# Portaging Richard Paul's Model to Professional Practice: Ideas that Integrate

by Robert Niewoehner

**Abstract**

Richard Paul originally developed and disseminated his approach principally through venues targeting K-12 and university education. Together with Linda Elder he sought to ground a culture of critical thinking. Paul and Elder, in collaboration with this author, then extended their approach into the professional practice of engineering. The *Engineering Reasoning Thinker's Guide* contextualized the model for engineers. Though intended for engineering students, it resonated with engineers in industry practice, providing a pattern for other guides, such as *Clinical Reasoning.* Presuming familiarity with the components of Paul and Elder's approach, this article demonstrates their approach's applicability to and utility in domains of professional practice, whether engineering, medicine, law, or business. Their approach provides a framework for conceptualizing, synthesizing, and applying material from disparate domains in popular business literature. Organizations that embrace Paul and Elder's vocabulary will improve the collective thinking skills of their entire work-force. Paul and Elder's approach provides ideas that *integrate*.

**Keywords:** critical thinking, professional, engineering

## Introduction

An undergraduate student provoked my interest in critical thinking. I had practiced engineering professionally for twenty years and was adapting to teaching undergraduate engineers. Grading this senior's semester project distressed me. A month short of graduating near the top of his class, from a difficult program, his written work lacked evidence that he could reason. I had come from the work world into which he was headed, and I knew that his future supervisors would need him to think well, more than any other skill we imparted to him. I had recently been one of those hiring bosses. Yet, we had allowed this ostensibly good student to get through our program without demonstrating in a project that was supposed to represent his pinnacle academic achievement that he could *think.*

My distress led me to the work of Richard Paul. First, I wanted to know how to reorient my teaching to foster the development of students' thinking skills. Second, as an institutional leader, I wanted to understand how our institution could improve the apparent defect I had observed in that student's education. At home, my concern further included teaching my four then-young sons to think well. Reading Paul's early work and watching his workshop videos convinced me of that work's general applicability to my teaching. So, I went to California to take a week-long workshop with Richard, Linda Elder, and their collaborators.

My epiphany occurred during the second day in a "Socratic Questioning" workshop, while paired with the Dean of Music from a mid-western university. In the middle of a task Richard had given us, my partner exclaimed, "This is so relevant to what I teach!" I replied, "Well, this is really relevant to what I teach, and our subjects could not be more different." I shared the identical conversation the following day with a Chairman of Pediatrics from a Canadian medical school, after which I remarked, "There's something powerfully portable here." I was particularly struck by Paul's exhortation to "Focus on ideas that integrate."

The following year, I met with Paul and Elder in their home to discuss adapting for engineers their *Scientific Thinking* (2015). Linda cornered me, asking, "How has using this model changed the way you personally think?" Taken aback, I realized their model was changing not simply how I teach, but how I think. I eventually reached an answer that appeared to satisfy them both, and we completed *A Miniature Guide to Engineering Reasoning* the following year (Paul, Niewoehner and Elder, 2006).

The publication of that Thinkers' Guide revealed other constituencies I had not expected. I had contributed to *A Miniature Guide to Engineering Reasoning* believing it would fill a gap in engineering education (Paul, Niewoehner, and Elder, 2006). I did not expect the reception extended by supervisors and leaders in diverse engineering workplaces who were concerned for the continued intellectual development of their technical workforce. Indeed, it is easy to find business leaders identifying critical thinking skills as among the attributes they most need in today's workforce (Wagner, 2010).

In the ten years since, I've interacted with many organizations seeking to apply the Paul-Elder approach to their daily work. As my own teaching has drifted more towards technical business leadership, I've been attentive to alignment of their work with that of other authors, particularly those writing in the business and technology sectors. In the examples and cases that follow, I intend to illustrate the portability of the Paul-Elder approach into domains far afield from Paul and Elder's direct educational reform, while within the broad scope of their hoped-for impact. In these cases, I'll assert that the critical thinking model has spurred my apprehension and application of what others have written, and has enriched the tools and models offered by others. Even with the books I've read this summer, Paul and Elder's model has provided a framework for me to organize and more easily remember what I've read and learned. The Paul-Elder approach has proven to be "Ideas that Integrate."

## Overview of the Paul Model

I'll trust that others in this issue have provided fuller discussions of the Paul-Elder approach to critical thinking. The model is described in several full-length books, as well as scores of booklets which they call *Thinkers' Guide*s (e.g. Paul & Elder, 2006). Hence I will only briefly summarize their approach, describing those adaptations that I have found assist its contextualization to professional practice.

Before I review the Paul-Elder approach, I should comment on the value of a general model of thinking. Coincident with his retirement from Harvard's Graduate School of Education, David Perkins summarized his forty years leading research into thinking and learning (2013). Perkins reported that a variety of thinking organizers have been demonstrated to show significant impact on and transfer of targeted thinking skills. "Not only can [we improve thinking], it can be done in a variety of successful ways. What they have in common is thinking organizers." Paul and Elder's model is one such thinking organizer.

Perkins challenged his audience on five points relating to the use of thinking organizers. First, learners need explicit instruction in their use. Second, thinkers need a metacognitive framework for recognizing when particular thinking skills apply. Third, thinking organizers are best when socialized, meaning that they've become embedded in a group's *common vocabulary*. Fourth, Perkins refuted claims that thinking skills are discipline-specific, insisting they're universal, while acknowledging they should be "situated." Paul, Elder and I described *Engineering Reasoning* as a "contextualization" of their approach for engineers. Finally, Perkins insisted thinking organizers couldn't be divorced from "thinking dispositions" and called for further study in this domain. Paul and Elder's Intellectual Virtues instantiate and explicate the dispositions Perkins stressed.

My own conception of critical thinking has been instrumentally shaped by Paul and Elder's definition: "Critical thinking is that mode of thinking—about any subject, content, or problem—in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them." But, Paul would have been the first to insist that I express this in my own voice, with personally meaningful examples.

I define critical thinking as the deliberate assessment of our own thinking which seeks to improve our thinking and which spans our reception and analysis of what we hear and read from others. *Critical thinking intentionally questions itself.* In other words, two processes work in parallel. The first organizes our thoughts and information to answer our questions, the goal of our thinking. The second parallel process simultaneously questions the health and quality of our thinking in the first process with the goal of its refinement and improvement.

The flight control systems of today's commercial airplanes illustrate these parallel processes. For safety, the flight control computers are typically quad-redundant, meaning most of the vital components have four identical copies, physically distributed so damage to one doesn't damage them all. Hence, four identical sensor packages share their measurements with four computers, which route commands via four independent wire bundles. Thus individual component failures cannot cause the whole system to fail. Thousands of times each second, all four computers observe their sensors and the control inputs and independently calculate where the rudder should next be commanded. Together, they command the rudder to move.

But the flight control system does more than calculate new control positions. In parallel, with every computer clock-frame, those same four computers repeatedly ask one another, "Do we agree? Do we agree? Do we agree? Do we agree?" If one computer or component disagrees with the other three, then its health is doubted and the system ignores the errant computer or sensor, literally voting it off the data bus. *The primary process controls the airplane*; *the second process monitors the health of the first*. The health monitoring process protects *the system's decisions* from failure, ensuring its integrity, safeguarding the airplane, its passengers, its crew.

Critical thinking monitors and questions the health of our thinking, whether as individuals or as teams. When we *observe*, critical thinking challenges the data's validity. When we *organize the data*, critical thinking warns us of our biases and blind spots. When we *assume*, critical thinking reveals and challenges assumptions. When we *conceptualize*, critical thinking prompts us to consider alternative mental models. When we *interpret*, critical thinking reminds us of other points of view. When we *communicate* by talking or writing, critical thinking requests clarification and refinement. Critical thinking seeks the immediate quality and long-term refinement of our thinking as individuals. Likewise, in the organizational context of teams, critical thinking seeks the enhancement of team learning and performance.

If critical thinking monitors the health of our thinking, what are the particular questions it should ask? A practical model of critical thinking should provide a schema for asking vital questions.

Questioning skills appear frequently in the business literature as vital to business success, particularly in domains dependent on innovation. Research by Dyer, Gregersen, and Christensen found that dozens of prominent innovators excelled at three of five distinct leadership skills: Questioning, Observing, Networking, Experimenting, and Associating (2011, 29). These innovators' productivity did not depend on having all five skills; strength in three sufficed, yet every one of the innovators excelled at Questioning. Questioning was the indispensable skill.

Many companies have embraced "Action Learning" as a method for problem solving and for leadership development in focused problem-specific sessions (Marquardt, 2011). Action Learning's core practice is simple: "statements are only allowed as a direct answer to a question." Questions therefore ground the process, and the quality of the questions determines the quality of the outcomes. Some practitioners/proponents explicitly embed the Paul-Elder approach in Action Learning as a means to boost organizational competency (DeLeon, 2012).

Some of my friends regard Marquardt's *Leading with Questions* as one of their favorite business books (2010). An Action Learning advocate, Marquardt, urges leaders to develop their inquiry skills, over against the advocacy skills that might likely have been responsible for their rise to leadership.

Personally, however, I reacted to *Leading with Questions* in the same way I reacted to reading Mortimer Adler's classic *How to Read a Book:* I would need to carry these books with me to implement their suggestions. The detailed approach in the books was excellent, but it was difficult to portage. However, I wouldn't need to carry the books if I had a schema for asking great questions, regardless of the discipline. The Paul-Elder approach constitutes a schema for growing towards expertise in asking questions, whether in my classroom, at my dinner table, or in a business meeting.

Paul and Elder's approach is comprised of four dimensions. The Elements of Thought span the substance of our thinking. The Intellectual Standards provide universal criteria against which thinking should be judged. The Intellectual Virtues describe the traits or habits of mind of a critical thinker. The barriers of egocentricity and sociocentricity are the main Impediments to Critical Thinking. Paul frequently characterized question-asking from these four dimensions as "basic intellectual moves." The sub-sections below describe the minor amendments I make in order to contextualize the model for professional/business settings.

### *1.1. The Elements of Thought*

Paul asserts that *all* thinking entails eight elements, whether or not they're explicit. We think for a *purpose*, with some immediate *question*. Our *point of view* entails *assumptions*. *Mental models* or *concepts* organize the *information*. A *conclusion* answers the question and has *implications*. Disproving Paul's assertion would merely require imagining some line of thinking in which one of the elements is absent, but so far I have not found one.

Paul insisted there is no particular order to these elements; they work as an ensemble, constituting the elements of our thinking on a subject. While I agree, I also remember the natural pairings above as an aid to my memory. Moreover, this order reinforces the inductive line of reasoning commonly found in technical writing. I started my abstract above with a bullet list of the Elements of the paper I intended to write. I thence turned those bullets to prose, combining them and re-ordering them for readability.

I slightly amend Paul's model by complementing 'concepts' with 'mental models,' a term emerging from the cognitive sciences and popularized in business contexts by Peter Senge's *The Fifth Discipline* (2006, 166ff). Modern cognitive science has validated Aristotle's classical insight, "The soul never thinks without a mental image [*phantasma* in Greek]." Mental models in particular have received attention in the recent literature on innovation and creativity.

We now know we reason with mental models. Within the cognitive sciences, competing theories of the late 20th century surrendered to the current understanding of our thinking, where thinking simulates events with mental models (Johnson-Laird, 2006). In *The Mind's New Science,* Howard Gardner (1985) remarks, "the major accomplishment of cognitive science has been the clear demonstration of . . . a level of mental representation." The mind manufactures models. Phillip Johnson-Laird pioneered much of this work, publishing *Mental Models* in 1986, followed by *How We Reason* in 2006. Johnson-Laird (2006, 165) explains, "Our capacity to hold things in mind is limited, and so we tend to reason with mental models."

Given that you and I think in models, mathematician George Box (2005) warns: "All models are wrong. Some models are useful." But "Don't fall in love with a model." Here, Box addresses those who work with statistical models, but his exhortations apply equally to anyone who desires to think well, once we realize that our reasoning employs mental representations. If we're mindful that our mental models are mere *representations that we've constructed*, then we will be attentive to the fact that appropriate alternative models may exist, and that it is likely that our teammates, customers, or professors are working from mental models different than our own. In *Thinking in New Boxes,* De Brabandere and Iny (2013, 276) note, "Concepts must be identified because conceptual frameworks empower, but they can also constrain." The most successful models of the past may obscure the models that will promote future success or innovation.

Both the frequency with which "mental models" now appears in the business and innovation literature and the concept's grounding in the cognitive sciences commend amending Paul's nomenclature to anchor this valuable insight in the framework of the Elements of Thought. Paul's approach then draws attention to mental models as one of the eight elements of our thought, rather than as an entity that stands alone in import. Thereby his approach grounds discussions of mental models in a broader, more robust framework of thinking. Focus on the Elements of Thoughts in this way provides an idea that integrates.

1.2. Intellectual Standards.

A survey of intellectual values going back to Greek antiquity reveals universal standards for qualifying good intellectual work, whether in the arts, sciences, or humanities, and regardless of the language. Paul and Elder's *Intellectual Standards* (2008) treats the subject wonderfully. They acknowledge that their lists are not comprehensive (or consistent across their publications), that some disciplines might place more or less emphasis on particular standards, and that a discipline might prefer a synonym. I contend that *for organizations, whether schools or businesses, the power of intellectual standards emerges from having a common vocabulary for good intellectual work.*

I teach to the following list of standards, with several adjustments and additions from the list found in *Engineering*

*Reasoning.*

- Clear
- Precise
- Relevant
- Fair
- Concise
- Broad
- Significant
- Systemic
- Accurate
- Deep
- Logical
- Complete

While Paul and Elder typically catalog the standards as nouns, I prefer adjectives, grammatically emphasizing how the standards qualify the Elements of Thought: e.g. a *clear* purpose, a *significant* question, *accurate* assumptions, a *logical* conclusion.

My two additional standards are *concise* and *systemic,* whose inclusion I will explain and defend, and I will also identify a major application of the standards that first appeared in *Engineering Reasoning.* First, concision serves clarity as a hand-maiden. They routinely appear ensemble in corporate writing manuals, or even the FAA's guide to radio communications; "clear and concise" are almost inseparable. The pantheon of great communicators exhort concision. Homer linked these thoughts (Krieger, 2002), "Few were their words, but wonderfully clear." Cicero warns (Wickham, 1903, 357), "Every word that is unnecessary only pours over the side of a brimming mind." Thomas Jefferson (1814) counseled, "The most valuable of all talents is that of never using two words when one will do." I first included *concise* after repeatedly observing that the poorest student work was often too long just as often as it was too short. Including concision reminds my students (and me) to maximize the signal-to-noise ratio.

Second, I included *systemic* because of the importance of Systems Thinking. Systems Thinking rose to prominence because complex systems abound: technical, biological, ecological, financial, social, etc. Increasingly, we find ourselves frustrating our own efforts because our attempts to effect some change have systems implications that we have not contemplated. Systems can interact with their environment and with other systems in surprising ways; behaviors emerge that wouldn't have been anticipated. Who would have imagined, for example, that re-introducing wolves into Yellowstone National Park would change everything in the eco-system including the course of rivers? (Wolves). Systems Thinking has emerged as a science with applications spanning multiple fields, and system behaviors are at the root of many of our most vexing social and technological challenges (Meadows, 2008).

For several years, I treated *systemic* as a special case of the standards *deep* and *broad*. But, those two standards are already rich with significance, and I found their meaning was diluted if I lumped systems thinking with either. Thus, when I urge engineers to go deeper, I intend that they remove simplifying assumptions and increase the complexity of their analysis, and when I urge them to think more broadly, I'm asking them to think about alternative mental models, or think about problems from other stakeholders' viewpoint. In contrast, when I urge them to think systemically, I'm urging them to thing about the connections of their system-of-interest with the world surrounding that system, those systems with which it must cooperate and those with which it will compete. Furthermore, I'm urging them to think about how the world outside their system will react to their system—whether physically, socially, electronically, environmentally, etc. This calls for an independent standard.

Furthermore, in *Engineering Reasoning*, we explicitly extended the scope of the standards' application to graphical communication within the field of engineering. Business and technical communications depend on graphical evidence as often as on prose. In an age of "big data," stories emerge from trends that can frequently only be noted in graphical formats. Edward Tufte (1997, 53) highlighted the following paragraph as the single most important thought in any of his landmark books on graphical communications:

> Visual representations of evidence should be governed by principles of reasoning about quantitative evidence. For information displays, design reasoning must correspond to scientific reasoning. Clear and precise seeing becomes as one with clear and precise thinking.

Though I had long delighted in Tufte's books, it was as I listened to him in a workshop that I realized, "If the standards are universal, they must apply to graphs and figures as they do to prose."

### *1.3. Intellectual Traits and Virtues*

In his retirement address (Perkins 2013), David Perkins reserved his strongest message for the role of dispositions in intellectual behaviors, "The data is in; dispositions affect thinking behaviors much more than IQ." What Perkins called "dispositions" in his address, Paul and Elder label "traits and virtues." I prefer the latter term, as "virtues" emphasizes my moral obligation to aspire to them all, rather than remaining content with a disposition to exhibit one or two.

The intellectual traits and virtues include:

- Intellectual Humility
- Intellectual Integrity
- Intellectual Courage
- Intellectual Empathy
- Intellectual Perseverance
- Confidence in Reason
- Intellectual Autonomy
- Fair-mindedness
- Intellectual Curiosity

We added "Intellectual Curiosity" to the list in *Engineering Reasoning*, given the frequency it appears in descriptions of technical tragedy and success. The expression appears five times in the *Columbia Accident Investigation* report (Gehman et. al., 2013, e.g. 102), collectively representing a rhetorical lament, as if the Board were asking, "Where was the intellectual curiosity?"

Particular intellectual virtues are extolled in numerous best-selling business books. In *Emotional Intelligence* (2005) and *Primal Leadership* (2002), Daniel Goleman insists that intellect qualifies men and women for executive leadership, but *empathy* enables their success once there. Jim Collins' research for *Good to Great* highlights CEO *humility* as the best predictor of great companies' financial performance (2001). Edgar Schein insists *Humble Inquiry* belongs at the heart of leading learning organizations (2013). Matthew Syed's *Black Box Thinking* highlights innovation's dependency on innovators' attitudes towards failure, and their intellectual *perseverance* (2015). In a *Harvard Business Review* classic, Kim and Mauborgne emphasize "Fair Process" in managing knowledge workers: leaders need not give knowledge workers their way, but effective leaders must give them their *fair* say (1997). So, we see prominent business authors and researchers highlighting particular thinking dispositions and virtues, consistent with Perkins's charge to contextualize dispositions.

The Paul-Elder framework emphasizes the set of virtues as collectively descriptive of the thinker I should strive to be. For many years, growth in humility was my greatest developmental need, while other traits came more naturally, such as autonomy, curiosity, and confidence in reason. As I made sluggish progress, two professional mentors urged me towards more empathy as a leader. Of course, hearing their thoughtful counsel gracefully challenged my humility. I acknowledged they were right—eventually. Subsequently, growth in empathy has been my personal project for several years.

Hence, the Paul-Elder articulation of virtues describes the dispositions I aspire to exhibit more completely than do any one of these other wonderful authors. Surely, as I read further, I'll find substantiated exhortation in some future author whose work I'll embrace and can readily weave into the structure Paul and Elder provide. Again, Paul and Elder's approach provides "Ideas that Integrate."

Among the organizations with which I regularly consult and teach, several routinely request workshops on intellectual virtues for their mid-career leaders. In a workshop on my campus, my then-18-year-old son was paired with a retired Navy admiral, who had recently served as Associate Administrator with NASA. I asked participants to recall and then share one positive and one negative personal story exemplifying the workplace power of *one* intellectual virtue. That night at dinner, I asked my son, "How was your time with Craig?" "Dad, you asked us for one positive story and one negative story illustrating a virtue. Do you realize that in that five minutes he'd listed a positive story and negative story for *every* single virtue?" "So, what did you take away?" "Virtue matters at work."

I urge you to watch and reflect on Dr. Peter Attia's TED-MED talk (2013), "What If We're Wrong About Diabetes?" Then, ask yourself, "How were intellectual virtues evidenced in his talk?" He does not use the term "virtue"; he's talking medicine to an audience of medical professionals. Yet, his personal example movingly reinforces my son's observation on professional effectiveness: "Virtue matters."

**Workplace Examples**

In the examples that follow, I describe two issues in the business literature, and then illustrate how the Paul-Elder approach intersects with those issues, enriching the insight they provide. Furthermore, in each case, it is clear that proficiency with the Paul-Elder approach enables accelerated application of the counsel it offers.

*1.1. Moving Teams from Advocacy Cultures to Inquiry Cultures*

A team's approach to inquiry and advocacy influences both its creativity-and the commitment felt by team members toward team goals. This touches upon some of our most difficult conversations within professional teams and on challenges for project leaders. A team's approach to inquiry and advocacy distinguishes critical thinkers from competing colleagues.

First, creative teams need conflict. Pat Lencioni lists "Fear of Conflict" as the second of his *Five Dysfunctions of a Team* (2002). In my world, engineers commonly assemble teams with mixed expertise, both because we need the diversity of insights into problems and solutions and because it is through such teams that younger participants grow. The point of teams is not simply to divide up the labor, but more importantly to achieve outcomes that, as a consequence of breadth of insight and expertise, are greater than the sum of the parts. A team's problem may require expertise from structures, electrical, and programming. The more ill-structured the problem, the more valuable the diversity of insights (Sawyer, 2007). The challenge is always to foster constructive conflict and avoiding the pitfall of unproductive conflict.

Furthermore, teams can descend into a number of decision-making dysfunctions. The strongest personality in the room may dominate, even bully, forcing their peers into a course of action (drafting others in their ascent up the ladder of inference). Social loafing or social fear may limit an individual's willingness to contribute. The team might prematurely rush to converge on an answer when more discussion might uncover better alternatives. Truly innovative ideas will commonly not be the first to the table; solution-driven engineers may rush to close on the first viable option, or on a legacy solution, rather than exploring the full opportunities of the design space. Worse, teams that over-value peace will be slow to converge and may choose the answer that makes everyone happy, rather than best answer to the problem. These are all artifacts of a failure to promote healthy conflict.

How can we distinguish between the conflict we want and the conflict we dread? Lencioni distinguishes *ideological* from *interpersonal* conflict, promoting the clash of ideas rather than of people. Garvin and Roberto (2001) call these *cognitive* and *affective*. Pixar's Ed Catmull (2014) describes a culture of safe ideological conflict as foundational to the artistic and commercial success of their movies.

How can we direct teams into clashing over ideas without butting heads? *Inquiry* promotes the former; *advocacy* encourages the latter. The table below summarizes the distinction, adapted from Garvin and Roberto (2001). Most of us with any experience in work or academic teams will recognize the advocacy team meeting, where conversation devolves to the two most passionate voices in the room.

Observers who do not hear questions in a meeting know they are watching a team with an advocacy culture. In contrast, in a team with an inquiry culture the conversation will be characterized and shaped by questions, and an observer should note deep listening on the part of those not speaking. Inquiry cultures seek clarity and charity; advocacy cultures seek conquest.

The point is that proficiency in the Elements of Thought provides immediate proficiency in promoting an inquiry culture because team members always have eight great questions they can ask and countless more that emerge from the eight families of questions the elements represent. When presented with an idea that either you do not understand or with which you disagree, you can tease out the eight elements from your teammate's proposal. (1) "What assumptions underlie your proposal?" (2) "What stakeholders are you prioritizing?" (3) "What information do you think is most valuable?" (4) "Could you elaborate on your reasoning connecting the data with your conclusion?" (5) "What implications are you contemplating or seeking to avoid?" (6) "How do you define the problem at hand?" (7) "What organizational or customer need will this serve?" (8) "What conceptual foundation does your proposal embrace?" These questions are particularly important when a stalemate looms. Hidden assumptions and implicit mental models are commonly the unrecognized source of conflict; exposing these may diffuse the conflict, or reveal other unseen alternatives.

Similarly, when challenged by others in presenting our own ideas, the elements are again a resource in explaining our proposal. "I'm using data from . . . ." "I've assumed . . . ." "The following mental model is key to my thinking . . . ." "My rationale behind my conclusion was . . . ." "I believe the implications of this course would be . . . ."

Table 1 Decision Making Cultures

| | **Advocacy** | **Inquiry** |
|---|---|---|
| **Mental Model** | A contest | Collaborative problem solving |
| **Purpose** | Persuasion/ lobbying | Learning |
| **Participant's Role** | Spokesperson | Critical thinker |
| **Behaviors** | Strive to persuade<br>Defend your position<br>Downplay weakness | Present balanced argument<br>Remain open to alternatives<br>Accept criticism |
| **Minority Opinion** | Discouraged or dismissed | Cultivated, celebrated |
| **Outcome** | Winners and losers | Collective ownership |

So, whether needing to steer the room into inquiry or having been thrust into the role as an advocate, team members can ground their questions with the Elements of Thought. The use of the Elements broadens a team's consideration of the factors affecting their thinking.

The Intellectual Standards are a similar resource from which to draw good questions in team problem-solving settings. Bringing the Standards into the conversation sharpens the team's thinking. "What are the significant factors we should consider?" "How could we clarify our interdependence?" "Is this the most accurate information available?" "What emergent system behaviors are possible?"

One need not be the team leader to influence a team's culture towards inquiry. And though familiarity with the Elements and Standards is clearly helpful, such familiarity is not absolutely necessary for all teammates. The embrace of and growth in the intellectual virtues will move the thinker personally towards an inquiry contribution rather than advocacy, whether or not their teammates grow with them.

Explicit strategies exist for fostering inquiry behaviors in teams. Action Learning is one such explicit protocol for promoting inquiry cultures through problem-solving team sessions, and it has been successfully embraced by numerous companies (Marquardt, 2011). While many books and workshops are available on the subject, the fundamental ground rule for an Action Learning problem-solving session is pretty simple: "Statements can only be made in answer to a question." The resultant dynamic during such sessions is very interesting.

My limited personal experience with

Action Learning sessions has been very positive. First, I find the protocol encourages intellectual virtues, notably intellectual humility, empathy, and fair-mindedness. Instead of devoting my attention to crafting a clever answer, I listen more intently to craft a perceptive question, building on what I have heard. Indeed, I may listen to others more intently in Action Learning groups than any other setting.

The shift from an advocacy culture in a team does not require certification in Action Learning. An undergraduate engineering student met with me weekly during a recent semester for mentoring in leading a capstone design team of a dozen classmates. His faculty supervisor expressed dismay in December about the team's stunted progress through the fall, yet in the spring reported that the team's productivity changed dramatically. When I asked the student what he'd done differently, he told me, "I quit telling my classmates what to do and resolved to lead solely with questions. I learned that they did not need me giving them answers; they'd needed me to guide them to devising answers." He had intentionally shifted his team's culture from advocacy to inquiry, and both he and his faculty mentors thought it decisive in bringing about greatly improved results.

### *1.2. Restraining the Rush to Judgment*

We rush to judgment when we seize upon easy answers by creating a story that satisfies our preconceptions. Accident and incident reports in high technology sectors are replete with descriptions of thinking habits that failed professional organizations. We commonly draw conclusions that we believe follow directly from the evidence and we are inattentive to the influence of our assumptions on those conclusions or the extent to which we might have filtered the data by virtue of our point of view or mental models. Paul and Elder's approach provides technical organizations such as mine with tools for developing the habits and traits of mind that are the antidote to the glaring missteps that grieve us. I will share several examples below, beginning with a "good news" story, in which intellectual virtue prevented an incident.

An industry flight test team shared their story of a near-miss at a 2014 industry safety conference (Bombardier, 2014). A demonstration test point for a twin-engine commercial airplane customer nearly ended in disaster. The test called for an abrupt throttle chop to idle on one engine coincident with the airplane lifting the nose for takeoff. It's a critical test because it is dangerous; the manufacturer has to prove that the airplane is controllable even with an engine failure at the worst possible moment. A fatigued, inexperienced co-pilot raised the nose ten knots early, well below the speed at which control was assured, and the pilot and copilot had to wrestle the airplane back into control, averting disaster. Everyone blamed the co-pilot; the test point was repeated with another crew; the customer was satisfied; the case was closed. No one noticed they had rushed to judgment.

One cautious manager remained unsettled, suspicious, and intellectually curious. Over the objections of those who wanted to move on to other work, he insisted they dig deeper into the incident. That deeper investigation initially raised more questions than answers, and further analysis revealed a software bug unmasked by an under-serviced nose-wheel. With a unique alignment of conditions, the software bug had prematurely indicated rotation speed to the co-pilot, who had acted perfectly in accord with the displayed information. The discovery of the bug exonerated the co-pilot. More importantly, this software load was flying worldwide in scores of customers' airplanes. Those airplanes might still be flying with that software had one manager not stood his ground, an act requiring intellectual autonomy and courage, and followed up on an intuition, "Now, that's odd." The near-miss was scary enough; the team had seized the easy answer and nearly deprived themselves of the chance to discover a latent software flaw in the airplanes flown by their customers worldwide. Fortunately, the incident was a flag one manager chose not to ignore.

Recall the *Deepwater Horizon/ Macondo* oil spill of 2010 that released almost five million barrels of oil into the Gulf of Mexico, killed eleven oilmen, and devastated the Gulf of Mexico. The well blow-out, explosion, and subsequent environmental disaster were directly attributed to leakage of oil and natural gas through cement seals at the bottom of the well, 18,360 ft. below sea level, 13,000 ft. below the sea-bed (Graham et al., 2011). At the time of the blow-out and explosion, drilling was complete, and the well was being capped for later use. The presidential commission cited nine distinct decisions on the part of the drilling companies that significantly raised the risk of seal failure and blow-out, and that resulted in all the grievous implications we watched on TV (Graham, p. 125). The precise cause of the failure remains unknown, the evidence buried under a mile of seawater and another two miles of rock.

Seven of those nine decisions were made by engineers ashore, under financial and schedule pressures that typify every engineering activity. The commission despaired that the engineers ashore never systematically considered the elevated risk of those seven decisions' *cumulative erosion* of their safety margins. Each decision appeared to have been taken in isolation as a reasonable cost and schedule-saving measure; but, taken together, they significantly undermined the well's integrity. More importantly, the erosion in overall safety margin was not communicated to those aboard the rig. Nor had lessons and observations been forwarded from an "eerily similar" close call four months earlier in the North Sea (Graham, p. 124). Such warnings might have adjusted the later drilling crew's interpretation of what they observed, fostered heightened caution, and reframed the mental models that propelled them up a tragic ladder of inference.

Those aboard the rig had the opportunity to arrest the blow-out, as had happened in the North Sea episode, but they ran afoul of confirmation bias, derailing accurate interpretations of what they saw. The morning of the tragedy, tests of the well seal's integrity had been cancelled because the cementing process had gone smoothly, with expected surface observations. The immediate interpretation was that, if the surface indications were good, then the seals 3-1/2 miles below were good, and the test crew was sent ashore to save the test's considerable expense. Emails danced between the rig and shore proclaiming "Went well!" and "Great job!"

Next, an over-pressure test at mid-day went smoothly, demonstrating no leakage out of the well column into the porous oil-laden rock. This reinforced confidence in their conclusion that the cement seals were in good shape, so yet another feedback path shaped the data-filtering rung of the ladder of inference.

The eighth decision exemplifies the hazard posed by the ladder of inference; here the participants were blind to what we can, retrospectively, regard as their irrationality. The final test, depressurizing the well column, failed all three times it was repeated, and this should have suggested a gas/oil leak through the seal and into the well column. In the test, the pressure was bled to zero, the top was sealed, and then the pressure rebounded to almost 1500 psi as if the well was being pressurized from below. This thrice-failed test was dismissed *because it contradicted their previously established convictions* that all was good. An alternative test was devised which the well appeared to pass, and all the while the primary instrumentation continued to indicate a leak allowing oil to press into the well. Drillers interpreted the indication as due to a sensor failure, and thus justified their dismissal of the failed results. But, tragically, if the readings were correct, they signaled a risk of blow-out.

After the "passed" leak test, the well was re-opened to pump out drilling mud before pouring a second cement seal. The ninth and fatal decision was failing to monitor ancillary indications that would have clearly indicated whether the seal was holding. But the successful alternative test had been accepted at face value. The accident report points to as many as four data indications of an unfolding blow-out, starting almost 30 minutes before the point at which the blow-out might have been averted (Graham, pp. 109ff). We can't know what the drillers were watching or thinking; they were the first to perish. It is likely that a bubble of natural gas expanded rapidly as it rose through the well, accelerating everything above it as it rose. Once past the valve on the seabed floor, a massive explosion was certain once the gas bubble "kick" hit air, though quick action might still have arrested the months-long spill that followed.

So, as with the *Challenger* and *Columbia* accidents, data waved red flags that were explained away by inferences consistent with what engineers and operators expected to see. You and I would be culpable of the tenth puzzling decision in the *Deepwater* case if we were to deride the participants, believing we're immune or wiser. These were rational, experienced technologists. Too many studies show that, if you just change the people without changing the culture/system, then you still get the same outcome (Senge, 2006). You and I would likely have made the same judgment errors in the presence of reinforcing loops that convince us to dismiss anomalous results. To get a different outcome, we must change the thinking patterns and reinforcing loops.

Not only are we not immune to the rush to judgment in our *technical* judgments, with implications for our customers and communities, but we are even more prone to rush to judgment in our dealings with others. The implications may not be as grave as killing eleven and polluting miles of beaches, but the behavior remains insidious and destructive.

We often rush to judgment when we ascribe motive to a colleague. "He must be doing this because. . . . ." We've committed the narrative fallacy in concocting a back-story that explains what we see (Kahneman, 2011). Meanwhile we've ignored or dismissed alternative explanations and falsely presumed that "what we see is all there is." We can't know someone's motive unless they tell us. Moreover, we know the narrative fallacy stubbornly resists new data. It uses a feedback path whereby new information is filtered so as to reinforce existing conclusions.

I lament having done this to a peer a number of years ago. Our organization was struggling to define our strategy, and relationships were strained. While I was gone on an extended leave, a peer announced a framework for working a task he'd been assigned. In my view, his framework renounced several years of work, and I concluded his motive had been to jettison that work while I was away. I learned of this on vacation, and I flamed him publicly by email, uncharitably and unnecessarily. My attack was fueled by my unwarranted presumption, but I later understood he was simply trying to make progress on his task and didn't understand what work had already been accomplished. Repairing the breech I aggravated has taken several years.

We rush to judgment when we ascribe opinions to others, based on some one thing we know about them. "You're retired military; you must support aggressive military intervention and adventurism." "You voted for xxx last election; you must believe . . . ." "All you (social affiliation) think . . .

." We allow ourselves complex opinions on matters of import to us, yet presume that those around us are simplistic and that they think monolithically with the group to which we've assigned them.

Such thinking behaviors harm both our own thinking and our relationships with others. For our part, our conclusions are often inaccurate, foreordained not by the data but by our unwitting assumptions. We will always filter data. The hazard is in not recognizing why we labeled some as relevant and significant and why we disregarded others. Our conclusions may appear plainly illogical to others, but they appear sensible to ourselves because we have unspoken assumptions operating within our internal unspoken argument.

As with my personal story above, the rush to judgment can severely erode team trust. Many will interpret the acts of others in the most unfavorable light, assigning motives at odds with our own. We presume they are acting out of self-interest or the interest of their division (or faction), rather than the interest of the whole. The gloomiest of us may presume our teammates intend our harm or failure.

Paul and Elder's model suggests several antidotes to this behavior. The Intellectual Elements, Standards, and Virtues particularly remind us to ask questions that expand our breadth, our depth, and systems interactions. First, recall the value of contrary, contradicting data and recall Francis Bacon's admonition to treat our favorite ideas with suspicion. If we're committed to accurate learning and reasoning, we'll habitually ask ourselves, "What evidence would prove us wrong?" This question also reflects intellectual integrity, humility, courage, and curiosity. In the *Columbia, Challenger,* and *Deepwater Horizon* situations, "prove it's unsafe" culturally displaced the expectations that engineers would need to "prove it's safe." Second, we must be mindful of the assumptions that color both the data we see, and the inferences we draw. "What are we assuming?" is always a helpful question. Similarly, "What data have we overlooked?" In the rush to answer a question, we can slow our ascent up the inference ladder by asking, "What alternative explanations can we imagine?" This question has been a staple of every accident board on which I have worked. Even when the evidence points strongly to a particular cause, investigators build their case by systematically rebutting all imaginable alternatives.

Where other people are the subject of our hasty inferences, our thinking lacks virtue as well as excellence. Fairmindedness calls for charitable thinking, believing first that others' motives are upright and their decisions rational from within their point of view. Empathy and humility both call for questions, not inferences, empathy because I should really want to understand others' perspectives, humility because I am mindful of the possibility that I am the one in the wrong. Curiosity compels us not to feel settled with the answers we get, but always to be seeking to refine or rebut them. Autonomy calls us to resist being swept along by the theory of the day. It seems we are back to "Humble Inquiry."

Hence, as my teaching and study have shifted from purely technological towards more leadership and team behavior, I have found Paul and Elder's approach more valuable as an explicit tool for describing and addressing the thinking behavior that characterizes teams that excel and those that struggle  I can also add that I have learned through conversations with colleagues that other Navy organizations have come to the same conclusion and have imbedded Paul and Elder's approach in their practices.

**Summary**

I've gained valuable insight into leading technical teams through all the authors I've cited above, and grown as a consequence both as a leader and educator. Paul and Elder's influence has been foundational; their construct of critical thinking provides the framework through which I process, assimilate and more rapidly apply others' insights. And I have never seen a domain where their framework did not apply.

This embodies what I believe Richard Paul meant when I so frequently heard him exhort, "Focus on ideas that integrate." For me, his are the ideas that integrate all else that I learn. To my mind, the business and organizational insights of Goleman, Senge, Schein, Collins, Agyris, Sinek, Drucker, Catmull, Syed, and others do not stand independently, nor do they stand in contention (e.g. "Collins says humility is most important, but Goleman indicates it is empathy. They can't both be right.") Instead, they actually reinforce one another and deepen my understanding of each. Goleman and Collins mutually exhort me to grow in intellectual virtue, a concept that Paul and Elder helped me better understand. Marquardt and Collins have each challenged me to inquire more and advocate less; Paul and Elder have taught me the questions with which to open my every inquiry. Senge, Catmull, and Syed have called me to place learning at the center of my organization's culture; Paul and Elder taught me the locus of learning is the question.

This week I read another appeal from my corporate leadership to better foster critical thinking skills among those we lead. I'm not sure that such corporate appeals express anything more than a vague idea of what they seek. In contrast, the Paul-Elder approach has provided my agency—one within that corporate structure--with a *substantive understanding* of what we mean by critical thinking and how we might develop it in our people.

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