Innovation Generation

How to Produce Creative and Useful Scientific Ideas

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It All Depends on How You Look at It

"Problems cannot be solved by thinking within the framework in which the problems were created."

—Albert Einstein

Innovative thinking is not normal—it is messy and erratic. It is scribbling outside the lines, marching without a map. Habitual thinking, in contrast is, “neat” and “defined”, allowing you to experience the world in a way that is efficient and predictable. Normal thinking involves using tried-and-true expectations to process new information and make inferences. Linguists call these expectations or assumptions cognitive frames. Frames, as it turns out, are far more powerful than you might imagine.

Frames are everywhere and affect much of what you observe and infer. Consider your frames when you go to a restaurant. There you expect to order a meal, to have food provided, and to pay for these services. These elements describe almost all restaurant experiences all over the world. But what if the events did not quite happen that way?

Sitting at a lovely neighborhood bistro, you order pasta. The waitress, a young brunette with an infectious smile, brings a steaming plate of linguini. She gently moves your fork aside and sets down the dish. Then
she takes one step back. You are thinking how impressed you are with the service, but not with the food. The sauce on your noodles is barely enough to be detectable. When the waitress asks if there is anything else you need, you thus politely ask for a bit of extra marinara. Her reply is, "Go to the kitchen and get it yourself."

Such an out-of-expectation response would stop you in your tracks. You wonder, "Did I misunderstand?"; "Did I insult her?"; or "Is she crazy?" Your emotions swing between embarrassment and anger. Why such confusion? Because the waitress just took your frame and violated it.

Frames are ubiquitous and compelling. The restaurant frame is that you are served—not that you must scavenge for your own food. When standing in a line, you join in behind the last person, consider it rude to cut in, and get agitated if each person is not served in turn. In a classroom, you consider it unacceptable for the teacher to simply not appear or to spend the whole class period reminiscing about his summer vacation.

When your assumptions are fulfilled, you are able to react swiftly and effortlessly. A breach of your expectations forces you to stop, figure out what went wrong, and ponder what to do next. Frames are the grease that allows you to speed through life. A frame break is an unanticipated and unwelcome disruption.

Think through a day and recall all of your many expectations and assumptions. If only a small fraction of your frames were breached, imagine how unsettling that would be.

Science too, has frames, sets of tightly held expectations termed paradigms. The germ theory (transmissible diseases resulting from viruses and bacteria), evolutionary theory (change in the genetic pool through natural selection), and the scientific method (data collection informing theory) are all paradigms. These frames allow scientists to rapidly progress in their mission to better understand nature. If science needed to validate with each experiment the presence of gravity or of atoms or of each chemical structure, envisage how much more slowly it would advance. Established first principles allow scientists to interpret rigorous, reproducible experiments with ease and thereby efficiently improve prediction for how the world works.

Scientific progress has not only established its own expectations but also America's. Advances in public health, for example, have led you to assume that your household tap provides clean water—you would be dismayed if out came a liquid that was brownish-orange. You assume that the food you eat is safe—certainly not that it will give you a case of bloody diarrhea.

Frames have several characteristics that impact innovation. First, frames are not permanent—they can change over time and with context. This turns out to be good for innovation because creativity (as you will later see) benefits from frame shifts. In a restaurant, it is clearly aberrant for a waitress to say, "Go to the kitchen and get it yourself." However, in other situations, this statement would be expectable. A little brother asks a big brother to fetch more pasta sauce. At best, the big brother replies, "Go to the kitchen and get it yourself." Worse, he gives the little one a shove to reinforce that it is not okay to ask. In a cooking class, a student naggs the teacher to bring more sauce. At best, he gets a negative response, or worse, a lower grade. So your reaction to "Go to the kitchen and get it yourself" all depends on context.

Let’s say you are a very frequent flier. You are on a plane bound for a usual destination. Headphones on, listening to a lazy Schubert waltz, you are happily focused on practicing a scientific talk. You barely notice those couple of bumps the plane takes as it descends through the clouds. Even when you take a pretty deep drop, you smirk at the other wide-eyed passengers, knowing that in Houston, in April, the thermals always make for a bumpy landing.

Now let’s consider other contexts and see what happens to your frame, your expectations. What if you were a journalist embedded with the 13th Marine Expeditionary Unit flying on a dangerous reconnaissance mission in Afghanistan? What if you were on a single-engine Cessna 172 wandering into an unexpected rainstorm? How about if you were Orville Wright on one of his first attempts at manned air flight? Pretty different
expectations, eh? Those circumstances change your reaction to the plane taking an unexpected dip. But would you worry that the laws of physics might change during your flight? Likely not.

Some frames that guide your experience are relatively fixed. Your sense of security about the laws of physics remains constant even while place and time affect your level of anxiety about the risk of flying. Similarly, in an undeveloped country, your assumption about the chemistry of water does not change even while your expectations about the purity of what will come out of the hotel tap do.

Imagine your expectations if you were a scientist working before Robert Koch and Louis Pasteur formalized the germ theory in the 1860's and 70's. Microscopy had been available since 1670 when Anton Van Leeuwenhoek visualized cells within plants and animals. After the discovery by Siebold in 1865 that bacteria are unicellular, scientists like you were regularly recognizing microbes within diseased human tissues. But what did the presence of such bacteria mean? Today, of course, scientists know that microorganisms in those tissues are pathogenic. Yet as a pre-germ theory scientist you had no context for such an interpretation. Instead, you were steeped in the idea that bacteria spontaneously generate. The line of reasoning was that if bacteria simply mysteriously arose in fetid meat, the same agents could spontaneously (and meaninglessly) arise in human organs.

Only after Pasteur and Koch established that specific diseases are caused by specific bacteria did you and other scientists have a context for understanding what you saw under your microscope. Before that revolutionary innovation, disease seemed to appear out of nowhere and thus could never be prevented. Afterwards, you understood the cause of infectious diseases and Joseph Lister spearheaded antisepsis.

A second characteristic of frames is that breaking them arouses strong emotions. This turns out to be bad for innovation because frames are thereby all the more hard-wired. Take that flight with the 13th Marine Expeditionary Unit. A plane dropping in Houston in spring is expected. A plane dropping in Afghanistan is not. When this happens, you don’t “alter your assessment.” In fact, you don’t think at all. You hold your breath, break into a sweat, and dig your fingernails into the flesh of your fists. You are terrified. Even before you hear that “Pop,” “Pop” around you, your assumption is the plane has dropped because it has taken enemy fire.

When frames are broken, such as in, “Go to the kitchen and get it yourself,” you experience confusion, embarrassment, and/or anger. When your plane descends unexpectedly in Afghanistan, you panic. Your reaction upon experiencing a frame break is immediate and visceral.

If I said, “I have a great new paradigm for the science of city planning. Let’s eliminate all traffic signs and signals from inner city streets and intersections.” Would you react by stopping and thinking about all the pluses and minuses? No. You would think to yourself, “This is madness. Get this dangerous woman locked up.”

But seven European cities have, in fact, removed all their inner city traffic signals.

According to Hans Monderman, the Dutch inventor of this idea, “The greater the number of prescriptions, the more people’s sense of personal responsibility dwindles.” In the town of Drachten, where the experiment is being tried out on a large scale, traffic planner Koop Kerkstra reports that the only two rules remaining are “Yield to the right,” and “Get in someone’s way and you’ll be towed.” The absence of traffic lights and signs means that drivers must proceed slowly and carefully rather than relying on external cues. This focuses their attention very acutely on other cars as well as bicyclists, moped riders, and pedestrians. Driving becomes an activity that is not for the faint of heart. This clears out traffic and may make roads safer. Remarkable, isn’t it? There are all sorts of logical reasons to remove traffic signs and signals from inner city streets—and you had such an immediate negative reaction.

The point is that cognitive frames are not just logic. They are a mixture of logic and passion. Their force in shaping the way we perceive and respond to our world is in their ability to elicit both reason and emotion.
In both daily life and in science, a common reaction to a frame or paradigm break is rejection.

A final characteristic of frames, and their most anti-innovative, is that frames are constraining. This constraint is useful in that it provides efficiency and predictability in the customary process of thought. Huge volumes of sensory input and complex social interactions are handled via frames with efficiency and effectiveness. Using frames, you quickly size up situations and prepare to react. But frames also limit the range of your thoughts. You assume that the waitress is crazy; you don’t imagine that you are on the TV show “Hidden Camera.” You assume that orange-brown water is tainted; you don’t envision that the color represents a new indicator for chlorination. Rather than juggling in your mind multiple possibilities, you jump to a single interpretation. Frames limit novel ideas, and this has consequences.

Frames in science, that is paradigms, can also be constraining. Paradigms necessarily narrow the range of hypotheses that scientists propose and the experiments they undertake. Like any other frame, paradigms can be constraining, emotionally laden, and entrenched but not immutable.

Before Jane Goodall devoted the second half of the twentieth century to studying chimpanzees in Gombe National Park, scientists thought of Pan troglodytes as unthinking, unpredictable animals. Chimps startled by teams of researchers barging into their habitats reacted with threat displays. Scientists labeled chimps as chronically aggressive, lower beasts. Despite the fact that Darwin’s evolutionary theory had, a century earlier, directly linked humans to primates, the deeply held paradigm was that behavior among humans and primates was entirely distinct.

What differentiated Jane Goodall from her colleagues was, in part, that she was untrained. Without a baptism in the prejudice of human superiority, her hypotheses were agnostic about the meaning of chimpanzee behavior. She did not approach the chimps in a posture of domination. Instead, she hid. At first, the nearby chimp troupe, aware of her presence, exhibited sometimes cautious, sometimes menacing behaviors. But Goodall did not immediately interpret this as proof that chimps are chronically aggressive, and she continued to watch until the animals went back to their normal habits. Then Goodall watched some more. Within a year, a discovery emerged that was none other than revolutionary. Chimps take branches, strip them of leaves, and use them to extract termites from termite nests. In other words, Goodall reported that chimpanzees, like humans, make tools.

Many learned experts proclaimed that this could not be. Tool-making, they asserted, is one of the sentinel behaviors that makes humans unique.

Undeterred, Goodall returned to the Gombe. In 1986, she published the massive tome: The Chimpanzees of the Gombe: Patterns of Behavior. In it, she again revealed a series of bombshells. Chimpanzees interact using highly complex social conventions that, passed down through generations, can only be defined as culture. They engage in cannibalism, persistent male battering of females, and adolescent-led intercommunity raiding, some motivated by revenge. Chimpanzees grieve and protect other family members. All of these chimp behaviors blurred the distinction between primates and humans.

Although Goodall was initially discredited for her lack of training and unusual methods, her findings were eventually accepted. Goodall’s work, considered narrowly, changed the experimental method for studying animals. More holistically, it shattered conventional beliefs that human behavior is uniquely superior. Before this paradigm shift, calling someone a chimpanzee would have been a profound insult. After the shift, such name calling would at most extract a smile.

Goodall encountered a limiting, entrenched, emotionally laden scientific paradigm. Using novel methods that were un tarnished by a priori assumptions, she shed pre-existing hypotheses. She frame-shifted. She innovated.
EXERCISES

1. To get a sense of how powerful frames are, take a look at these images. You will likely have an immediate association. Can you think of anything else they may be?

2. There is something odd about this map of the United States. What might the reasoning be for the reframing?

Source: The York Group (http://www.theyorkgroup.com/)

3. Consider the following mismatches between expectations and occurrence:
   - Walk into a classroom: What might happen that we would find really strange but, in another context, would be completely in keeping with your predictions?
   - At a scientific conference on bio-engineering, a speaker steps behind the podium and does something really jarring that would be expected in another context. What might it be?

4. Design an experiment that might arise from each of the following divergent frames regarding the policy of military vaccination. First frame: mass vaccination is necessary to protect against possible bioterrorism. Second frame: mass vaccination is an involuntary intrusion foisted on a captive population.
Say It Like You Mean It

“The metaphor is probably the most fertile power possessed by men.”
—Ortega Y. Gasset

Frames are deeply tied to language. They form the meaning behind your utterances. In turn, language strengthens your frames. The bi-directionality between frames and linguistics (called the Sapir-Whorf hypothesis) means that speech and frames are constantly reinforcing each other. What you say reveals what you mean; your expectations are fortified by patterns of speech.

The fact that what you say expresses what you believe seems fairly obvious. “Bigger is better.” Your frame provides the meaning. This may mean spend big now/get big car now in Western society versus save big now/get small car now in certain Eastern cultures. Same phrase—different frames—different meaning.

A less obvious insight is that language reinforces frames. How does that happen? Recent experiments have shown that English speakers tend to attribute cause. The English statement is: “John broke the glass.” But in Spanish and Japanese, the expression would be “The glass broke itself” (in Spanish, “Se quebró el vaso”). This turn of phrase actually appears to determine native speakers’ expectations. Caitlin Fausey at Stanford University in 2010 published some intriguing studies on how speakers of English, Spanish, and Japanese reacted to videos of people breaking eggs, popping balloons, and spilling drinks, either purposefully or accidentally. When later asked who had the accidents, the Spanish and Japanese speakers were less able than the English speakers to remember (although they readily remembered who committed purposeful acts). That is, speakers of languages that avoided attribution were less likely to assume that someone was to blame.

Similar observations have been made linking language to frames around time and space. Speakers of languages in which direction is not “right or left” but instead “north, south, east, or west” have better spatial orientation. If I ask you to close your eyes and point to the north, you, like most other westerners, would be hard pressed to get the direction correct. But any 9-year-old Australian aborigine would find such a task laughably simple. People speaking Kuuk Thaayorre greet each other not with “Hello” but with “Where are you going?” And the answer to this greeting might be, “A long way to the north-northwest.” So if you speak Kuuk Thaayorre, when you say “Hello,” you are relating your expectation that life is a compass. Your every greeting is reinforcing your direction-intensive frame.

The linguistic element that conveys your frames is the metaphor. Metaphors equate one concept (typically more abstract) to another (typically more concrete). “Bigger (concrete) is better (abstract)” is a metaphor. Metaphors are the essence of the potent mental pictures that both reflect and shape your thinking. As representations of frames, metaphors influence the way you think. Indeed a well known metaphor describes much of what we have been talking about: creative thought outside of habitual frames. It is “thinking outside the box.”

Metaphors are almost as ubiquitous as frames so, not surprisingly there are many types, a few of which are described here. Structural metaphors are a general category that describes abstractions more concretely. An example is: “Time is money”. “Time is money” conveys the frame that time is a limited resource and a valuable commodity. The inference is that time used other
than purposefully is wasted. Like any frame, "Time is money" is contextual. Not all societies accept the assumption of time as a kind of produce.

Oriental metaphors relate a spatial dimension to a more abstract concept. Metaphorically, up is good (e.g., "I feel up" and "Moving up in the world") and down is bad (e.g., "I feel down" and "I've been taken down a notch"). Up and down metaphors, representing good and bad frames, have real consequences. Taller people are of higher socio-economic status and more sexually desirable. Living on a hill is a sign of status.

Ontological metaphors portray experiences as objects or substances. This makes experiences easier to quantify and categorize. "I've got a mountain of work to do," quantifies the work as a lot because we associate mountains with being tall or large. "I can feel the magnetism between us" portrays love as a physical force.

Metaphors are everywhere, and their influence is pervasive. The following are all cooking metaphors. All represent frames and all heighten the phrase's level of vibrancy. For example, "He was burned by her refusal." Rejection is painful. But, you could cool down (another metaphor) the phrase by simply saying, "He felt rebuffed." Moreover, the frame is cooking: hot, sizzling, steamy—is your temperature rising?

- She knew she was going to be toast after her boss read her review. Toast refers to a burned and thus bad outcome.
- The worried parent grilled the child who returned home long after curfew. Tough questions apply heat to the recipient.
- He knew his team was cooked when the other team members all turned out to be twice their size. Cooked implies being defeated or finished.
- He was burned by her refusal. Rejection causes damage similar to meat cooked.
- The plan was half-baked. Not finishing the planning process is like cooking.

Metaphors have the same characteristics as frames. First, as you just saw, they are omnipresent. Second, metaphors are laden with emotion. George Lakoff, author of *Metaphors We Live By* (2003), describes metaphors as bringing together objective information (the real things we encounter) with imagination (the way we constructing meaning). Metaphors convey what Lakoff calls "imaginative rationality." Consider the terms "illegal aliens" and "economic refugees." They both describe non-nationals moving to our country while eliciting very different visual imagery. But both illegal aliens and economic refugees produce a stronger emotional kick than, say, "Non-nationals moving to our country." Thus, metaphors, like frames, grab at your heart strings and leave a lasting impression.
Third, metaphors are entrenched. Like frames, metaphors limit your thought patterns. If you believe Douglas Hofstadter, author of the Pulitzer Prize winning novel *Goedel Escher Bach* (1979), metaphors and the frames they represent organize your very memories. Why is it that we remember things in chunks: a written fact linked to its location on the page; a recalled experience when we revisit a place? According to a theory posed by Hofstadter in a Stanford lecture in 2001, it is because metaphors organize memories. Such a cognitive design around framed/metaphorical chunks explains two curiosities: why babies do not remember events and why each year seems to pass more quickly as we get older. His answers are that the young child has not yet learned to chunk. Babies see distinct events and cannot combine these into readily stored, related sets of concepts. “It is as if babies were looking at life through a randomly drifting keyhole, and at each moment could make out only the most local aspects of scenes before them. It would be hopeless to try to figure out how a whole room is organized, for instance, given just a keyhole view,” said Hofstadter. He uses the same idea to explain why life seems to accelerate with age: As people get older, they store information into larger packets and fewer chunks. Thus experiences seem sparser with each passing year. Surely if frames/metaphors are the file folders for memories, it goes without saying that the representation and organization of those file folders would restrict your patterns of thinking.

Metaphors, although entrenched, are not immutable. They can change and they can alter underlying frames. Indeed, the creation of a metaphor can so define a new concept that it can literally bring it into being. Back in the 1800s you would not have felt “spaced out” because such a feeling with its exact connotations had no label and did not in its present sense exist. Similarly you could not have had the experience of “blasting off,” “coming up for air,” and surely not “being wired.” Newly created metaphors can actually bring a concept into being. Your experience of the world is nuanced by the available metaphors.

A single word can also be defined by more than one metaphor, reflecting a complexity of shifting frames. Ideas can be plants, as in, “His ideas have finally come to fruition.” Ideas can be food: “All this paper includes is half-baked ideas and warmed-over theories.” Fashion can be a metaphor for ideas: “That idea went out of style years ago.”

In so far as metaphors and their frames systematize your memories and add an emotional valence, metaphors really matter. Metaphors can influence questions of profound import. Is a military attack against another nation a rape, a threat to our security, or the defense of a population against terrorism?

Metaphors can change meaning, and metaphors themselves can change. Fortunately for creativity, that means that by way of metaphors you can voluntarily alter frames. One of your best tools to identify a frame or paradigm and then shift out of it is your friendly neighborhood metaphor.

**EXERCISES**

1. Consider the metaphors “Child-bearing hips” or “I like a woman with a little meat on her bones” and the metaphor “We’ve got a big fat problem.” What do they mean? How might you react to them if you are in the United States? In India? At the time of a food crisis?

2. Make a metaphor: List as many metaphorical phrases or clichés as possible using the following words: death, time, compliance with rules, discovery, overeating, lack of exercise.
Overcoming Metaphors

“Stone which does not regenerate is the only thing in nature that constantly dies.”

—Francis Ponge

Frames are so central to your thinking and functioning that they are like powerful drugs. In Alcoholics Anonymous, the first step to recovery is admitting that one cannot control one’s addiction or compulsion. Controlling frames is not entirely feasible either. It is too much to expect that you will have no visceral reaction when someone next cuts you off on the freeway. A more attainable goal in regulating your reaction to frames is recognition. Once recognized, you can work to construct alternative frames. Metaphors are a practical means for recognizing frames.

Why do so few Americans have advanced directives, otherwise known as living wills? In a population study of people of age 50 years on average conducted in Sioux Falls, South Dakota, only 30% of respondents said they had a living will. Another survey conducted among patients with terminal illnesses found that only half had written directives (e.g., resuscitation, living on a respirator, force-feeding). Without these instructions, doctors must assume that patients want everything done. This explodes societal costs at the end of life. About one quarter of all Medicare dollars are spent on patients in their last year of life, the majority in the last sixty days. Some of these expenditures are unnecessary or even unwanted. Organ donation also suffers from the lack of advance directives because the best time for patients to agree to give a gift of life to others is while they still are able to decide.

The usual framing of death is that it is frightening and mysterious. “I’m scared to death. Dead zone. The void. The grim reaper. Time’s bony hand grasping the soul. The eternal abyss.” Death implies awe, fear, and guilt. Not surprisingly, patients and their families acting within this frame have a terrible time discussing death.

Reframing the problem entails envisioning an alternative frame. Again this can be accomplished through metaphor. Benjamin Franklin once said, “Nothing can be said to be certain except death and taxes.” Could this aphorism represent an alternative frame? “Death and taxes” is a metaphor that removes the awe. It links death to something that is less feared than disliked. Advance directives become something that is grudgingly tolerated; something downright bureaucratic. The old frame represented fear/guilt, whereas the new one represents distasteful obligation.

Could such an alternative framing help patients decide how they want to die? Consider a procedure wherein every year, when you submit your taxes, you are required to also submit a tax-like “Advance Directives” form? The form would consist of check-off choices just like a tax form but with each check-off box representing an end-of-life preference. Almost surely you would think about the options. Likely you would discuss the matter with loved ones.

Death as fearsome—death as a bureaucratic necessity—the frame is mutable. The initial frame restricts solution finding. The alternative expands the range of possible solutions. Reframing through revising metaphors can be a powerful tool for innovation.

Another ubiquitous metaphor is the one we use to communicate how science and medicine relate to disease. War. “The war on cancer...fighting diabetes...battling infectious disease...eliminating a scourge.”
implication when fighting a war is that there will be a winner and a loser. In the war on disease, humans believe we have no choice other than to be absolutely victorious. Success is judged by the degree to which disease has been eradicated.

But is it always judicious to rid the population of every last bit of disease? Consider the controversy over mammographic screening to detect breast cancer in women ages 40 to 49 years. Fierce debate has arisen and re-risen around this question. On the one hand, can we allow even a single woman to die from a preventable cancer? On the other, is it acceptable to engage in a program among younger women in which a far greater number of non-cancer abnormalities will be detected than cancers? In a risk assessment conducted by the prestigious national panel, the U.S. Preventative Services Task Force in 2009, the estimated number of women needing to be screened to detect one breast cancer among 40–49 year old women was 1900. While less than 1 per thousand screened women will have a cancer detected, about 1 in 10 will have a false positive test. The cost—both psychological and monetary—of the large burden of needless invasive procedures required to detect every possible cancer among young women is thus great. If it were clearly best to eliminate all disease no matter the cost, then there would be no dispute. The dispute suggests that the war metaphor is not ironclad.

On an individual level, “cancer as war” also has flaws. Cancer patients forge ahead with aggressive treatment, often without seriously questioning its harms. Chemotherapy is a poison not only to the cancer cells but to normal host tissues. Radiation burns away tumor but also damages adjacent tissue. In the case of uniformly fatal tumors, is it better to continue at all costs to extend life even if it is at the expense of quality of life? Some would say “No,” and instead elect for non-curative palliative care. If our relationship to cancer were truly an out-and-out war, then we would not stop to consider collateral damage. We would poison and burn until victory or death.

The “cancer as war” metaphor makes us less likely to think about cost (to the population or the individual) and more likely to seek conquest. Consider an alternative metaphor: “Cancer as neighbor.” If you are like most people, then you react to this idea with outrage. You think, “I’m not about to walk around with some cancer eating me while I invite it to have more dinner.” But consider Robert Frost’s notion that we don’t have to be hospitable to neighbors, only to live beside them. “Good fences make good neighbors,” he wrote. “Cancer as neighbor” is a metaphor that denotes a frame shift: “Coexistence with cancer.” Limited tumors rarely kill us—metastases do.

What if our basic research approach to cancer moved from a focus on elimination to a focus on containment? Rather than striving to destroy every single cancer cell, this alternative strategy focuses on strengthening our body’s immune defenses so as to limit a tumor’s spread and metastases. A branch of cancer science is exploring harnessing immunological mechanisms so as to limit metastatic growth without harming the rest of our bodies. Who knows if this new avenue of research will be productive, but it is certainly worth a try.

Let’s see how metaphors can help you to innovate. Going back to the systematic, stepwise approach to frame-shifts, this time your task will be to identify the frames with the help of metaphors. Bringing metaphors into the approach, the steps are now these:

Step 1: Develop an awareness of the current frame in part using metaphors.
Step 2: Consider consequences of the current frame.
Step 3: Devise an alternate frame with the help of metaphors.
Step 4: Consider consequences of the alternative frame, both positive and negative.

Example 1: Life.

1. Frame—gambling game. Metaphors: I’ll take my chances. The odds are against me. That’s the luck of the draw. Where was he when the chips were down? He’s a real loser.
2. Consequences—The approach to future health (among some) is one of risk-taking. For example: the gambling metaphor might lead to intermittent or no barrier contraception use, smoking, drunkenness, unsafe speed driving.

3. Alternative frame—take no risks. Metaphors: *Life is all we have*. *Life is sacred.*

4. Consequences—This alternative frame with its associated metaphors suggests that protection trumps risk-taking. Prevention becomes paramount. On the other hand, screening can go too far (no experts, for example, recommend mammographic screening for average risk populations under age 40 years). Another concern is how much can we legislate?

Example 2: *Discovery.*

1. Frame—causation is viewed as the emergence from a source, similar to birthing a physical object (a baby) from a container (the mother). Metaphors: *Edward Teller is the father of the hydrogen bomb. He conceived a brilliant theory. Universities are incubators for new ideas. His experiment grew from a fertile imagination.*

2. Consequences—Implications of the emergence frame are that ideas must be nurtured and defended just like children. Thus scientists should continue along a line of reasoning and defend that reasoning even when it does not fully explain all observations.

3. Alternative frame—ideas should be spawned and left to fend for themselves. Metaphors: *Toss out a new proposal and see if it sticks. Go out with your idea and spread the gospel. The only way to prove something is to repeat it.*

4. Consequences—This alternative suggests that the object is to generate novel approaches/concepts/theories but to let others try to defend or refute them. In this way, the assessment of new ideas will be unbiased. Flaws in established ideas will become evident more quickly and new theories will arise more readily. On the other hand, if the scientist who spawned an idea does not defend it, perhaps no one else will.