Glucklich)

- To teach re-enchanted science means to explore multiple ways of knowing: the eye of mind (reason and logic), the eye of flesh (our bodily experiences of the world), and the eye of contemplation (contemplative and spiritual dimensions of our existence such as compassion, love, poetry, beauty, and awe)

"Here gazes the intriguing mind
Driven by the poetry of thought
And by the amazing beauty
and connectedness of Nature"

(M. Sheider)

THE GOAL

Within this course, we will visit avant-garde scientific insights and theories, revisit science past (alchemy and astrology), and fly into the future (visions of 21st science and beyond). Traveling in the course's spacetime machine, together we will create a fun, living, beautiful, compassionate, magical, and poetic universe of

The overall goal of the course is to provide students with a sense of wonder, comfort, knowledge, and skills in teaching science and to envision changes in science education. The course will focus on:

> the content

We will not only follow BC K-7 SCIENCE IRP, but also review insights and understandings of the concepts related to physical science [matter, energy, time, space] derived from the leading edge science.

> the methods

This course intends to merge traditional methods of science teaching with the outdoors, global, adventure, humanities, and art education. It will incorporate lab experiments, drama, meditation, creative writing, expressive movement, drawing, photography, and video production as equally valuable and viable methods of scientific inquiry.

➤ *the settings*

By treating the entire world as a scientific laboratory, the course lends itself to being conducted not only in the traditional classroom, but also in informal settings, including outdoors, community, as well as in imagined universes of fiction and fairy tales.

➤ *the language*

We will explore possibilities for combining scientific language with the more expressive and poetic.

EVALUATION:

1. As a team assignment, you will be invited to conduct a 2-hour lesson related to forms of energy (sound, light, electrical, magnetic, etc.) One part of this assignment will involve collaborative work with elementary students. You will be invited to design multimedia materials for teaching of chosen forms of energy (two forms of energy for each team). The other part of the assignment will include presentation of the produced artifact in our class as well as conducting hands-on activities related to your forms of energy. The grade for this assignment will be based on the overall group performance, handouts, as well as your individual written reflection on the activity (40%)

Criteria for evaluation of presentations: content, clarity, and holistic approach

In your reflections about the activities following issues are to consider:

- a) your overall contribution to the activity;
 - b) the change in your conceptual understanding of the topic (if changed)
 - c) description of the creative process of video design with your team members. How did collective imagery unfold?
 - d) description of your collaborative work with your peers and elementary students. What issues emerged?
 - e) how (if) did producing multimedia educational material influence/change teacher role, teacher/student interactions, student/student interaction, as well as cognitive process.
 - f) what is your perspective on the potential of multimedia for science teaching?
 - g) is there any additional educational values in using self-produced digital materials versus pre-produced?
2. Expanding the walls of the classroom into the fascinating world: *informal/outdoor science education*. This will be your individual project. The topic and the format are up to you. You will be invited to submit written description of activity by Feb. 26th. The actual (10-15 min) performance of this activity will be conducted at the beginning of April during our outdoor lessons (see tentative schedule) (30%)
 3. Your final summary paper about what you have learned in this course and how would you apply this knowledge in your teaching. For this purpose, you need to write a reflective journal; however, you *will not* be required to submit the journal. As alternative to the written paper, the collage, or video, or play, or anything else will be also readily accepted. (30%)

TENTATIVE TOPICS AND SCHEDULE (13 weeks)

WEEK 1

Day1

Activity: " Make a steam boat." Traveling into the future in the time machine: Visions as to how science will revolutionize the 21st century. New science as empowered and (re) enchanted science. Your visions of the future

Day2

Welcoming the World. Celebrating the Beginning. Hello, Gaia! Outdoor activities. Physical and imaginary senses for exploring the world. Textures. Traditional and (re) enchanted scientific skills. Classification game

WEEK 2

Day 1

The structure of matter. Atoms...what an enigma they are! Historical and contemporary perspectives on the structure of matter. Exotic kinds of matter: dark matter and anti-matter. Is matter alive?

Hands-on experiments

Day2

The composition of matter: elements, mixtures, and compounds. Teaching safety in the lab through dramatic play. Separating mixtures: Cinderellas' contest. Fairy tales from the scientific point of view

WEEK 3

Day1

Four states of matter: gaseous, liquid, solid, and plasma. Kinetic-Molecular theory. The experiment: "Melting of ice." Ways to organize scientific inquiry. V-heuristic. Arts-based approach. Holonomic inquiry: imagine-- you are particles of water!

Day2

Celebrating four Earth elements: the air, the water, the fire, the earth. The sun with its brightness, the snow with its whiteness, the winds with its swiftness, the sea with its deepness. Future and history of science. Alchemy, astrology, quantum nonlocality, and holographic unity of our world.

Psychosynthesis in teaching science

WEEK 4

Day 1:

We live in a restless world! Changes. Physical and chemical Processes. Hands-on activities. Games. Chemical fantasia: chemistry, music, and beauty

Day 2:

Dragon's blood is an especially rare substance! Chemical Detectives. Digital detectives: activities from the science educational Internet site "The Brainium"

WEEK 5

Day 1

Reactions of oxidization. Rusting. Hands-on experiments with Rust. Digital technology, arts, dancing, creative writing, drama, and photography. What all of that has to do with rust? How "scientific" knowing and "artistic" knowing empower each other?

Day 2:

Solutions from pessimistic and optimistic perspectives. The magic of crystallization. Acids and bases. PH. Environmental Chemistry.

WEEK 6

Day 1:

Producing videos about Rust. Learning *imovie* editing program and Dreamweaver.

Day 2:

Producing videos about Rust. Learning *imovie* editing program and Dreamweaver.

WEEK 7

Day 1

Meeting with elementary students. Producing videos.

Day 2:

Meeting with elementary students. Producing videos.

WEEK 8

Day 1:

Meeting with elementary students. Producing videos.

Day 2:

Editing videos, producing multimedia presentation

WEEK 9

Day 1

Editing videos, producing multimedia presentation

Day 2:

Light and sound energy (SMALL GROUP PRESENTATION #1)

WEEK 10

Day 1

Electrical, nuclear, and magnetic energy (SMALL GROUP PRESENTATION #2)

Day 2:

Mechanical, gravitational, and elastic energy (SMALL GROUP PRESENTATION #3)

WEEK 11

Day 1

Thermal and chemical energy (SMALL GROUP PRESENTATION #4)

Day 2:

Summary: forms of energy and kinds of energy. A lesson in the swimming pool.

WEEK 12

Day 1:

Going hiking. Presentations of individual projects "Teaching science in informal/outdoor settings."

Day 2:

Going hiking. Presentations of individual projects "Teaching science in informal/outdoor settings."

WEEK 13

Summary of the course; individual work

