Conceptual Spiral

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For information on this edition, please see the last page.

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Focus

To make evident how science, engineering, and technology influence our ability to interact and cope with an unfolding reality that we are a part of, live in, and feed upon.

For Openers

Let's reexamine our abstract

What do we find?

Key Passage

...The theme that weaves its way through this *Discourse on Winning and Losing* is not so much contained within each of the seven sections*, per se, that make up the *Discourse*; rather, it is the kind of thinking that both lies behind and makes up its very essence. For the interested, a careful examination will reveal that the increasingly abstract discussion surfaces a process of reaching across many perspectives, pulling each and every one apart (analyses), all the while intuitively looking for those parts of the disassembled perspectives which naturally interconnect with one another to form a higher order, more general elaboration (synthesis) of what is taking place. As a result, the process not only creates the *Discourse* but it also represents the key to evolve the tactics, strategies, goals, unifying themes, etc., that permit us to actively shape and adapt to the unfolding world we are a part of, live in, and feed upon.

*Editors' note: Including this presentation and *The Essence of Winning and Losing* (1996)

Why is This Passage Key?

Because it suggests a general way by which we can deal with the world around us.

More specifically, we shall show that:

By exploiting the theme contained within this passage and by examining the practice of science/engineering and the pursuit of technology, we can evolve a conceptual spiral for comprehending, shaping, and adapting to that world.

Now

If the practice of science/engineering and the pursuit of technology are going to be a key for unveiling this "conceptual spiral,“ we should ask ourselves:

> In speaking of science, engineering, and technology, what do we mean?

Simple-Minded Message

Science can be viewed as a self-correcting process of observation, hypothesis, and test;

whereas

Engineering can be viewed as a self-correcting process of observation, design and test;

while

Technology can be viewed as the wherewithal or state of the art produced by the practice of science and engineering.

Raises Question

What has the practice of science, engineering and the pursuit of technology given us or done for us?

Examples From Science

Some Outstanding Contributors	Contributions
Isaac Newton (1687)	"Exactness"/predictability via laws of motion/gravitation
Adam Smith (1776)	Foundation for modern capitalism
A.M. Ampere/C.P. Gauss (1820's/1830's)	Exactness/predictability via electric/ magnetic laws
Carnot/Kelvin/Clausius/Boltzman (1824/1852/1865/1870s)	Decay/disintegration via second law of thermodynamics
Faraday/Maxwell/Hertz (1831/1865/1888)	Union of electricity & magnetism via field theory
Darwin & Wallace (1838/1858)	Evolution via theory of natural selection
Marx & Engels (1848 - 1895)	Basis for modern "scientific socialism"
Gregory Mendel (1866)	Inherited traits via his laws of genetics
Henri Poincare (1890s)	Inexactness/unpredictability via gravitational influence of three bodies

Examples From Science

Some Outstanding Contributors	Contributions
Max Planck (1900)	Discreteness/discontinuity via his quantum theory
Albert Einstein (1905/1915)	Exactness/predictability via his special & general relativity theories
Bohr/de Broglie/Heisenberg/Schrödinger/ Dirac/et al. (1913/1920s...)	Uncertainty/indeterminism in quantum physics
L. Lowenheim & T. Skolem (1915 - 1933)	Unconfinement (non-categoricalness) in mathematics & logic
Gödel/Tarski/Church/Turing, et al. (1930s ...)	Incompleteness/undecidability in mathematics & logic
Claude Shannon (1948)	Information theory as basis for communication
Crick & Watson (1953)	DNA spiral helix as the genetically coded information for life
Lorenz/Prigogine/Mandelbrot/ Feigenbaum/et al. (1963/1970s...)	Irregularity/unpredictability in nonlinear dynamics
G. Chaitin/C. Bennett (1965/1985)	Incompleteness/incomprehensibility in information theory

Examples From Engineering

Some Outstanding Contributors	Contributions
Savery/Newcomen/Watt (1698/1705/1769)	Savery/Newcomen/Watt (1698/1705/1769)
George Stephenson (1825)	Steam railway
H. Pixii/M.H. von Jacobi (1832/1838)	AC generator/AC motor
Samuel Morse (1837)	Telegraph
J.N. Niepce/J.M. Daguerre/Fox Talbot (1839)	Photography
Gaston Plante (1859)	Rechargeable battery
Z. Gramme/H. Fontaine (1869/1873)	DC generator/DC motor
Nicholas Otto (1876)	4-cycle gasoline engine
Alexander G. Bell (1876)	Telephone
Thomas A. Edison (1877)	Phonograph
Thomas A. Edison (1879)	Electric light bulb
Werner von Siemens (1879)	Electric locomotive
Germany (1881)	Electric metropolitan railway

Examples From Engineering

Some Outstanding Contributors	Contributions
Charles Parsons (1884)	Steam turbine
Benz/Daimler (1885/1886)	Gasoline automobile
T.A. Edison/J. LeRoy/T. Armat/et al. (1890-1896)	Motion picture camera/projector
N. Tesla/G. Marconi (1893/1895)	Wireless telegraph
Rudolf Diesel (1897)	Diesel locomotive
Italy (1902)	Electric railway
Wright Brothers (1903)	Gasoline powered airplane
Christian Hulmeyer (1904)	Radar
V. Paulsen/R.A. Fessenden (1904/1906)	Wireless telephone
John A. Fleming/Lee De Forest (1904/1907)	Vacuum tube
Tri Ergon/Lee De Forest (1919/1923)	Sound motion picture
USA—Pittsburgh (1920)	Public radio broadcasting

Examples From Engineering

Some Outstanding Contributors	Contributions
American Car Locomotive (1925)	Diesel-electric locomotive
J.L. Baird (1926)	Television
Warner Brothers (1927)	Sound motion picture, “The Jazz Singer”
Germany/USA (1932/1934)	Diesel-electric railway
Britain/USA/Germany (1935-1939)	Operational radar
Germany/Britain/USA (1935/1936/1939)	Television broadcasting
Hans von Ohain/Germany (1939/1939)	Jet engine/jet airplane
Eckert & Mauchly (1946)	Electronic computer
Bardcen & Brattain & Shockley (1947)	Transistor
Ampex (1955)	Video recorder
J. Kilby/R. Noyce (1958/1959)	Integrated electronic circuit
T.H. Maiman (1960)	Laser

Examples From Engineering

Some Outstanding Contributors	Contributions
Philips (1970)	Video cassette recorder
Sony (1980)	Video camcorder

Raises Question

Looking at the past via the contributions these people have provided the world:

What can we say about our efforts for now and for the future?

Grand Message

In a mathematical/logical sense we can say:

> Taken together, the theorems associated with Gödel, Lowenheim & Skolem, Tarski, Church, Turing, Chaitin, and others reveal that not only do the statements representing a theoretical system for explaining some aspect of reality explain that reality inadequately or incompletely but, like it or not, these statements spill out beyond any one system and do so in unpredictable ways;

Or conversely,

> These theorems reveal that we can neither predict the future migration and evolution of these statements nor just confine them to any one system nor suggest that they fully embrace any such system.

Grand Message (Continued)

Now if we extend these ideas and build upon them in a scientific/ engineering sense, we can say:

- Any coherent intellectual or physical systems we evolve to represent or deal with large portions of reality will at best represent or deal with that reality incompletely or imperfectly.
- Moreover, we neither have nor can we create beforehand a supersystem that can forecast or predict the kind of systems we will evolve in the future to represent or deal with that reality more completely or more perfectly.
- Furthermore, such a supersystem can neither forecast nor predict the consequences that flow from those systems that we create later on.
- Going even further, we cannot determine or discern the character or nature of such systems (super or otherwise) within themselves.

Grand Message (Continued)

Which altogether imply that:

> People using theories or systems evolved from a variety of information will find it increasingly difficult and ultimately impossible to interact with and comprehend phenomena or systems that move increasingly beyond and away from that variety—that is, they will become more and more isolated from that which they are trying to observe or deal with—unless they exploit the new variety to modify their theories/systems or create new theories/systems.

Raises Question

Taken together, what do the many contributions and Grand Message suggest?

Impression

While we can comprehend and predict some portions of the ever-changing world that unfolds before us, other portions seem forever indistinct and unpredictable.

Raises Question

Very nice, but what does all this have to do with our ability to thrive and grow in such a world that is seemingly orderly and predictable yet disorderly and unpredictable?

Comment

To get at this question let's take a closer and more general look at what science, engineering, and the pursuit of technology produce and how this is accomplished.

Furthermore, suspecting that these practices and pursuit are not wholly accidental nor obvious and that they seem to change us in some ways, let's also examine what keeps the whole enterprise going and how this enterprise affects us personally.

In other words,

In order to gain a richer image of science, engineering, and technology we will address the following questions:

- What do science, engineering and technology produce?
- How is this accomplished?
- What is the driving mechanism that keeps the process alive and ongoing; or put another way, what phenomena sustain or nourish the whole enterprise?
- Finally, how does this enterprise of science, engineering, and technology affect us personally as individuals, as groups, or as societies?

First of All

What do science, engineering, and technology produce?

If we examine the contributions from the practice of science and engineering and generalize from these individual contributions, what do we see? We see *new* ideas, *new* systems, *new* processes, *new* materials, *new* etc.

In other words,

Science, engineering, and technology produce change via **novelty**.

How is This Novelty Produced?

To examine novelty, we speak of it in terms of those features that seem to be part of that novelty. In other words, we reduce a novel pattern down to some features that make up that pattern. Different people in examining such a pattern may see differing features that make it up. In other words, there are different ways by which a pattern can be reduced, hence the possibility for differing features or parts. Regardless of how it comes out, we call this process of reduction, **analysis**.

Pushing this process even further, we can reduce many different patterns (analyses) to parts that make up each pattern and use these parts, or variations thereof, to make a new pattern. This is done by finding some common features that interconnect some or many of these parts so that a new pattern—whether it be a new concept, new system, new process, new etc.—can be created. We call this process of connection, **synthesis**.

Now if we test the results of this process with the world we're dealing with, we have an **analytical/synthetic** feedback loop for comprehending, shaping, and adapting to that world.

Pulling all this together, we can say that:

Novelty is produced by a mental/physical feedback process of analyses and synthesis that permits us to interact with the world so that we can comprehend, cope with, and shape that world as well as be shaped by it.

Which carries us to the question …

What is the driving mechanism that keeps the process alive and ongoing; or put another way, what phenomena sustain or nourish the whole enterprise?

One thing is clear: if our ideas and thoughts matched perfectly with what goes on in the world, and if the systems or processes we designed performed perfectly and matched with whatever we wanted them to do, what would be the basis for evolving or creating new ideas, new systems, new processes, new etc.? The answer: There wouldn't be any!

In other words,

The presence and production of mismatches are what sustain and nourish the enterprise of science, engineering, and technology, hence keep it alive and ongoing—otherwise there would be no basis for it to continue.

Very Nice, But …

How does this enterprise of science, engineering, and technology affect us personally as individuals, as groups, or as societies?

As already shown, the practice of science/engineering and the pursuit of technology not only change the physical world we interact with—via new systems, new processes, new etc.—but they also change the mental/physical ways by which we think about and act upon that world.

In this sense, the practice of science/engineering and the pursuit of technology permit us to continually rematch our mental/physical orientation with that changing world so that we can continue to thrive and grow in it.

Put simply, the enterprise of science, engineering, and technology affects us personally as individuals, as groups, or as societies by changing our orientations to match with a changing world that we, in fact, help change.

Now

If we reverse direction and reexamine where we have been, we can see that without the intuitive interplay of analyses and synthesis, we have no basic process for generating novelty, no basic process for addressing mismatches between our mental images/impressions and the reality they are supposed to represent, and no basic process for reshaping our orientation toward that reality as it undergoes change.

Put simply,

Without the interplay of analyses and synthesis, we have no basis for the practice of science/engineering and the pursuit of technology — because novelty, mismatches, and reorientation as the life blood ingredients that naturally arise out of such practice and pursuit can no longer do so.

Viewed in This Light

The preceding statements seem to suggest that the "Simple-Minded Message" presented near the beginning whereby:

Science can be viewed as a self-correcting process of observation, hypothesis, and test

whereas

Engineering can be viewed as a self-correcting process of observation, design, and test

should be modified as follows:

Science can be viewed as a self-correcting process of observations, analyses/ synthesis, hypothesis, and test

whereas

Engineering can be viewed as a self-correcting process of observations, analyses/synthesis, design, and test.

Why?

Without the interplay of analyses and synthesis, one can evolve neither the hypothesis or design and follow-on test, nor the original "Simple-Minded Message," nor this presentation itself.

Raises Question

What bearing does all this have on Winning and Losing?

Illumination

Novelty is not only produced by the practice of science/engineering and the pursuit of technology, it is also produced by the forces of nature, by our own thinking and doing as well as by others. Furthermore, novelty is produced continuously, if somewhat erratically or haphazardly. Now, in order to thrive and grow in such a world, we must match our thinking and doing, hence our orientation, with that emerging novelty. Yet, any orientation constrained by experiences before that novelty emerges (as well as by the Grand Message discussed earlier) introduces mismatches that confuse or disorient us. However, the analytical/synthetic process, previously described, permits us to address these mismatches so that we can rematch thereby reorient our thinking and action with that novelty. Over and over, this continuing whirl of reorientation, mismatches, analyses/synthesis enables us to comprehend, cope with, and shape as well as be shaped by the novelty that literally flows around and over us.

Maybe So

Yet, upon reflection, we still have a puzzle: Why does our world continue to unfold in an irregular, disorderly, unpredictable manner, even though some of our best minds try to represent it as being more regular, orderly, and predictable?

More Pointedly

With so much effort over such a long period by so many people to comprehend, shape, and adapt to a world that we depend upon for vitality and growth, why does such a world, although richer and more robust, continue to remain uncertain, ever-changing, and unpredictable?

Response

Very simply, review of "Destruction and Creation," this presentation, and our own experiences reveal that the various theories, systems, processes, etc. that we employ to make sense of that world contain features that generate mismatches that, in turn, keep such a world uncertain, ever-changing, and unpredictable.

These Features Include

- **Uncertainty** associated with the unconfinement, undecidability, and incompleteness theorems of mathematics and logic;
- **Numerical imprecision** associated with using the rational and irrational numbers in the calculation and measurement processes;
- **Quantum uncertainty** associated with Planck's Constant and Heisenberg's Uncertainty Principle;
- **Entropy increase** associated with the Second Law of Thermodynamics;
- **Irregular or erratic behavior** associated with far-from-equilibrium, open, nonlinear processes or systems with feedback;
- **Incomprehensibility** associated with the inability to completely screen, filter, or otherwise consider spaghetti-like influences from a plethora of ever-changing, erratic, or unknown outside events;

These Features Include (Cont.)

- **Mutations** associated with environmental pressure, replication errors, or unknown influences in molecular and evolutionary biology;
- **Ambiguity** associated with natural languages as they are used and interact with one another; and
- **Novelty** generated by the thinking and actions of unique individuals and their many-sided interactions with each other.

Underlying Message

There is no way out, unless we can eliminate the features just cited. Since we don't know how to do this, we must continue the whirl of reorientation, mismatches, analyses/synthesis over and over again *ad infinitum* as a basis to comprehend, shape, and adapt to an unfolding, evolving reality that remains uncertain, ever-changing, unpredictable.

Now

If we connect this continuing whirl of reorientation, mismatches, analyses/synthesis and the novelty that arises out of it with the previous discussion we can see that we have:

A conceptual spiral for

Exploration	Discovery	Innovation
Thinking	Doing	Achieving
Learning	Unlearning	Relearning
Comprehending	Shaping	Adapting

Hence, a conceptual spiral for generating

Insight	Imagination	Initiative

Which Raises the Question

Can we survive and grow without these abilities?

No!

Which Suggests

The conceptual spiral also represents:

A Paradigm for
Survival and Growth

Point

Since survival and growth are directly connected with the uncertain, ever-changing, unpredictable world of winning and losing, we will exploit this whirling (conceptual) spiral of orientation, mismatches, analyses/ synthesis, reorientation, mismatches, analyses/synthesis … so that we can comprehend, cope with, and shape—as well as be shaped by—that world and the novelty that arises out or it.

About this edition

This edition of *Conceptual Spiral* is an Apple Keynote rendering of the typewritten version dated "July/August 1992." It was created by converting a PDF of the original with Acrobat's OCR function and then transferring the text to PowerPoint then to Keynote. That version was edited for accuracy and some of the typographical flourishes Boyd used for his oral briefings were toned down for readability. It was his last major briefing and the only one not focused on armed conflict. Perhaps for that reason, it is the least familiar to most students of Boyd's work. John, however, intended for his concepts to apply to more than warfare or even conflict. As he opens the Abstract to his collection, *A Discourse on Winning and Losing*: "To flourish and grow in a many-sided. uncertain and everchanging world that surrounds us, suggests that we have to make intuitive within ourselves those many practices we need to meet the exigencies of that world." In *Conceptual Spiral*, Boyd zeroes in on how we create those "many practices." Page numbers correspond to the original.

About the Editors

Chuck Spinney was a colleague of Boyd's both in the Air Force and in the Office of the Secretary of Defense, where he participated in every edition of the *Discourse.* Chuck is the author of *Defense Facts of Life* and numerous monographs and op-eds. His commentaries on defense issues appear from time to time in his blog, http://chuckspinney.blogspot.com/.

Chet Richards worked with Col Boyd on his first paper, "Destruction and Creation," on his later presentations, *Conceptual Spiral* and *The Essence of Winning and Losing*, and near the end of Boyd's life, on business applications. He is a retired colonel in the Air Force, and wrote a book, *Certain to Win (2004)*, that applies Boyd's concepts to business. He is also the author of three books on defense policy.

Ginger Richards was co-owner and president of Kettle Creek Corporation and created the layouts for the PowerPoint and Keynote versions of all Boyd's briefings.

Bluffton, South Carolina USA
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