CRITICAL THINKING

The fundamental mission of UNO is to increase the frequency of and the fruits of critical thinking. For a human, mere thought is an inevitable consequence of life. In contrast, critical thinking is an interactive evolution of knowledge with the world. Critical thinking is the application of the abstracted theories to the real.[1] Critical thinking is a method of exploring for truth. The first requirement is an open mind, the second is an active mind engaged in a searching and thorough analysis, and the third is the avoidance of some common mistakes.

All life predicts the future. Life needs food, needs to avoid danger, and needs sex. Failure on any of these three and "death" will be the result. Short-term accuracy of those predictions is needed for the individual to avoid death. Multigenerational accuracy of those predictions is needed for the species to avoid extinction. Superior critical thinking increases the accuracy of both short-term and long-term predictions.

Critical thinking is analysis that goes deeper than the surface. Usually surface analysis will see no more than the symptoms, and will not see the underlying causes of the symptoms. A focus on symptoms, rather than on causes, necessarily misdirects the analysis, reduces its predictive accuracy, and shortens the maximum duration of any accurate prediction. Each of these three undesirable results springs from merely analyzing symptoms.

All analysis is flawed. All predictions are wrong.[2] When the quality of analysis increases and the quality of prediction increases, then the likelihood of error discovery increases; however, the short-term absence of obvious error will reduce the probability of error discovery prior to the arrival of the long-term. (Please re-read the preceding sentence and think about its meaning.)

Some of the most likely culprits of flawed analysis are:

post hoc ergo propter hoc;
correlation is causation;
unintended consequences;
bounded rationality;
acting as if an open system is a closed system; and
believing the analysis is completed.

Post hoc ergo propter hoc is Latin and means "after this therefore because of this". That this maxim exists in Latin should give you an idea for how many years humans have been making this error. The first measure of a critical thinker is a person who avoids the error of *post hoc ergo propter hoc*. Thunder follows the flash of lightning, but lightning does not cause thunder. Both lightning and thunder have the same cause.[3]

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[1] The second definition of critical in *The American Heritage Dictionary* is: "Characterized by careful and exact evaluation and judgment." That same dictionary's second definition of thinking is: "Characterized by thoughtfulness; rational." For this handout, you should think of critical in the "mission critical" sense, rather than the pejorative meaning of critical.

[2] Some would say: "All forecasts are either lucky or wrong."

[3] What is that shared cause?

Believing that **correlation is causation** is similar to, but independent of, *post hoc ergo propter hoc*. This fallacy masquerades as truth in many contexts, not just the one-to-one relationship between lightning and thunder. This error is doubly tempting. First, the scientific method[4] uses correlation to buttress an assertion of causation; therefore, every well-trained thinker will use correlation. Second, a person who falls into "correlation is causation" trap appears to be a sophisticated thinker because of the use of mathematics to support the erroneous assertion. The listener, as a critical thinker, must independently validate the assertion. The "correlation is causation" error only can be avoided by critical thinking that validates that the assertion is supported by logical accuracy as well as correlation. Otherwise, causation is not "proved". The equal employment opportunity laws of protected classes reflect a legislative rejection of the correlation is causation error.

Unintended consequences are inevitable. Recall the distinction between actual causation and proximate causation.[5] Typically, the law affixes liability only to those consequences that could have been intended by a reasonable person acting rationally. Reality is far less forgiving. In reality, all consequences of an act are included in the "profitability" assessment, not just those that were intended by an ignorant actor.[6] In business, a particularly rude surprise awaits those who make decisions, in a formalistic fashion, based upon discounted present values. What appears to be "profitable" today may be wholly unacceptable as experienced in the out years (e.g., balloon payments come due).[7] In addition to being remote, moving into the future also expands the feasible pathways of (intended and unintended) consequence. ***Complex causation*** becomes the norm the farther into the future one moves. With the increase in complex causation, the likelihood of accurate understanding of that complex causation decreases, and increases the likelihood of unintended consequences.

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[4] Per *The American Heritage Dictionary* the scientific method is: "The totality of principles and processes regarded as characteristic of or necessary for scientific investigation, including rules for concept formation, conduct of observations and experiments, and validation of hypotheses by observations or experiments." *A central tenant of the scientific method is that it does not prove, rather it disproves with a stated magnitude of error.*

[5] The law makes the distinction between actual causation and proximate causation in assigning liability for torts. Actual causation is limited to the unbroken chain of events starting at the defendant's original action and ending with the plaintiff's injury. In contrast, proximate causation recognizes the defendant only can see so far into the future, and should not be liable for what the defendant reasonably could not see. Proximate cause limits legal liability to those injuries that could have been reasonably foreseen at the time of the defendant's action breaching the defendant's duty of care to the plaintiff.

[6] Recall, all persons at all times are ignorant, especially with respect to the remote consequences of an action. See also below, bounded rationality.

[7] "Discounted present value" uses a mathematical formula to equate the magnitude by which a dollar tomorrow is worth less than a dollar today. The Rule of 70 gives the periods needed to double or to halve a dollar value. Seventy is divided by the interest rate (stated as an integer) yielding the number of periods needed to double or to halve the dollar value. For example, if the interest is 7% per year, then the Rule of 70 states that a dollar today is worth twice as much as a dollar in 10 years (i.e., 70 / 7 = 10). By this logic, at a 7% interest rate, $1 now is worth over $16,000 in less than 100 years. Accordingly, via this logic this generation should take a $1 "profit" and impose a $16,000 cost on our "children" 100 years in the future. Such thinking does not explore whether the scale of the future cost will be manageable in the future or whether the present day choices doom the future. For additional material on this issue see, http://cba.unomaha.edu/faculty/mohara/web/GovGenuineProfit.pdf.

Our knowledge is limited. As our knowledge increases, our awareness of our ignorance increases.[8] Since the foundation of our knowledge is finite, and reality appears to be infinite, even what we know to be "true" may be false. Accordingly, our ignorance is limitless. As an unavoidable result of our humanity, our analysis and understanding of the world is afflicted by **bounded rationality**. Our perception of reality is tethered to our physical beings and is modified by our social and psychological beings.[9] We literally can not see some things and thus tend to[10] exclude those from our analysis. This failing is in addition to our ignorance.[11] Our analysis always is flawed; even when we do it as well as it could possibly be done by humans (or any other finite entity). Our analysis can be no better than the outer limits of our bounded rationality.[12]

In theory, a system can be open[13] or a system can be a closed.[14] In reality, no system is closed. In practice, a system may be sufficiently closed that our bounded rationality can not see the external interactions[15] or we may perceive it "profitable" to exclude the known, but relatively small, interactions from our analysis. For the sake of simplicity, often we will **act as if an open system is a closed system**. Given our bounded rationality we must do this. The type of error I wish to draw your attention to is worse than a mere and unavoidable extension of our bounded rationality. Instead of analysis that is erroneously truncated as a consequence of unavoidable bounded rationality, our analysis also tends to be flawed because we will be drawn to the closed system analytical flaw out of other human failings: laziness or duplicity or deliberate ignorance. Once we begin to analyze a system from the closed perspective, we blind ourselves to the

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8 Einstein used the example of a candle in the dark. A candle when lit creates a sphere of light. All of the dark is our ignorance, the light is our knowledge, and the boundary between the light and dark is our understanding of our ignorance. When we learn we increase both our knowledge and our known ignorance. When we make the candle's flame larger, the sphere of light is larger as is the area of the boundary between light and dark. Knowledge and the boundary of known ignorance increase simultaneously. With Einstein's expanding candle flame in the dark analogy, which is growing faster: our knowledge or our known ignorance?

9 Some would argue that we also have spiritual manifestations, which may increase, reduce, or otherwise alter our maximum parameters of perception. And you would argue … ?

10 For example, human vision does not see in the infrared portion of the light spectrum. Humans do build machines that can see such infrared light. However, humans rarely use such machines and humans do not always use such machines when such machines would be beneficial for seeing reality.

11 Recall the difference between ignorant (i.e., does not know) and stupid (i.e., can not know). Our physical, social, and psychological limits make us "stupid". See also the handout "Reasonable Expectations". In this sense, all humans are "stupid". However, this is not remotely close to the most frequent meaning of the word "stupid", since that normally contains an implied relative stature compared to other humans rather than to other species.

12 Per Artimus Ward (1834 - 1867): "It ain't so much the things you don't know that get you in trouble. It's the things that you know that just ain't so." Per William Butler Yates (1865 - 1939): "Education is not filling a pail, but lighting a fire." Per Albert Einstein (1879 - 1955): "Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world."

13 That is, a part of and interactive with the rest of reality.

14 That is, distinct from and inert with respect to the rest of reality, even if dynamic within itself.

15 For example, the magnitude of any specifically suspected interactions may be so small as to be beyond the outer limits of our perception capabilities.

possibility of a whole class of complex causations.[16] We structure our analysis so that it *can not* yield accurate predictions. A critical thinker must keep an open mind, and assuming an open system is one prerequisite of an open mind.

Our laziness, duplicity, and deliberate ignorance do not stop there. It is in our nature to seek completeness. We crave it. Shave and a hair cut, … .[17] Our analysis will be flawed because we will stop our analysis **believing our analysis is complete**. Just as a system can not be closed, so too our analysis can not be complete. We will need to make intermediary decisions as we construct a desired future based upon our predictions. That need for intermediary decisions, however, does not require us to assume the analysis supporting those intermediary decisions was a complete analysis. More accurate analysis would validate some of our intermediate decisions prior to the making of subsequent decisions, but we will forego such validation in our rush to completeness.

Critical thinking requires more than mere avoidance of error. Critical thinking is an active and relentless pursuit of truth. Any intermediary truth is, at best, of suspect accuracy (we can get lucky). The open mind must explore for its own errors, not just the errors of others.[18] We must seek to avoid merely repeating our experiences, and instead we need to learn from each iteration,[19] only then we will expand our knowledge base and understanding of the contexts within which we act. If we do succeed in learning, then, rather than being able to reduce our commitment to an active and relentless pursuit of truth, we must increase our efforts. Our iterative analytic efforts must be sustained since we know that our ability to detect our own errors decreases with increases in the quality of our analytic skills and predictive pronouncements.

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[16] Business analysis is particularly susceptible to this error. Business focuses upon profit, especially profit in an accounting, finance, and/or economic sense. Accounting, finance, and economics each is a means of viewing an organization or an activity. Each is a lens through which we view the world and this lens both increases our visual acuity and blinds us. For example, accounting is purposefully objective and purposefully oriented towards a closed system analysis. How does an accountant "account" for negative or positive externalities (e.g., a decimated home life of an overwork manager) on the balance sheet? How does finance? Economics? Each is a different lens, but each comes with blinders that create closure artificially. In calculating whether the shareholders' wealth is maximized via the decision to close an old manufacturing plant in the USA and to open a new manufacturing plant in a lesser developed nation, is that calculation of the shareholders' profit net of gains and losses for all participants, including the environment? In reality, no system is closed and the calculation of "profit" always yields a net value. (See also, notes 5 and 6 above, as well as the text accompanying note 7 above.)

[17] For those not native to the USA, this is a very old barbershop jingle, and it ends with the words "two bits' (i.e., $0.25). This jingle has a musical pattern attached to it (i.e., 1 beat, short pause, 4 fast beats, long pause, 2 beats). The pattern is so cultural that the USA prisoners of war in the Hanoi Hilton used to this musical jingle as a digital signature for the Morse Code messages they tapped out on the walls. Their captors never could replicate the musical beat in all of the captors' attempts to originate fraudulent messages aimed at fermenting discouragement and desertion among the prisoners.

[18] In business especially, almost always it is superior to find cause(s), rather than to find fault.

[19] Per W. Edwards Deming (1900 - 1993): "That man does not have twenty years of experience. He has had one year experience twenty times."