North American Skull Base Society 26th Annual Meeting: Innovation and Creativity in Skull Base Surgery

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If you always do what you always did, you will always get what you always got.

—Albert Einstein

Surgery has been likened to a musical performance.¹ It is no coincidence that the ancient Greeks attributed both medicine and music to the God, Apollo. In particular, surgery is like jazz music, requiring a great deal of improvisation. This is one of the aspects of surgery that is most appealing—every case is different and deviates from the script to some degree. Just like music, surgical improvisation occurs on a continuum from interpretation (taking minor liberties) to embellishment (rephrased but recognizable) to variation (introducing new elements) to improvisation (little resemblance to the original). This presentation will attempt to answer questions about innovation in surgery and the creative process.

During my career, I have witnessed profound changes in the practice of skull base surgery. The evolution of skull base surgery can be divided into periods characterized by different surgical principles (►Table 1). Each period represents a paradigm shift that follows a typical cycle of adoption² from early innovators to laggards until a new standard is established and the cycle repeats itself. Much like the grieving process, there is an emotional progression from denial, anger, and fear to eventual acceptance, enthusiasm, and ownership. Following a technology trigger, expectations often exceed the reality. A peak of inflated expectations is followed by a trough of disillusionment before proceeding up a slope of enlightenment to a plateau of productivity.³

What Are the Drivers of Innovation?

Change may be the result of new knowledge, technology, or external forces. Ideally, evidence-based medicine is the source of new knowledge. Rather than being truly disruptive,

new technologies are often enablers, facilitating further progress along a particular path.⁴ External forces that may drive change include patients and advocacy groups, insurers, and government.

Innovation is dependent on both internal and external factors.⁵ Internal factors (individual or group of individuals) that affect the process of innovation include knowledge, imagination, and attitude. External factors include resources, habitat (environment), and culture. The individual innovator must possess the courage to innovate, display the requisite behavioral skills, and have the necessary cognitive abilities.⁶ An aptitude for associational thinking, the ability to link two disparate areas, is particularly important.

Does Innovation Occur Incrementally or by Great Leaps?

Innovation has been defined as “an introduction of something new, including a new idea, method, or device.”⁴ Innovation can be incremental (e.g., modification of existing technique), enabling (e.g., endoscopy), or disruptive (e.g., electronic health record). Although we think of progress occurring along a straight timeline, in reality, progress is erratic with periods of acceleration and deceleration. To achieve a higher level of progress, it is not always enough to proceed along the same path. Sometimes it is necessary to try a completely different path with a temporary worsening of outcomes before reaching a higher level.

Innovation is an emergent phenomenon. Don't look only to your superiors for inspiration. In *The Evolution of Everything*, Ridley argues that the exchange of ideas leads organically to series of trial and error, resulting in innovation.⁷ The expression that we are all dwarfs standing on the shoulders of giants (“*nanos gigantum humeris insidentes*”) is attributed to Bernard of Chartres, a 12th century French Neoplatonist philosopher, scholar, and administrator.⁸ As depicted in the church windows in Chartres, France, we are able to see farther because of the

Table 1 Evolution of skull base surgery

Period	Principles
1970s	Exploratory phase
1980s	Open cranial base surgery
1990s	Endoscopic pituitary surgery; keyhole surgery; radiosurgery
2000s	Endoscopic endonasal cranial base surgery
2010s	Multipoint surgery; functional EES

Abbreviation: EES, endoscopic endonasal surgery.

contributions of those who precede us. Innovation is inevitable based on the collective experience and is rarely the result of individual effort. Frequently, across multiple disciplines, the innovation precedes the scientific insight.

Who Are the Innovators?

In his book, *Old Masters and Young Geniuses: The Two Life Cycles of Artistic Creativity*, David Galenson, an economist, describes two types of innovators, conceptual and experimental.⁹ In disciplines as diverse as literature, painting, filmmaking, architecture, and music, examples of both types can be found. Conceptual innovators are characterized by a sudden inspiration that is simplistic in its vision, general in its scope, and upsets tradition. The conceptual innovator has a very clear vision of what they want to achieve and generally achieve their greatest work in the early stages of their career. They can be described as a “young genius.” An example is Maya Lin, the architect who designed the *Vietnam War Memorial* at the age of 23. In contrast, the experimental innovator progresses gradually, constantly striving for an imprecise goal that is often not attained. They are known for superb craftsmanship and a respect for traditions. They are best described as an “old master,” achieving their greatest accomplishments late in their career. In contrast to Maya Lin, Frank Lloyd Wright achieved his greatest architectural masterpiece, *Falling Water*, at the age of 70. It is said that “great experimental innovators may add substantive content to a discipline while great conceptual innovators may change the domain.”

What Is the Relationship between Innovation and Creativity?

If innovation is viewed as a cell, then creativity is the nucleus; it is the driving force for innovation. Creativity is not the same as the genius. From an evolutionary viewpoint, there is a survival advantage for a population that contains creative individuals. Creative individuals explore new possibilities that are potentially risky, but may offer high rewards. In modern society, there are also intrinsic rewards of creativity. In his book, *Creativity: Flow and the Psychology of Discovery and Invention*, Mihaly Csikszentmihalyi describes the creative state as having flow, or being “in the zone.”¹⁰ It is a state of being “fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity.”

The individual rewards of creativity are primarily intrinsic; the creative process is its own reward.

Is There a Creative Personality?

Creative individuals share certain characteristics.¹⁰ Of these, curiosity is probably the most important characteristic; they are always asking questions. Creative individuals are not easily categorized; they are complex with opposing traits. They may display one trait in one situation and the opposite in another situation. Creative individuals exhibit divergent thinking rather than convergent thinking. A divergent thinker considers all of the possible ways to reach a solution, whereas a convergent thinker thinks directly for a final solution, excluding other possibilities.

Creativity (and innovation) requires more than a genetic predisposition. It requires access to a domain (a specific area of knowledge) and access to a field (a group sharing a domain).¹⁰ Without a foundation of knowledge or expertise in a domain, how can one innovate? As the famous jazz musician, Charlie Mingus said, “You can’t improvise on nothing; you’ve gotta improvise on something.”¹¹ Also, an innovation is not an innovation until it is recognized by others in the same field and stands the test of time. These three essential elements form an innovation triangle of person, domain, and field that interact with each other.¹⁰

How Does the Creative Process Work?

The creative process proceeds through a series of steps.¹⁰ It starts with a preparation phase, where one is gaining the knowledge and experience within a domain. This is followed by a period of incubation that may last for years. Creative ideas may hide just below the surface in the subconscious and often appear as a sudden insight during a time of reflection. This leads to periods of evaluation and further elaboration of the innovation. The cycle continues with another period of incubation. As Linus Pauling, the Nobel laureate chemist said, “The best way to have a good idea is to have lots of ideas.”¹¹ The successful innovator is able to winnow out the bad ideas and pursue the most promising ones.

You will never reach your destination if you stop and throw stones at every dog that barks.

—Winston Churchill

The environment is an important element of innovation.¹⁰ It is important to have strong mentors who provide freedom from dogma. There should be a free flow of ideas with access to others across multiple disciplines. Support from family and colleagues provides an opportunity to innovate. It helps to be in an environment with adequate resources: time, equipment, funding. A resource that is important for surgeons is access to patients with a sufficient volume of surgeries. The aesthetics of the environment also appear to be important. Innovators often seek out tranquil places of natural beauty for their inspiration as well as an escape from the distractions of

everyday life. Participation in semiautomatic activities, such as walking or driving, is particularly conducive to reflection with sudden flashes of insight. For example, Albert Einstein was very fond of taking long walks on the Princeton campus while discussing his ideas with his closest colleagues. In the absence of beautiful surroundings, one can personalize space (feng shui) and routine to provide a more suitable environment. A room can be transformed into a creativity space. For busy physicians, it is essential to take control of one's time. The books by time management expert, Stephen Covey, stress the importance of residing in zone 2 (important and nonurgent activities) as much as possible.¹¹

Every act of creation is first an act of destruction.

—Pablo Picasso

My barn having burned down, I can now see the moon.

—Mazuta Masahide,
17th Century Poet and Samurai

As soon as we commit our thoughts to paper (in the form of a journal or textbook), it is a failure of sorts, because we are fixing our ideas and not allowing them to change. It can limit our ability to consider other possibilities.

Only fools have made up their minds and are certain.

—Michel de Montaigne

It is our own way of thinking that often gets in the way of the creative process. Our cognitive abilities are susceptible to multiple types of cognitive bias and heuristics. One particular (and amusing) example is the Dunning-Kruger effect, in which the poorest performers are the least aware of their incompetence.¹² With mastery comes a greater perception of how little you know and less certainty about what you believe.

Persistence—not strength or even intelligence—is the key that unlocks our potential.

—Winston Churchill

Although wisdom comes from experience, it also comes from failure. The successful innovator is not afraid to fail and there is often a long trail of failures in the past of every great innovator. In her book, *The Rise*, Sarah Lewis stresses the importance of the near miss.¹³ Failure to achieve perfection provides the necessary drive to keep striving. An example is Paul Cezanne, the painter, who often painted over his works and left many unsigned because he was never satisfied that they were finished. The Native American Navaho recognizes this inability to achieve perfection and incorporate a “spirit line” or intentional defect into their works to reflect this. In a sense, every surgery is also a near miss; there is always an opportunity for improvement.

Can Creativity Be Fostered?

Within the surgical disciplines, what can we do to enhance creativity and drive innovation? We could start by selecting the most creative individuals as part of the residency selection process. But how can we measure creativity and the ability to innovate? From the prior discussion, we have a basic profile of the character traits and can assess traits such as curiosity, divergent thinking, perseverance, risk tolerance, etc. The “innovation triangle” of person, domain, and field suggests that a proper foundation and environment are also needed. Knowledge within a domain and technical expertise can be enhanced through educational programs targeting specific areas. The most creative environments are multidisciplinary. The corollary is that the most dynamic areas are at the juncture of different domains (e.g., skull base surgery). Networking within and across disciplines should be encouraged to promote the exchange of ideas.

“The Innovator’s DNA” by Dyer, Gregersen, and Christensen provides a blueprint for innovation.⁶ The five key skills of disruptive innovators include questioning, observation, associations, networking, and experimentation. Innovators ask lots of questions and are naturally curious about everything. They are keen observers and approach situations with the naiveté of a child, seeing with fresh eyes. Knowledge across domains provides associations, with the ability to see connections between disparate areas. Networking is a tool for exposing oneself to new ideas and testing hypotheses. Frequent experimentation allows rapid testing of hypotheses and directs further efforts.

Once you start down the dark path, forever it will dominate your destiny.

—Yoda

There is a dark side to innovation. As outlined by Miller et al, innovation introduces ethical issues related to patient safety, informed consent and shared decision making, the cost of care, and professionalism.¹⁴ Surgical innovation exists on a continuum from practice variation to experimental research.¹⁵ Where something falls on the spectrum is dependent on timing relative to treatment, similarity to the standard of care, the reason for innovation, safety and effectiveness, and outcomes. There are established guidelines and processes in place for oversight of innovation at both ends of this spectrum. It is the transition zone that is most problematic. Schwartz describes three types of transition zone innovations: Type A (response to an acute problem in the operating room); type B (no adequate therapy for a life-threatening problem); type C (premeditated, but for a specific patient). To help handle these situations, she proposes the ETHICAL model: Expertise, Technical skills, Hazards, Informed consent, Conflict of interest, Analysis, and Literature. The process of innovation culminates in the diffusion and adoption of the innovation by others in the field. “Diffusion and adoption of innovations before having supporting evidence (however) is not an option for surgical innovation.”¹⁶ It is appropriate that some centers will pioneer an innovation, with further elaboration and critical evaluation,

but dissemination should not be widespread until the value is established.

A difference, to be a difference, must make a difference.

—Gertrude Stein

Innovation cannot succeed in every environment. A proper culture must exist in which there is acceptance of change, tolerance of risk and failure, and collaboration. If the domain is too limited due to superspecialization, isolation does not allow adequate diversity of ideas. Lack of resources, whether it is people, technology, or funding stalls innovation. Too much oversight and regulation can stifle innovation. Conflicts of interest may incentivize maintenance of the status quo without consideration of alternatives.

Standardization has been promoted as a way to improve quality and safety through the promulgation of evidence-based best practices. Standardization also increases efficiency (decreases waste). Although it is often perceived as the opposite of innovation, standardization and innovation can coexist. The standardization provides a baseline for continued improvement.

How can you increase your own creativity and drive innovation within your own career?

1. Be curious about everything; ask lots of questions. Pursue the best ideas.
2. Reject the status quo. Don't believe everything you think. Recognize your own cognitive bias.
3. Discover other domains and new experiences. Look for the new associations that bridge disciplines.
4. Network within your field to enrich and test your ideas.
5. Take some time to relax and reflect.
6. Shape your space; control your time.
7. Create flow in your daily activities.

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