Chapter Four

COMPETENCY #2—
KALEIDOSCOPIC THINKING

[Edison has a] remarkable kaleidoscopic brain. He turns that head of his and these things come out as in a kaleidoscope, in various combinations, most of which are patentable.
—Western Union patent attorney Edward Dickerson

Thomas Edison loved ideas. He loved to generate new concepts, and to combine familiar concepts in original ways. He expressed his delight in idea generation and exploration when he commented, “I would like to live about three hundred years. I think I have ideas enough to keep me busy that long.”

As Dyer and Martin observed:

Edison’s inexhaustible resourcefulness and fertility of ideas have contributed largely to his great success, and have ever been a cause of amazement to those around him. Frequently, when it would seem to others that the extreme end of an apparently blind alley had been reached, and that it was impossible to proceed further, he has shown that there were several ways out of it.

Edison reveled in the process of defining and solving problems from diverse angles, and this made his mind especially fertile. In a diary entry on July 12, 1885, he celebrates the workings of his own “mental kaleidoscope,” which he used to “obtain a new combination of ideas.”

Kaleidoscopic thinking is our phrase for Edison’s extraordinary approach to idea generation. This competency is an innovator’s toolbox for outgunning the competition through original thought.
The kind of creative thinking Edison espoused is often suppressed in most schools today. Fortunately, it can be relearned in adulthood.

The Elements of *Kaleidoscopic Thinking* are:

6. Maintain a Notebook
7. Practice Ideaphoria
8. Discern Patterns
9. Express Ideas Visually
10. Explore the Roads Not Taken

**ELEMENT 6: MAINTAIN A NOTEBOOK**

What do Leonardo da Vinci, Isaac Newton, Pablo Picasso, Charles Darwin, Marie Curie, Albert Einstein, and Thomas Edison all have in common? They all kept notebooks.

In his teenage years as well as at Menlo Park and beyond, Edison recorded his thoughts, observations, and visualizations in notebooks. Like other great minds, Edison jotted down his thoughts freely. His notebooks contain fragments of ideas and plenty of pictures. This daily practice helped him sharpen his observations, develop new ideas, and make creative connections between diverse aspects of his research.

Edison loved nature and keenly observed his surroundings from the time he was a young boy. He continued recording his observations about the natural world throughout his life by jotting down his observations in notebooks. When Edison was twenty and living in Cincinnati, he was, according to Paul Israel, “in the habit of using small pocket notebooks to make ‘notes and diagrams’” to record his thoughts about the world of nature, or noting the results of his experiments in chemistry and telegraphy. Edison and his laboratory staff generated more than 2,500 notebooks in his lifetime, most 200 to 250 pages in length, and ranging in size from 8.5" × 6" to 9" × 11". Edison always had a pocket notebook at the ready, and used these to augment those he maintained in his laboratory.

In addition to serving his creative process, Edison’s notebooks also secured his intellectual property. In October 1870, Edison met Lemuel Serrell, a noted patent attorney. Serrell advised Edison to maintain careful records of his ideas, and that “such a record would be essential to defend his inventions in the patent office or
In 1928, Edison jots an entry in one of the more than 2,500 notebooks he generated with his staff. His distinctive handwriting makes Edison's notations easy to differentiate from those of his laboratory compatriots.
in the courts.” After receiving this advice, Edison wrote in his notebook, that for “all new inventions I will here after [sic] keep a full record.”

Edison took Serrell’s counsel to heart and began dedicating notebooks for specific uses. In the summer of 1871, Edison created a series of four notebooks which would serve as official records “to be used in any contest or disputes regarding priority of ideas or inventions.” He named the four notebooks as follows: 1) Gold & Stock Telegraph Co., with the first page reserved for “any ideas contained in this book which I do not see fit to give said G & S Telegraph”; 2) Record of Ideas day by day applicable and for the Dot and Dash system of fast Telegraph invented for Geo Harrington and D H Craig; 3) Dot and Dash and Automatic Printing Translating System, Invented for myself exclusively, and not for any small-brained capitalist; and 4) Ideas conceived, and experiments tried on miscellaneous Machines and things.

As Edison gained fluency in maintaining several notebooks for different purposes, he also began writing in many of them, “I do not wish to confine myself to any particular device.” This statement not only served a legal purpose—allowing his ideas to be directed for multiple different kinds of patents—it expressed Edison’s love for working on multiple projects simultaneously.

Edison’s notebooks expressed the remarkable functioning of his kaleidoscopic mind. The notebooks made it much easier for him to make connections between his multiple projects and diverse areas of investigation. One of his most inspirational moments of connection came on his visit to the laboratory of inventor William Wallace in September 1878. In a flash, Edison instantly connected all he knew to that point about electricity and incandescence. He realized that an electrical current could indeed be subdivided and he saw how it could be done. As he phrased it, “I have struck a big bonanza.” This bonanza of inspiration was, of course, predicated on the perspiration he had invested through his reading, experiments, and notebook work. And what did Edison do when the inspiration flashed in his mind? He immediately grabbed his notebook and began scribbling ideas.

Through Edison’s use of notebooks, the tangible world of experimentation met the intangible world of imagination. The award-winning linguistics research of University of New Mexico professor Vera John-Steiner, author of Notebooks of the Mind, helps us appreciate this essential aspect of Edison’s kaleidoscopic thinking. John-Steiner’s research shows that notebooks can provide a crucial bridge between the raw thought of the “inner world” of our minds and the “outer world” of speech. John-Steiner helps us understand the value of
Edison's notebook drawing of a telegraph escapement mechanism, dated 1871.
recording ideas, as Edison did, in a fragmentary and incomplete fashion. She explains that even though our internal thoughts are often fragmented, clumsy, and imperfect, they are also highly symbolic. Raw ideas represent a “highly condensed language of thought where each word may stand for manifold ideas.” In terms that Edison would particularly enjoy, she points out that our inner speech is like “telegraphic thought,” where “a single word is so saturated with sense that many words would be required to explain it in external speech.” Use of this tele-
graphic style in keeping a notebook “makes it possible to gallop ahead, exploring new connections” without needing to “stop and explain specifics in precise, readable prose.”

Take a look at the Edison notebook entries shown on pages 87 and 88. Here you can see Edison’s “telegraphic thought” represented in both words and sketches. They are not neat and tidy. Words and pictures are often scrawled on the page, imperfectly formed. This is the “saturated sense” that John-Steiner describes, where each word and image is fuller in meaning than can be described in the moment of creation.

These notebook entries represent the raw beginnings of ideas that Edison later fleshed out into fuller form, ideas leading to innovations that changed the world.

Creating Innovation Literacy: Maintain a Notebook

Do you have to do any writing as part of your job? If you do, chances are that whatever you write will be read and evaluated by others. Most of the writing we do at work must have a beginning, middle, and end. It must demonstrate a clear logical flow or your message won’t communicate its meaning to others. If you go on a business trip you will probably need to fill out an expense report when you return; even if you work at a very innovative organization, chances are that your boss is unlikely to suggest that you “Be creative!” or “Just make something up.” Most of the writing that is done in the workplace—expense and other reports, proposals, plans, and memoranda—must be well reasoned, organized, and the numbers must add up properly. This kind of linear thinking is important to the everyday running of a business but it is not conducive to generating new ideas.

The beauty of maintaining a notebook as Edison did is that you can express yourself freely in nonlinear fashion. By recording your incomplete, fragmentary associative process you stimulate and inspire new highly saturated streams of thought. Begin by acquiring a blank-page journal or bound notebook. If you prefer, you can, of course, use your computer or PDA for the same purpose. You can dedicate different notebooks to specific subjects as Edison did and/or use one for all your observations. There are many ways to approach working with a notebook. Here are some tips to help you get the most out of your notebook.

• Find the best time for you. Some people like to devote a set time in the morning or evening to make their notebook entries while others prefer to use it at
the moment they feel inspired. Experiment with the timing that works best for you.

- **Generate first, then organize.** A notebook invites you to freely express all your thoughts and feelings without having to hold anything back. Unlike business or academic writing, no one will criticize or judge it. Avoid allowing your own internalized critic to censor or edit your writing. If your notebook process leads you to generate an idea that you want to develop for practical use, you can then choose to critique it.

- **Use your notebook to record information.** As you record ideas, facts, stories, quotes, definitions of vocabulary words, jokes, and any other information that you find intriguing or inspiring, you’ll discover that the recording process helps stimulate your production of new ideas and associations.

- **Doodle and draw!** In addition to words, the notebooks of Edison, Darwin, Leonardo, and many other great minds contain sketches, doodles, and drawings. Playing with images will stimulate your imagination.

- **Choose a theme.** Your notebook invites you to “free associate” and move from one topic to another. But sometimes a theme can help inspire and motivate you to greater depth. Julia Cameron and Mark Bryan, authors of *The Artist’s Way at Work*, offer many practical work-related themes for notebook exploration, such as: How do I stay creative in a hostile and competitive environment? How can I remain creative despite criticism? How can I clarify and apply my strengths to my work? How can I handle an impossible workload?

- **Experiment with stream of consciousness.** Start writing in your notebook—or typing on your computer—and don’t stop for at least ten minutes. Just keep the words flowing onto the page even if it seems that you are generating gibberish. This is a great way to burn through your habitual associations as you generate new connections.

Dr. John Wai, Director of Medicinal Chemistry at Merck & Co., Inc., comments on the value of keeping a notebook:

Writing down my ideas frees up my brain from remembering so many details, especially if the ideas are branching out in many directions. It’s like a sketchbook of an artist, or a burst of beautiful harmonies or chords written down by a composer. To me, a notebook is a medium to nurture and capture my creative thinking, not an archive of my thoughts. The contents range from random
thoughts, to detailed analyses, to how best to present certain things visually. There are also a lot of half-baked ideas and dead-end mental exercises!

Like Edison, Wai translates his nonlinear musings into practical innovation. He comments,

For two years, our team was focusing on a series of promising leads for optimization as drug candidates. For the same two years, I thought of many other distinctly different structures that could offer significant advantages to what we were working on. As resources became available, I went through my notebook and worked on two that I perceived as better ones. Both worked!

**ELEMENT 7: IDEAPHORIA**

| To have a great idea, have a lot of them. |
| — *Thomas Edison* |

The word “idea” comes from the Greek *idein*, which means “to see.” Euphoria is a state of delightful well-being. Ideaphoria is a neologism for the delightful well-being that accompanies the effortless flow of insights and ideas. We use the term to refer to Edison’s approach to generating new ideas. He used three primary methods to generate ideas rapidly, and on command: word association; analogical thinking; and fantastical storytelling. These methods are relatively easy for adults to learn and apply, and all will generate tremendous results.

Edison began his three-stage ideaphoria process with raw association. Through using his notebooks, he created associative linkage between the ideas and experiences he already had with new ideas inspired by what saw in the world around him, or in the laboratory. He formed a habit of noting down his thoughts and regularly reviewing what he had written the previous day. He also regularly reviewed material from prior weeks and even years. His reviews inspired further torrents of possibilities and, as ideas flowed, he jotted them down in his notebooks. He didn’t worry about whether he was right to begin thinking along a particular path because he knew that no matter where he entered the process, the results he sought would eventually emerge through chains of ideas all linked together. The order did not matter to him at this stage.
Edison’s associative thinking “produced page after page of possible approaches to the problem” at hand. A member of his staff who’d worked with Edison for twenty years remarked: “Edison can think of more ways of doing a thing than any man I ever saw or heard of.”

In one classic case, Edison asked one of his engineers to submit some sketches representing possible approaches to the creation of a new piece of specialized ore-milling machinery. The engineer generated three drawings that he promptly submitted to his boss. Edison wasn’t satisfied, but the engineer protested that there was no other way to proceed. As Dyer and Martin recount the conversation, “Mr. Edison turned to him quickly and said: ‘Do you mean to say that these drawings represent the only way to do this work?’ To which he received the reply: ‘I certainly do.’”

This exchange took place on a Saturday afternoon. After a day off, Edison stopped by the engineer’s desk first thing on Monday morning and casually handed him a folder that contained forty-eight different designs for the new equipment. And, Edison’s prolific idea generation wasn’t just an academic exercise; one of his sketches formed the basis for the successful development of the new equipment.

Although it was rare for Edison to boast about his own genius, he admitted to being prolific with ideas. “I speak without exaggeration,” he noted to a reporter, “when I say that I have constructed three thousand different theories in connection with the electric light, each one of them reasonable and apparently likely to be true.”

**Analogical Thinking**

Analogical thinking is a way to generate insights by bringing together ideas that at first seem quite different from one another, but are later seen to be related in some way. From his early days in Port Huron and throughout his adult life, Edison reveled in literary analogy and metaphor. Edison’s enthusiasm for classical literature, particularly Victor Hugo, led his telegrapher chums to give him the nickname “Hugo.” Edison particularly admired Shakespeare’s use of metaphor and analogy. Shakespeare’s famous line, “Now is the winter of our discontent,” appears in several of Edison’s notebooks. In this metaphorical sentence, a season—winter—is likened to an emotion—discontent. The bringing together of these two disparate ideas yields an image that transcends simply saying, “It was cold and depressing outside.”
Edison believed analogical thinking was fundamental to his invention process. In a 1915 interview, he stated that he considered “‘a logical mind that sees analogies’ to be an essential quality of an inventor . . .” When developing the incandescent light bulb, Edison realized that the flow of electricity through wires or other filament substances he was examining was like the flow of a message through telegraph equipment.

When developing a high-efficiency generator that more than doubled the output of existing generators, Edison “treated the magnetic lines of force in [the] generator as analogous to the internal currents of a battery and compared the flow of current in an armature with that in a battery.”

Analogies also played a critical role in Edison’s invention of the phonograph. Edison’s deep knowledge of telegraphy allowed him to think of the telephone as a form of telegraph. Grappling with how to produce a written record of incoming telephone messages, Edison envisioned using a recorder similar to the embossing recorder-repeater he was then developing for Western Union. He began asking himself how the recording of telephone messages from a telegraph-like instrument could behave in ways similar to the recorder-repeater. He then drew an analogy between the operation of the recorder-repeater and the indentations created by mechanical embossing technologies he’d developed for the electric pen. All these analogies came together in Edison’s “talking machine.” And then he used analogy again in envisioning the creation of the motion picture camera, “. . . an instrument which does for the Eye what the phonograph does for the Ear.”

Contemporary research into the nature of practical intelligence confirms that analogy is one of the mind’s most powerful problem-solving tools. John Clement of the University of Massachusetts has conducted wide-ranging research on how higher-order thought operates. Much of it begins with analogical thinking. Clement discovered that a key element in the mind of an innovator is the ability “to generate analogies both within and across disciplinary boundaries.”

**Fantastical Storytelling**

Edison’s third ideaphoria technique was to write fantastical stories and “talk out loud” about speculative ideas that fascinated him. In 1890, Edison agreed to hold
a series of interviews with George Parsons Lathrop, a well-established reporter who married the daughter of famous American author Nathaniel Hawthorne. Lathrop, who had previously served as editor of the *Atlantic Monthly*, held an abiding belief in the power of ideas, as demonstrated by his establishment of the American Copyright League to successfully secure international copyright laws. The purpose of Lathrop’s interviews was to explore the great inventor’s mind, his methods, and his musings about the future. These he ultimately compiled into a single work entitled, “Talks with Edison,” which met with popular acclaim.

Among the extraordinary ideas they discussed were Edison’s thoughts about atoms and molecules. At the time of Edison’s interview with Lathrop, atomic theory was embryonic, Einstein was eleven years old, and Newton’s laws reigned supreme. Remarkably, Edison’s theories and ideas about controlling particles at small scales began to sound like a modern description of nanotechnology, or even genetic engineering. Lathrop describes their conversation:

But in addition to being extremely practical in his thoughts and processes, Edison has a rich imagination of a creating sort, and moods of ideal dreaming . . . One day at dinner he suddenly spoke, as if out of a deep reverie, saying what a great thing it would be if a man could have all the component atoms of himself under complete control, detachable and adjustable at will. “For instance,” he explained, “then I could say to one particular atom in me—call it atom No. 4320—‘Go and be part of a rose for a while.’ All the atoms could be sent off to become parts of different minerals, plants, and other substances. Then, if by just pressing a little push button they could be called together again, they would bring back their experiences while there were parts of those different substances, and I should have the benefit of their knowledge.

The favorable public reception to Lathrop’s “Talks with Edison” led to a proposal for a science fiction novel on the future, to be entitled *Progress*. Edison was to draft notes about what he felt would be true about the world in AD 2226, and Lathrop would do the actual writing. Ultimately, Edison devoted himself to other priorities and the proposal never came to fruition, but he did write one hundred pages of notes for the book, thirty-three of which still survive, and can be viewed online.
Edison’s “fantastical stories” and musings stimulated his imagination and led him to conceive of things that seemed impossible to others, like incandescent light, talking machines, and moving pictures.

Using the three approaches of ideaphoria—association, analogy, and fantasy—Edison suspended the world of everyday logic. He intuitively developed methods for following optimal brain pathways to generate a constant onslaught of ideas.

As neuroscientist Dr. Richard Restak states, “If you want your brain to function optimally, eliminate the tendency to deal with everything in strictly chronological terms . . . do away with the idea that the world must correspond to illusions of sequence and rational order.” As Restak and other researchers emphasize, creativity isn’t a mysterious gift; it is a natural human ability. Complexity experts Bill Welter and Jean Egmont, in their book *The Prepared Mind of a Leader*, point out that while creativity is complex, our “imagination is based on human capabilities and experiences each of us already has had and just need to practice reassembling in new ways.” Edison’s approach to ideaphoria provides a powerful guide for adults to practice “reassembling in new ways.”

**Creating Innovation Literacy: Ideaphoria**

Please try this standard creativity test to benchmark your current level of ideaphoria.

**“Alternative Uses” Exercise 1** In your notebook or on a piece of scrap paper, take two minutes and write down as many uses as you possibly can for a paperclip.

Take the total number of answers you wrote down and divide by two to calculate your score in terms of uses per minute.

The international average score is four uses per minute. A score of eight is excellent and a score of twelve or more correlates significantly with other genius-level measures of idea-generation ability.

When we give this test to groups of gifted children they invariably get genius-level scores, whereas most of our corporate clients generate average results. Why do the gifted children do so well? Because they immediately figure out that this is a test of *writing speed*. The test is purely quantitative. It asks you to think of “as many uses as you possibly can.” It doesn’t ask you to think of “uses that you can defend before a board of directors, or senior management who will determine
your pay based on the logical strength of your responses.” But, most people in the organizational world interpret the instructions through this habitual lens.

Edison intuitively understood that free association was an important element in thinking outside the box. He knew that if you want to get a good idea you must first get a lot of ideas. Try this next exercise again now that you know this clue.

“Alternative Uses” Exercise 2  This time, in two minutes, write down as many uses as you possibly can for a brick. To think like Edison, focus on pure free association. Like the gifted children, treat this as a test of writing speed. Write down answers as fast as you can without analysis or criticism. Then, after you have generated a genius-level score, go back and use your imagination to explain your off-the-wall answers.

The low score that most corporate folks get initially is indicative of an organizational pandemic that interferes with innovation efforts at all levels. Chances are that you and your colleagues suffer from premature organization: the compulsion to organize one’s ideas before generating them. Premature organization prevents conception and locks you into the box.

One of the simplest and most profound things you can learn from Edison is: Generate first, then organize. Edison’s approach to analogical thinking and fantastical storytelling offers further support for your excursion into greater ideaphoria.

Analogical Thinking Exercise  The ability to see unexpected relationships and make unfamiliar connections was a delightful trademark of Edison’s creativity. Linking things that seem to be unrelated is a wonderful way to awaken ideaphoria. Practice looking at things that, at first glance, seem unrelated and find different ways to link them. Or consider things that are obviously related and find connections between them that are not so obvious.

Experiment with drawing at least three links between the following things. There are no “right” answers in this exercise, only creative ones, so have fun.

- West Orange, New Jersey, and Shakespeare
- The light bulb and your job
Dr. Robert Langer, a 2006 inductee into the National Inventors Hall of Fame, describes the role analogical thinking has played in his ability to solve complex problems. In overcoming the challenge of developing a polymer to facilitate a drug delivery mechanism that could release a medication over time rather than all at once, Langer asked, “What if we could develop a polymer that had a surface like soap—a surface that could erode harmlessly?” Guided by analogical thinking, he and his team succeeded in developing such a polymer, which could be delivered either through a pill, an injection, or even an embedded wafer. As he notes, “Just like soap, the polymer we developed dissolves layer by layer, which makes it very, very safe to use in the body.”

Langer also recalls how analogical thinking spurred another breakthrough idea:

One day I was just watching this TV show on PBS. I really wasn’t even paying that much attention to it. I just kept seeing how they were making these chips for the computer industry, and I thought to myself, “Wouldn’t that be a great way to deliver drugs! What if you could create a microchip that could be like a drug delivery device?”

With the help of his laboratory colleagues at MIT, Langer translated this analogy into a profound advance in the technology of drug delivery (US Patent 5,797,898), an advance that has benefited countless patients around the world.

**Fantastical Storytelling Exercise: Image Streaming**  Dr. Win Wenger has been researching genius for more than thirty years. Through his Project Renaissance, Dr. Wenger explores the most effective means for ordinary people to
develop the knack of genius. One of his most intriguing discoveries is “image streaming.” Image streaming is a deceptively simple way to energize your right hemisphere and emulate Edison’s process of fantastical storytelling.

To begin, find a comfortable place to sit, and enjoy a few full, easy “sighing” exhalations to help you relax. Gently close your eyes, and then, simply describe aloud the stream of images that flows through your mind. To get the most from this simple but powerful practice you’ll want to follow these important guidelines.

Describe the images aloud, ideally to another person or to a tape recorder. Silent description doesn’t produce the desired Edisonian effect. Make your descriptions multisensory. If you see an image of a sandy beach, for example, be sure to

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FANTASTICAL THINKING IN THE COSMIC MOLECULE

Thomas Edison described our solar system as a “cosmic molecule.” His free-flowing imagination allowed him to generate ideas that were far ahead of his time. Edison used fantastical thinking to conceive of the following:

- A transatlantic cable that could use the etheric force (high-speed radio waves, i.e., wireless technology) to transmit messages
- Photography in total darkness
- Electroplating in a vacuum
- Producing electricity from coal
- Artificial silk, leather, wood, and mother-of-pearl
- Aerial navigation
- High-speed trains
- A single vaccination that could inoculate children against a variety of diseases
- Antigravitation chambers (zero gravity)
- Suspended animation
- Space travel and interplanetary telegraphy
describe its texture, aroma, taste, and sound as well as its appearance. Of course, it may seem strange to describe the taste of a beach, but remember, this is an exercise in thinking like one of the most imaginative people who has ever lived. Descriptions in the present tense are more effective in eliciting vivid imagination, so express your flow of images as though they are happening in the now.

You can do image streaming without a theme as a free-form, spontaneous adventure in ideaphoria. Image streams usually gather their own momentum and express themes without your conscious instruction. And you can also use this technique to ask a specific question or explore a particular theme, as Edison did when he sent one of his atoms out to “become part of a rose.” Dr. Wenger has used the method to develop numerous practical inventions and educational innovations.

**ELEMENT 8: DISCERN PATTERNS**

Edison cultivated an awareness of patterns in the world around him beginning in childhood. He came to believe that nature expressed itself in precise, mathematical patterns. Edison’s belief in the omnipresence of these patterns gave him unshakeable confidence that he could ultimately decipher nature’s codes. Edison revered the patterns in nature as expressions of God’s handiwork. He was astonished and endlessly fascinated by the beauty and infinite connectedness he perceived in the natural world.

He cultivated his ability to discern patterns, and all of his technological discoveries rest in one form or another on this skill. Many of Edison’s world-changing inventions were created through the recognition of patterns of connection between seemingly unrelated technologies. His passion to discover patterns helped him to understand trends, find gaps in the marketplace, and determine how technology could be applied to solve problems in new ways.

Edison began exercising his ability to discern patterns by filling in missing lines of press copy during his years as a telegrapher. As a novice telegrapher, he discovered that glitches in transmission were common. He often had to make up several sentences based on the overall pattern of the message, so that the messages would be complete. Edison quickly became remarkably adept at this, so that he could “write down what was coming and imagine what wasn’t coming.”

As an adult, Edison expanded his internal pattern database through his voracious reading, persistent experimentation, and by filling his laboratories with
specimens from nature including vast collections of ores, chemical powders, bark, plant fibers, clays, exotic metals—thousands of compounds of every description. Although he believed that the ability to perceive patterns was available to anyone, he expressed dismay that more people did not discipline their minds to do it. He noted, “It is astonishing what an effort it seems to be for many people to put their brains definitively and systematically to work.”

In his book *Blink*, journalist Malcolm Gladwell describes the ability of an expert art historian to rapidly determine the authenticity of an expensive Egyptian statue purchased years ago by the Getty Museum. The art historian studies the statue for a few moments, and confidently proclaims it to be a fake. Gladwell describes how this kind of instant—yet accurate—assessment happens in “the blink of an eye,” and expresses an “intuitive knowing.” Upon reflection, experts who make such summary judgments can usually find the basis for their conclusions. In the case of the art historian, it was the design of the fingernails that was not consistent with the pattern of the genuine article. His keen observation was an expression of pattern recognition.

Edison used pattern recognition in a similar way. He could look at reams of laboratory reports, or the summaries of experimental findings prepared by his employees, and detect erroneous data immediately. His mind seemed to process patterns in the data instantaneously. As one of Edison’s master mechanics noted:

> Edison would examine the tabulated test sheets. He ran over every item of the tabulation rapidly, and, apparently without any calculation whatever, would check off errors as fast as he came to them, saying: ‘You have made a mistake; try this one over.’ In almost every case the second test proved he was right.

Edison’s ability to detect errors quickly was manifest in his early experiments with wiring systems for the incandescent light. Edison began using copper for lead-in wires because of its exceptional conductivity and lower cost versus platinum. However, when he realized that several lighting experiments he’d conducted in exactly the same way had yielded different results, he seized upon the notion that the copper wire he was using must have had “dead spots.” Immediately, Edison began cutting the wire into small segments, noting darker patches where he hypothesized that impurities had contaminated the copper during manufacturing. After chemical analysis, both Edison and the manufacturer realized he was correct. Edison saw in a flash that the pattern of results he obtained was inconsistent
not because of his experimental method, but because of the quality of the materials. This insight was critical to the success of his lighting system, and initiated dramatic improvements in the manufacture of copper wire in the United States.

In 1879, after achieving his landmark 14.5-hour burn for the first filament, Edison began to project the trajectory of burn rates he felt were achievable with even better-quality materials. His ability to discern patterns in his data, then use these patterns to make projections, allowed him to achieve successively higher threshold levels of lamp life. His experiments also led Edison to begin calculating what kind of filament supply would be required for various levels of consumer demand, determining the economic viability of his work with incandescence at various consumer usage rates. His forecasts, like his acumen in detecting errors, proved to be remarkably accurate.

Edison’s awareness of patterns also allowed him to see how the component parts of solutions he had generated in one area of experimentation could apply to applications in another completely different area. For example, to make the phonograph work, Edison had to find a way to transform sound waves into kinetic energy so the waves could be stored and replayed. He began experimenting to see how sound waves could be transferred to surfaces such as foil, wax, and other substrates without being distorted. Years of observing how incoming Morse code messages were tapped out by the chiseled stylus on most telegraph equipment led Edison, in another moment of inspiration, to see how this same chiseled stylus might be used to transfer sound waves onto cylindrical records. He applied the principles of a stylus to constructing phonograph needles that could activate the sound patterns etched into the grooves of his records, without damaging the grooves themselves. These remarkable achievements came because Edison discerned a pattern in the way indentations are made in both recording telegraph messages and in storing sound waves kinetically.

As he collected data, Edison would regularly ask, “Have I seen this anywhere else before? Is there a pattern here?” Edison’s wide-ranging reading and experimentation enabled him to create a broad context for his observations. He thus could often discern patterns where others could not. He was open to seeing patterns emerge in all areas of his work.

As Malcolm Gladwell observed, the “aha!” we sometimes feel when seeing a pattern emerge is because a new connection has been established—one that is surprising and novel. These connections do not typically arrive through direct conscious effort, as with analogy, where relationships can be intentionally paired.

Dr. Richard Restak emphasizes that the ability to discern patterns requires an
ability to shift context fluidly, and make new connections in a way that allows harmonious, fluid movement between the left and right hemispheres of the cerebral cortex. This is how we can “see the forest and the trees.” In zooming out to assess macro patterns of the forest we call upon the facilities of the right brain. In zooming in to assess component parts of the trees, we call upon the facilities of the left brain. Edison’s achievements in discerning patterns were a reflection of his ability to mobilize and coordinate these two modes. This whole-brain thinking skill is an essential element of innovation literacy.

Creating Innovation Literacy: Discern Patterns

What is one of the simplest and most powerful tools you can learn to improve your ability to discern patterns and promote the harmonious functioning of the hemispheres of your brain? Mind Mapping®!

Edison’s ability to discern patterns began with his fascination with the natural world. If you contemplate the structure of patterns in nature as he did, you will see that a tree or a plant, for example, are networks of life, expanding in all directions from a trunk or stem. However, the most amazing network of all is right inside your skull. Each of your billions of neurons (brain cells) branches out from a center, called the nucleus. Each branch, or dendrite (a word that comes from the Greek word meaning “tree”), is covered with little nodes called dendritic spines. A gap between nodes is called a synapse. Our thinking is a function of a vast network of synaptic patterns.

A mind map is a graphic expression of these natural patterns of the brain. Mind mapping is a simple, easy method for helping you discern patterns and make creative connections. It was originated by British brain researcher Tony Buzan, who was inspired by his study of patterns in nature, recent brain research, and the notebooks of great minds like Leonardo da Vinci and Thomas Edison.

All you need to begin is a few different colored pens and a large sheet of blank paper.

Here’s how to do it:

• Begin your mind map with a symbol or picture (representing your topic) at the center of your page. Starting at the center opens your mind to a full 360 degrees of association. Pictures and symbols are much easier to remember than words and enhance your ability to think creatively about your subject.
• **Use key words.** These are the information-rich nuggets of recall and creative association.

• **Connect the key words with lines radiating from your central image.** The branches will show connections clearly.

• **Print your key words.** Printing is often much easier to read and remember than writing.

• **Print one key word per line.** This can enhance the precision of your thought.

• **Print your key words on the lines, and make the length of the word the same as the line it is on.** This maximizes clarity of association and encourages economy of space.

• **Use colors, pictures, dimension, and codes for greater association and emphasis.** This will strengthen your memory and inspire your creativity.

Mind mapping makes it easy to have all your ideas for a topic on one piece of paper arranged in a way that encourages you to see relationships between them and discern patterns.

A senior research associate for a leading chemical company describes how he used mind mapping to discern patterns. He was attempting to “integrate a large amount of apparently unrelated data on a pulp bleaching process.” After putting all the data on a mind map he commented, “As I began to make connections between the various elements of the process, I could identify and define an invention for which a patent is now pending... The mind mapping process took less than an hour and clearly was the key to defining and refining the new invention.”

There are also many programs available for mind mapping on your computer. These programs can be very useful, especially for sharing mind maps with others via the Internet. We strongly recommend, however, that you learn and practice mind mapping “by hand” first.

Professor James Clawson of the University of Virginia’s Darden Graduate School of Business commented in a recent conversation with the authors on the importance of discerning patterns in the management of innovation:
The ability to discern patterns out of oceans of disparate data has become a central skill of effective management. This ability, essentially *inductive logic*, asks that one become skilled at seeing the raw data in all its volume and chaotic naturalness—and infer from that data, as Edison did, the patterns that lie underneath. This skill is the essence of the scientific method. Unfortunately, much of our educational system does just the opposite . . . College and graduate school (MBA) students are too often told what the theories and/or principles are and then told to apply them to their attempts to manage. Many strategically challenged managers and executives want to apply deductive principles long after they’re proven unproductive—because that’s how they’ve been trained. The ability to discern patterns remains relatively rare but it’s increasingly critical, especially for anyone who hopes to innovate.

Dr. John Wai, Director of Medicinal Chemistry at Merck & Co., Inc., describes the importance of discerning patterns in his team’s efforts to develop innovative pharmaceuticals:

The process of pattern-seeking is very visual with drug design. I use computer modeling as well as plastic molecular models that I can touch and continually manipulate. One day, while looking for patterns in one particular class of inhibitors I’d been working on, it struck me that there was a unique element of symmetry in the molecules after dissecting them to the minimum. I then reconnected the crucial atoms back in an alternative way—using chemical bond patterns—and the structure revealed its secrets! From there my team was able to move forward with recommended testing for a unique new drug.

Discerning patterns gives us the creative edge we need to succeed. Awareness of patterns stimulates everyone on our team to think deeper. It urges us to expand and diversify the leads we pursue. It is analogous to the evolution from reptile to bird—only faster.
ELEMENT 9: EXPRESS IDEAS VISUALLY

Some dreamed of a new alphabet, a new language of symbols through which they could formulate and exchange their new intellectual experiences.

—Hermann Hesse, The Glass Bead Game

When you gaze into a kaleidoscope, you see all kinds of multicolored patterns. As you turn it the patterns shift, creating visual delight. Edison delighted in the process of exploring ideas visually in his kaleidoscopic mind. He translated his internal visions into an endless series of drawings. He developed many of his most creative ideas through the process of visual representation, a process that also included the creation of three-dimensional models and prototypes. Visual metaphor helped Edison look at his ideas from many angles, building from the known toward the unknown.

Edison always loved taking machines apart and then reassembling them. He also enjoyed scavenging for spare parts and then experimenting with different ways to combine them to create something new. As he explored how things worked he naturally wanted to discover how they could work better, and he began to use drawings to facilitate his understanding. Edison's visual explorations are extraordinary not only for their breadth and number, but because many are rendered from the perspective of an observer seeing the interior of an object from its exterior. Edison's visual “X-ray” imaginings allowed him to “see” how a yet-unperfected machine might function. His drawings capture the essence of how a machine might be able to work. And this is precisely why his mechanics could so successfully develop prototypes based on his sketches.

Edison used visual representations of ideas not only to build three-dimensional prototypes of his inventions, but to expand his thinking about what was possible. Through use of visual metaphor, Edison built out from what he did know toward what he did not know. In this process, he used images of concrete objects whose properties he understood and combined them with representations of concepts he did not understand. By imagining and sketching how different materials might function together in different circumstances—even wildly outlandish ones—he discovered new ideas.

Visual metaphors advanced Edison’s thinking about the telephone transmitter, the electric light, the acoustic telegraph, and many other breakthroughs. On this
and the following pages are three of Edison's drawings completed in the mid- and late 1870s during his investigation of the most extraordinary challenge of his career: subdividing an electrical current. The images he developed helped him explore the questions, “What could the circuit look like?” “How can I create a circuit architecture that works smoothly?” “What are the components that will enable the circuit to operate efficiently?” “How do all these electrical components relate to each other?” “How can I conceive of an electrical circuit—which I don’t yet understand—to be like a telegraph circuit—which I do understand?”

The drawing on the left was completed on January 26, 1876, illustrating a Multiplex telegraph circuit. The Multiplex was an actual patented design of Edison's that allowed multiple telegraph machines to operate on the same line. Here Edison combined his knowledge of telegraphy and electromechanics in developing his visual representation.

Bearing this first image in mind, look at the drawing on page 107, completed more than two and a half years later on September 13, 1878. This drawing shows an electrical circuit that could split a single electrical current into discrete packets, powering individual lights. Edison again relies here on his knowledge of telegraphy to create a visual metaphor for his evolving ideas. He borrows the wiring techniques and structural architecture of a telegraph circuit, but employs principles of distribution within each individual circuit specifically related to electricity. Edison thus visually “experiments” with seven different structural combinations, each drawing upon his deep knowledge of telegraph mechanics, telegraph circuit regulators, and telegraph relay wiring.
The visual techniques he employed in this drawing advanced his thinking about electrical currents and filaments.

Roughly five weeks after completing this second drawing, Edison had learned more about the filament through additional laboratory experiments. The third notebook drawing shown on page 108, entered on October 25, 1878, reveals additional detail, particularly in the spiral designs of the filaments (also called “burners”). Although Edison’s had not yet identified the optimal shape and size for the filament—hence the continued use of the telegraph metaphor—he had found that spiral filaments effectively dispersed heat, thereby increasing burn-life.

Together, these three drawings illustrate how Edison used visual metaphors to evolve his thinking from areas that he knew well toward areas that he did not.

Edison also used drawing as a way to play with evolving concepts and designs. He found drawing to be a practical way to “unstick” his mind. Edison’s use of visualization in his mind and drawings on paper is consistent with decades of research demonstrating that vivid visual representation is one of the best ways to enhance memory and creative thinking.

Visual metaphors played a key role in breakthroughs achieved by Leonardo, Newton, Darwin, Einstein, James Watson and Francis Crick, and many others. Scientific historian Howard Gruber has conducted extensive research on the role of visual images in the creative process of great scientists. He states, “The scientist needs them in order to comprehend what is known and to guide the search for what is not yet known.”

Edison’s gift for visually exploring ideas on paper, also offered him an effective
Six weeks and several iterations later, Edison completes Electric Light Caveat #85 on October 25, 1878, showing his incorporation of a spiral design for the filament to more rapidly diffuse heat from its incandescent surface.
way to communicate with his teams. Edison’s staff had varying levels of formal education. Some had a technical education, some a master’s degree, and some almost no formal education whatsoever. By using visual images, Edison transcended any communication barriers posed by written language, creating common ground for all. Drawings became the code of Edison’s laboratory, the unspoken language everyone understood.

Edison shared his drawings with the laboratory staff to show them the entire scope of an idea on one page. Regardless of how he delegated the work for each invention, every team member could see what the entire concept looked like right from the start, understanding how his individual part fit into the whole. Edison used drawings to create a shared vision of innovation.

Creating Innovation Literacy: Express Ideas Visually

The eye of the master will do more work than both his hands.

—Benjamin Franklin

The best thing you can do to develop your ability to express ideas visually is to learn how to draw or paint. While not everyone can be a Leonardo, Picasso, or Georgia O’Keeffe, the good news is that it is surprisingly easy to learn to draw well enough to facilitate the process of kaleidoscopic thinking. Indeed, the main impediment to experiencing the benefits of expressing your ideas visually is the belief that drawing is difficult and something that only artists can do.

Children’s drawings are remarkably artistic, expressive, and alive because they haven’t yet developed the habit of criticizing and analyzing every mark they make on a page. You can experience a rebirth of your childlike enjoyment of drawing by learning to temporarily suspend your adult habit of self-criticism. If you allow yourself to play with images, doodles, color, and form in the manner of a child, you’ll be surprised and delighted by the process and the result.

The most successful approaches to helping adults learn how to draw are based on strategies for accessing the same innocent artistic awareness you had when you were a child. Dr. Betty Edwards, author of Drawing on the Right Side of the Brain, has taught millions of people around the world how to draw. She guides her students to let go of their reliance on the verbal, critical, analytic “left-hemisphere dominant” mode. This mode is useful for criticizing art but not for making it. Instead, Edwards invites students to use the nonverbal, intuitive, “big picture” right
hemisphere. Her simple, elegant methods make it easy to begin to see and then draw in a natural manner.

In his classic book *The Natural Way to Draw*, Kimon Nicolaides explains that the way to learn to draw is “perfectly natural.” He emphasizes that, “It has nothing to do with artifice or technique. It has nothing to do with aesthetics or conception. It has only to do with the act of correct observation, and by that I mean a physical contact with all sorts of objects through all the senses.” In other words, the ability to draw is largely a function of focused sensory awareness. As Frederick Franck, author of *The Zen of Seeing*, and many others have emphasized, drawing emerges naturally when we give deeper attention to the world around us. As Leonardo da Vinci proclaimed, all drawing springs from “knowing how to see.”

Earlier you were introduced to mind mapping as a tool for discerning patterns. Mind mapping is also a marvelous way to express your ideas visually. As you experiment with learning to draw you can include more drawn images in your mind maps, and gain even more benefit from this *kaleidoscopic thinking* tool.

If you are reluctant to learn to draw and haven’t yet incorporated the skill of mind mapping, you can, nevertheless, boost your ability to think kaleidoscopically and benefit from the visual expression of your ideas by engaging the services of a graphic facilitator. Graphic facilitators are more than just illustrators. Now hired by Apple, Intel, Procter & Gamble, among other Fortune 500 companies, they are skilled in using a variety of visual tools to help you develop a vivid, shared vision in strategy, product development, problem-solving sessions, and many other situations.

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Dr. Jim West describes the importance of expressing ideas visually in his work:

“I’m very dyslexic, so I can’t read something and learn only from the reading. If I look at a bunch of equations, the equations as they stand don’t mean very much to me. It’s how they graph out. Then I can understand what they’re telling me in terms of the parameters that are involved. When I see something graphically, then I begin to understand it, but not until I begin to see it that way do I really fully understand it.”
In the republic of mediocrity, genius is dangerous.
—Robert Ingersoll

Innovation demands the ability to think independently and act courageously. Throughout his career, Edison had the courage to embrace views that were counter to prevailing belief. As Niccolò Machiavelli, one of history’s great political innovators, wrote:

It must be remembered that there is nothing more difficult to plan, nothing more doubtful of success, nor more dangerous to manage than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old institutions and merely lukewarm defenders in those who would gain by the new ones. The hesitation of the latter arises . . . in part from the general skepticism of mankind which does not really believe in an innovation until experience proves its value.

Edison often stood in opposition to “those who would profit by preservation of the old institutions.” This element—explore the roads not taken—energizes the fruits of all the other elements of kaleidoscopic thinking.

Edison’s challenge to conventional scientific thinking about incandescence provides a perfect example of his willingness to explore the roads not taken. Historians of science generally agree that the phonograph is the supreme reflection of Edison’s originality; the quadruplex telegraph is the greatest expression of his technical finesse; the alkaline storage battery his most compelling example of persistence; and the kinetoscope motion picture system his most ingenious combination of technologies. But the incandescent electric lighting system is by consensus the most revolutionary expression of Edison’s inventive genius. It was born from his
courage to defy convention and to embrace a staunchly contrarian point of view.

In the 1870s, Edison saw that existing methods of providing light and power were messy and unsafe. Lanterns with gas, oil, grease, or other substances often led to nasty spills and fires. Edison envisioned a form of lighting that was easy and safe, as well as affordable. But “those who would profit by preservation of the old institutions”—namely the firms selling oil, grease, and gas—took every opportunity to oppose and even ridicule his efforts. Edison was undeterred. As he stated, “I shall make the electric light so cheap that only the rich will be able to burn candles.”

In addition to opposition from those with vested interests, Edison faced the scorn and ridicule of luminaries in the world of science. In 1878, finding the means to heat any substance to a white-hot glow without destroying it seemed impossible. As Sir W. H. Preece, the chief engineer of Britain’s post office, commented, Edison’s effort would be “an absolute ignis fatuus.” “Ignis fatuus” is a medieval Latin term for a light appearing over swampy ground at night caused by spontaneous combustion of substances such as methane gas, but it also carries the implication of something illusory and even foolish. Another distinguished expert proclaimed, “Much nonsense has been talked in relation to this subject. Some inventors claimed the power to ‘infinitely divide’ the electric current, now knowing or forgetting that such a statement is incompatible with the well-proven law of conservation of energy.” And, Britain’s prestigious Royal Institution concluded that practical incandescence was “utterly impossible.”

On November 4, 1879, just over one year after the Royal Institution’s pronouncement, Edison applied for his basic patent on the incandescent electric lamp.

Edison often embraced ideas that were outside the mainstream, including the works of Robert G. Ingersoll (1833–1899), a charismatic American orator and champion of “free thinking.” Ingersoll inspired many original thinkers of the age, including Mark Twain, Frederick Douglass, and Oscar Wilde. When Wilde toured the United States, he attended several of Ingersoll’s sold-out speeches and pronounced him to be “the most intelligent man in America.”

Ingersoll reveled in irreverence. He said, “I’d rather smoke one cigar than hear two sermons.” He preferred science to faith: “Any doctrine that will not bear investigation is not a fit tenant for the mind of an honest man,” and, “In nature there are neither rewards nor punishments. There are consequences.”

Ingersoll, Faraday, Paine, Lincoln and, of course, his father Samuel Edison all served as role models for Edison. They inspired him to challenge conventional
thinking and to achieve the “utterly impossible.” As stated by complexity experts Welter and Egmon, challenging convention at the level that Edison did,

requires developing the guts and the courage to stand on your own convictions, and step out of the mainstream when necessary. Taking a disruptive path requires commitment to human values as well as a desire to fundamentally change/improve a given situation or thing. It demands the utmost in self-awareness, testing the depths of one’s strengths and weaknesses.

Creating Innovation Literacy: Explore the Roads Not Taken

Innovation demands both cognitive and emotional intelligence. Thomas Edison is a paragon of the cognitive freedom and emotional fortitude required to innovate. As he observed, most people are unwilling to discipline themselves to think through new ideas. He commented, “There is no expedient to which a man will not go to avoid the labor of thinking.” Edison’s contemporary, the Irish dramatist George Bernard Shaw, makes the same point in amusing fashion, “Few people think more than two or three times a year; I have made an international reputation for myself by thinking once or twice a week.”

The willingness to consider new ideas intellectually must be supported by the courage to champion them into reality. Few know more about championing practical innovations than Curtis Carlson, CEO of SRI International. In their book *Innovation*, Carlson and his collaborator Bill Wilmot emphasize: “There must be a champion who proactively identifies with the customer and who addresses the funding, bureaucratic, political, human, and technical challenges that every innovation faces.” They add, “No champion, no project, no exception.”

Dr. Donald Keck was inducted into the National Inventors Hall of Fame in 1993 for his co-invention of the first optical fiber. He comments on championing innovation in a big company: “One of the things that you find out early on working for a large corporation is that nobody has more interest in getting your invention through the pipeline than you do.” Keck’s ability to heed a different drummer was, as he explains, a critical element in this breakthrough. “Dr. Bob Maurer hired me into Corning right out of graduate school. Bob instilled in us the notion of being contrarian. As Dr. Peter Schultz—one of my other collaborators—and I thought back over the years, we said, ‘You know, we took the road less traveled.’ ”

Keck adds,
We later found out that Bell Labs had a group of 20 or 30 people trying to invent the same fiber we were. British Telecom had a similar effort. I’m sure that Nippon Telephone and Telegraph in Japan had a major effort as well. But all of those labs pursued what I now term “the engineering approach.” They took the very best that anybody knew at the time, and simply tried to improve it. But all our experiments told us we wouldn’t get very far at all if we followed that line of thinking. We took a revolutionary path instead. There were actually three disruptive innovations that went into creating optical fiber. It turns out we took a contrarian direction on all the key pathways we pursued.

How do you cultivate the intellectual and emotional strength, like Donald Keck and his collaborators, to explore roads not taken? Do what Edison did and immerse yourself in the study of great, independent thinkers and innovators. We believe Edison is an extraordinary role model, but there are many others, including those who inspired Edison himself. Make a list of your most inspiring champions and learn as much as you can about them. As Mark Twain wrote, “Really great people make you feel that you too can become great.”

Do not go where the path may lead, go instead where there is no path and leave a trail.
—Ralph Waldo Emerson

Edison’s kaleidoscopic mind brought forward revolutionary ideas that changed the way we live. In bringing the world electric light, Edison bucked conventional wisdom. But he also had to develop an entire array of new equipment to drive electricity from a central power station out to homes miles away. He had to find investors to subsidize development of his work, price the equipment properly, protect his ideas, and not drive himself to an early grave in the process. Edison’s ability to manage more than forty projects simultaneously at the height of developing his electrical power system stands as testimony not only to his exceptional kaleidoscopic thinking abilities, but his capacity for managing complexity—a key skill covered in Competency #3: Full-spectrum Engagement.