

CONCEPTUAL SPIRAL

April-July 1990

John R Bayol

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 six 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 (analysis), 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.

? – 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

- Isaac Newton (1687)
- Adam Smith (1776)
- A.M. Ampere/C.F. Gauss (1820's/1830's)
- Carnot/Kelvin/Clausius/Boltzman (1824/1852/1865/1870's)
- Faraday/Maxwell/Hertz (1831/1865/1888)
- Darwin/Wallace (1838/1858)
- Marx/Engels (1848 – 1895)
- Gregory Mendel (1866)
- Henri Poincare (1890's)
- Max Planck (1900)
- Albert Einstein (1905/1916)
- Bohr/de Broglie/Heisenberg/Schrodinger/Dirac/et al (1913/1920's...)
- Godel/Tarski/Church/Turing/et al (1930's ...)
- Claude Shannon (1948)
- Crick/Watson (1953)
- Lorenz/Prigogine/Mandelbrot/Feigenbaum/et al (1963/1970's...)
- G. Chaitin/C. Bennett (1965/1985)

Contributions

- “Exactness”/predictability via laws of motion/gravitation
- Foundation for modern capitalism
- Exactness/predictability via electric/magnetic laws
- Decay/disintegration via second law of thermodynamics
- Union of electricity & magnetism via field theory
- Evolution via theory of natural selection
- Basis for modern “scientific socialism”
- Inherited traits via his laws of genetics
- Inexactness/unpredictability via gravitational influence of 3 bodies
- Discreteness/discontinuity via his quantum theory
- Exactness/predictability via his special & general relativity theories
- Uncertainty/indeterminism in quantum physics
- Incompleteness/undecidability in mathematics
- Information theory as basis for communication
- DNA spiral helix as the genetically coded information for life
- Irregularity/unpredictability in nonlinear dynamics
- Incompleteness/incomprehensibility in information theory

EXAMPLES FROM ENGINEERING

Some Outstanding Contributors

- Savery/Newcomen/Watt (1698/1705/1769)
- George Stephenson (1825)
- H. Pixii/M.H. von Jacobi (1832/1838)
- Samuel Morse (1837)
- J.N. Niepce/J.M. Daguerre/Fox Talbot (1839)
- Gaston Plante (1859)
- Z Gramme/H. Fontaine (1869/1873)
- Nicholas Otto (1876)
- Alexander G. Bell (1876)
- Thomas A. Edison (1877)
- Thomas A. Edison (1879)
- Werner von Siemens (1879)
- Germany (1881)
- Charles Parsons (1884)
- Benz/Daimler (1885/1886)
- T.A. Edison/J. LeRoy/T. Armat/et al (1890–1896)
- N. Tesla/G. Marconi (1893/1895)
- Rudolf Diesel (1897)
- Italy (1902)

Contributions

- Steam engine
- Steam railway
- AC generator/AC motor
- Telegraph
- Photography
- Rechargeable battery
- DC generator/DC motor
- 4-cycle gasoline engine
- Telephone
- Phonograph
- Electric light bulb
- Electric locomotive
- Electric metropolitan railway
- Steam turbine
- Gasoline automobile
- Motion-picture camera/projector
- Wireless telegraph
- Diesel locomotive
- Electric railway

EXAMPLES FROM ENGINEERING

Some Outstanding Contributors

- Wright Brothers (1903)
- Christian Hulmeyer (1904)
- V. Paulsen/R.A. Fessenden (1904/1906)
- John A. Fleming/Lee De Forest (1904/1907)
- Tri Ergon/Lee De Forest (1919/1923)
- USA-Pittsburgh (1920)
- American Car Locomotive (1925)
- J.L. Baird (1926)
- Warner Brothers (1927)
- Germany/USA (1932/1934)
- Britain/USA/Germany (1935-1939)
- Germany/Britain/USA (1935/1936/1939)
- Hans von Ohain/Germany (1939/1939)
- Eckert/Mauchly (1946)
- Bardeen/Brattain/Shockley (1947)
- Ampex (1955)
- J. Kilby/R. Noyce (1958/1959)
- T.H. Maiman (1960)
- Philips (1970)
- Sony (1980)

Contributions

- Gasoline powered airplane
- Radar
- Wireless telephone
- Vacuum tube
- Sound motion picture
- Public radio broadcasting
- Diesel-electric locomotive
- Television
- Jazz singer/sound motion picture
- Diesel-electric railway
- Operational radar
- Television broadcasting
- Jet engine/jet airplane
- Electronic computer
- Transistor
- Video recorder
- Integrated electric circuit
- Laser
- Video cassette recorder
- 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

- 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.

which 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 everchanging 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 sustains or nourishes 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 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 analysis 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 sustains or nourishes 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 orientation to match with a changing world that we, in fact, help change.

? – 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) introduce 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, analysis/synthesis enables us to comprehend, cope with, and shape as well as be shaped by novelty that literally flows around and over us.

NOW

If we connect this continuing whirl of reorientation, mismatches, analysis/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, everchanging, unpredictable world of winning and losing we will exploit this whirling (conceptual) spiral of orientation, mismatches, analysis/synthesis, reorientation, mismatches, analysis/synthesis...so that we can comprehend, cope with, and shape, as well as be shaped by that world and the novelty that arises out of it.

CONCEPTUAL SPIRAL

CONCEPTUAL SPIRAL

CONCEPTUAL SPIRAL

CONCEPTUAL SPIRAL

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 sustains or nourishes the whole enterprise?
- Finally, how does this enterprise of science, engineering, and technology affect us personally as individuals, as groups, or as societies?

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 sustains or nourishes the whole enterprise?
- Finally, how does this enterprise of science, engineering, and technology affect us personally as individuals, as groups, or as societies?

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 sustains or nourishes the whole enterprise?
- Finally, how does this enterprise of science, engineering, and technology affect us personally as individuals, as groups, or as societies?

? – 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?

IMPRESSION

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

? – RAISES QUESTION – ?

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

EXAMPLES FROM ENGINEERING

Some Outstanding Contributors

Contributions

- | | |
|---|------------------------------------|
| • 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 |
| • American Car Locomotive (1925) | • Diesel-electric locomotive |
| • J.L. Baird (1926) | • Television |
| • Warner Brothers (1927) | • Jazz singer/sound motion picture |
| • 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 |
| • Bardeen & Brattain & Shockley (1947) | • Transistor |
| • Ampex (1955) | • Video recorder |
| • J. Kilby/R. Noyce (1958/1959) | • Integrated electric circuit |
| • T.H. Maiman (1960) | • Laser |
| • Philips (1970) | • Video cassette recorder |
| • Sony (1980) | • Video camcorder |

EXAMPLES FROM ENGINEERING

Some Outstanding Contributors

- Wright Brothers (1903)
- Christian Hulmeyer (1904)
- V. Paulsen/R.A. Fessenden (1904/1906)
- John A. Fleming/Lee De Forest (1904/1907)
- Tri Ergon/Lee De Forest (1919/1923)
- USA-Pittsburgh (1920)
- American Car Locomotive (1925)
- J.L. Baird (1926)
- Warner Brothers (1927)
- Germany/USA (1932/1934)
- Britain/USA/Germany (1935-1939)
- Germany/Britain/USA (1935/1936/1939)
- Hans von Ohain/Germany (1939/1939)
- Eckert & Mauchly (1946)
- Bardeen & Brattain & Shockley (1947)
- Ampex (1955)
- J. Kilby/R. Noyce (1958/1959)
- T.H. Maiman (1960)
- Philips (1970)
- Sony (1980)

Contributions

- Gasoline powered airplane
- Radar
- Wireless telephone
- Vacuum tube
- Sound motion picture
- Public radio broadcasting
- Diesel-electric locomotive
- Television
- Jazz singer/sound motion picture
- Diesel-electric railway
- Operational radar
- Television broadcasting
- Jet engine/jet airplane
- Electronic computer
- Transistor
- Video recorder
- Integrated electric circuit
- Laser
- Video cassette recorder
- Video camcorder

? – RAISES QUESTION – ?

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

KEY PASSAGE

...the theme that weaves its way through this "Discourse on Winning and Losing" is not so much contained within each of the six 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.

CONCEPTUAL SPIRAL

CONCEPTUAL SPIRAL