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Surgeons as Innovators: From Ideas to Entrepreneurship

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Insights

- Surgeons have a strong history of innovation across all specialties of surgery.
- Although surgeons may feel compelled to provide creative solutions to the problems they face in their clinical practice, they experience a wide range of barriers to see new innovations to fruition.
- Not only are surgeons working to meet increasingly stringent fiscal benchmarks, but it is also common for them not to have access to resources needed to be innovative.
- There are now training programs that equip surgeons with the skills and professional network needed to translate new ideas to practice.
- Current context in the healthcare system is not always conducive to innovation, but with the right attitude, surgeons can harness the right resources to actualize their creative potential and transform the field of surgery.
- Our acronym **I.N.S.P.I.R.E.** provides a list of actions surgeons can implement to unleash their creative potential and turn their ideas to innovations.

"Surgeons have historically been idea generators and creative practitioners within their craft. In the technology life cycle, as initially described by Utterback, the first phase of idea generation and evaluation is fluid and requires vision and flexibility. When asked where the greatest weakness in product innovation is, many managers indicate the idea generation phase. The surgeon's training requires daily situation assessment, decision analysis, and frequent development of new processes. Each clinical case offers unique challenges and requires a degree of creativity. For this reason, surgeons often excel at the creative, fuzzy front end of technology development."

"Surgeons are increasingly under pressure to achieve a fiscal report card that is black and not red. Workload increases, reimbursement decreases, and extra time, which was traditionally dedicated to teaching, research, and innovation, becomes harder to find. Fiscal responsibility is a necessary feature of the modern economy, but increasing efficiency and operative productivity may not be a sustainable strategy within the profession."

Riskin et al (2006) (1)

"We, as surgeons, best understand the realities of how to bring these solutions to the bedside. Thus, the surgeon-investigator, while an endangered species, should never become extinct, because everything we use is manufactured."

Dr. Thomas Krummel,
Surgeon-in-Chief at the Lucile Packard Children's Hospital,
Co-Director of the Biodesign Innovation Program at Stanford University (2)

Revolutionizing Surgery: Why Surgeons Should Lead the Way

Among the different specialties of medicine, surgery has one of the richest histories of innovation. Despite a deep tradition of creative problem solving in surgery, surgical innovation is typically not formalized through academic training programs, nor is it routinely encouraged or facilitated in the workplace. Indeed, this is not surprising when surgeons' first priority is caring for patients in increasingly demanding environments, where their performance is measured through quickly evolving

fiscal benchmarks. Yet, recognizing the pivotal role surgeons play in generating solutions for problems in surgery highlights the importance of integrating innovation in this profession. Through their work experience and expertise, surgeons develop in-depth knowledge of clinical problems which is integral for devising the necessary solutions. However, beyond having their personal creative streak, surgeons also need to be in the right environment where their ideas can be effectively translated to innovations. Successful surgical innovations can not occur in silos and need collaboration with individuals with expertise in different disciplines. Additionally, the introduction of innovations in the market place also requires business and economics knowledge which is not part of most surgical training models. Surgical innovation is needed not only for surgical progress, but it also has significant implications for informing health policy (1). With the right mindset, perseverance, and professional surroundings, surgeons can revolutionize the field of surgery – continuing the longstanding tradition of innovation that has been a part of this profession from the very beginning.

> "It is the unsolved problem, or the repetitive failures of existing therapies that stimulate surgeons to find a better way. As a scrub tech, Tom Fogarty witnessed first hand the inadequacies of a groin to popliteal arteriotomy to extract an embolus. Indeed, such a procedure was frequently followed by several more and then by an amputation. Throughout history, surgeons have been the most prolific medical device innovators. Our lexicon in innovation must reflect a history that has often been less dependent upon market forces than upon patient outcome, peer review, and peer esteem. It should be noted that the impetus for surgical innovation may be changing as surgical care and health care, as a whole, are managed with fiscal performance as at least one primary outcome measure."
>
> **Riskin et al (2006) (1)**

> "In the early days of surgery, patients desperate for a chance at a cure for dire or difficult-to-treat ailments sought out those offering the latest techniques. The landmark surgeons of the past were known for challenging the common perception about where in the body, whether it was the heart or the brain, it was possible to go safely and what was technically possible, from endoscopic surgery to transplantation."
>
> "Modern surgery has perpetuated a culture of innovation. Patients still equate the newest with the best and often seek it out, and surgeons and hospitals promote themselves by offering novel techniques. Surgery departments, societies, and journals reward innovation with career advancement, awards, and publications."
>
> **Youngerman & McKhann II (2015) (3)**

The State of Innovation in Surgery

While there have been several definitions of innovation over time, they all have a common element – which involves taking new ideas and putting them in practise (1). It is not surprising that many surgeons have been successful innovators thus far, since the coupling of new ideas with hands-on practice is a key tenet of surgery (1). These ideas can come in different forms, such as technology, technique, service delivery approach, or different combinations of these elements. Exhibit 1 shows examples of different innovations in surgery according to the type of change in technology they introduced.

Focusing on a specific specialty of surgery, the field of orthopaedics is going through a lot of "disruptive innovations", which has been defined as "cheaper, simpler, more convenient products or services that start by meeting the needs of less-demanding customers" (4). As many new innovations seek to improve the functionality of products or services to satisfy the most sophisticated customers of the upper end of the market, they often miss simpler and less expensive alternatives that meet the needs of less demanding customers at the lower end of the market (4). Yet, these simpler innovations remain a good investment as they get better over time and can meet the needs of the majority of consumers (4). Exhibit 2 shows examples of disruptive innovations in orthopaedics surgery that have been paying large dividends thus far. It is hypothesized that a wide range of innovations will continue to define orthopaedic surgery. These include technological advancements fuelled by engineering excellence (e.g. hybrid medical devices combining implants with instruments for greater efficiency), truly personalized medicine (e.g. 3D bioprinting of patient-specific implants), robotic revolution (e.g. software driven navigation systems), and value-based healthcare (e.g. using algorithm-driven approaches to improve safety and efficiency of procedures) (5).

Exhibit 1: Different Forms of Innovations in Surgery (1)

Type of Innovation	Definition	Impact	Example in Surgery
Enabling technology change	Supports further developments within a field	High	Instrument sterilization – this supported many advances within surgery
Incremental technology change	Marginally improves currently available technology and does not result in significant technology shift	Unchanged	A new surgical clip that has better holding strength and placement characteristics
Disruptive technology change	Topples industry leaders and leads to large loss in market share	Overturned	During early development, percutaneous transluminal balloon angioplasty was dangerous and inferior to open coronary artery bypass. It later proved to be disruptive within the cardiothoracic surgery field, leading to a change in market share toward interventional cardiology.
Sustaining technology change	Improvement typically made by current industry leaders to maintain the growth rate within an existing technology niche.	Unchanged	Inventing the coronary stent improved outcomes within an existing market but it did not topple other industry leaders.

Exhibit 2: Disruptive Innovations in Orthopaedic Surgery (4)

Area of Care Delivery	Example	Impact
Diagnostics	Point-of-service Radiology: The Mini-fluoroscan	Increased access to real-time imaging
Surgical Techniques and Technologies	Surgical Implant Generation Network (SIGN) intramedullary nail	Low-tech treatment option to enhance the level and access to orthopaedic care in the developing world
Care Processes	Expanding role and contributions of physician assistants and nurse practitioners	Delivery of high-quality orthopaedic care with greater access and lower costs
Healthcare Delivery Systems	Ambulatory Surgery Centers	Delivery of focused, efficient, high-quality patient-centered care

Key Drivers and Barriers for Surgical Innovation

Surgeons can experience diverse difficulties in the workplace which call for creative solutions (6). They not only have a strong understanding of clinical needs, but they are also well positioned to anticipate future advances and opportunities in their profession (1). Surgeons are typically lead users in the field of surgical intervention, thus they can readily identify emerging market opportunities (1). Given the nature of the corporate structure and funding processes, which often rewards individuals for proven solutions, companies typically do not focus on identifying emerging markets for new solutions (1). This explains why many surgeons had much success in start-up companies by using disruptive technology – they are aware of the specific needs in their profession, can foresee potential markets, and are able to promote their inventions as thought leaders in their field (1).

Despite the clear advantage surgeons have to drive surgical innovation, implementing new ideas to practice remains challenging for several key reasons (Exhibit 3). Compared to the last two decades, surgeons now apply for and receive fewer grants, publish less and feel that research is not a part of their professional role (7). While surgical departments continue to value research, individual surgeons feel that research activities take away from their clinical duties which results in fewer papers and patents from surgical fields (8). Surgeons' perspectives of their work have become increasingly narrow, leading to a specialization/treadmill mentality (2). This outlook presents a significant challenge for surgeons to achieve their creative potential when they do not consider innovation within the scope of their work.

Beyond the surgeon's personal traits that support creative problem solving and facilitate technology development and adoption, context is just as important for driving surgical innovation. Timing of an innovation is important as it determines the interest level from the broader community, technology availability, as well as cost-effectiveness (1). Being with the right people in the right environment is

necessary for surgeons to achieve their creative potential. The place where a surgeon engages in creative work is a strong determinant of the availability of intellectual as well as financial resources, both of which are critical for diffusing new innovations in the market. For example, a surgeon who works in a small city is less likely to have the intellectual interaction and academic connections that enable innovations to get noticed (1). Even when surgeons have great ideas, it can be challenging to actualize them in practice without the necessary technical skills. Specifically, the disconnect between engineering and surgical departments can make innovation a challenge. Most surgeons do not receive any formal training on entrepreneurship and the commercialization process, which is required for transitioning innovations out of the lab to patients (2). Furthermore, with increasing focus on conservative patient management strategies which emphasizes cost minimization, justifying innovations based on cost/benefit analyses is not always possible.

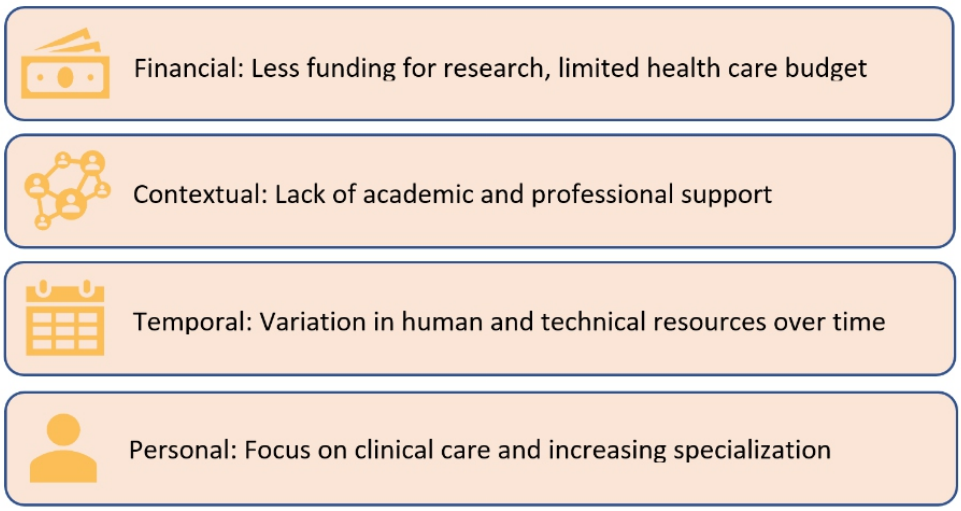

Exhibit 3: Diverse Barriers for Surgical Innovation

"An entrepreneur is someone who undertakes and operates a new enterprise or venture and assumes considerable responsibility for its success. Thus, the entrepreneur seeks independence, autonomy and control to maximize the likelihood of success. These adjectives are often used to describe surgeons. We are programmed as problem-solvers."

"In order for inquisitive people to succeed, they must be allowed to explore, permitted to fail and given credit for their successes…this requires a permissive and celebratory environment."

Dr. Thomas Krummel,
Surgeon-in-Chief at the Lucile Packard Children's Hospital,
Co-Director of the Biodesign Innovation Program at Stanford University (2)

> "The surgeon should be aware of the fact that patients threatened by severe illness display a surprising and sometimes alarming readiness to accept uncertainty and reach out for something new. The surgical scientist must avoid exploiting this willingness of patients to try something new in a desperate situation. It is the surgeon rather than the patient who makes the judgment of appropriateness. This judgment should not be left to the patient, who will always seek new hope and new treatment in a desperate situation, but who lacks the scientific background to make this judgment."
>
> **Moore (2000) (9)**

Inspiring the Next Generation of Surgeon Innovators

In order to overcome the many challenges that surgeons currently experience to see their ideas come to fruition, a health system wide shift in perspective is needed. There should be increased efforts to make research and innovation a more seamless process with greater gratification (8). This will involve making more funding available for research, removing administrative roadblocks that make it difficult for busy surgeons to conduct research, as well as having clear pathways to implement findings and products from research in practice. Given the widespread perception among surgeons that research is not within the scope of their responsibilities, training programs should revise their approach to education which highlights the important role of surgeons in problem solving and contributing to the progress of their profession. Additionally, there should be education opportunities for surgeons who are interested in an entrepreneur stream, where they learn how to successfully commercialize innovations and learn from individuals from diverse disciplines who have experience supporting innovative endeavours (8).

Indeed, there are already a wide range of initiatives now implemented in different settings, which can serve as examples for education and research centers looking to implement an innovative approach to their work. For example, Surgical Innovations, a program part of the University of California, San Francisco's Department of Surgery and Bioengineering & Therapeutic Sciences, is a collaborative initiative that supports open communication between clinical academic surgeons and bioengineering colleagues (10). This allows surgeons to take advantage of the technical skills provided by their engineering colleagues to bring their ideas to life, which has led to many ground-breaking inventions (10). In this program, clinical trainees, graduate students, and post-doctoral fellows work together to move technology from bench to clinical studies (10).

While the value of surgical innovation can not be denied, it is also recognized that without proper evaluation, governance, and training, there can be significant risks associated with these activities. The Royal College of Surgeons of England developed a good practice guide for introducing new surgical innovations, new techniques, and technologies in a manner that provides robust oversight, as well as protects patient safety while supporting surgical innovators and encouraging their creative pursuit (11). This is a detailed guide that provides a framework of steps to consider when developing a new innovation, which includes training, patient consent, ethical considerations, regulatory requirements and cost implications. It also includes a series of recommendations on governance arrangements, audit, and demonstrating safety and effectiveness (11).

There are many other resources that current surgery trainees can tap into if they feel inclined to engage in innovative work in their clinical practice. Context matters a great deal to turn creative ideas into a reality, however, with the right intention and conviction, tomorrow's surgeons can successfully engage in meaningful problem solving through innovations and transform the field of surgery. Our acronym **I.N.S.P.I.R.E** provides a list of actions surgeons can implement to instill greater levels of creativity in their clinical practice and optimize impact.

- **I** Improve problem solving with non-conventional approaches.
- **N** Network locally, nationally, and globally with professionals from diverse disciplines.
- **S** Strategy for innovation includes breaking problems into multiple needs for expertise.
- **P** Proactive, rather than reactive, with all steps of the innovation process.
- **I** Include ethics in all your key decision-making.
- **R** Reconstruct your day to include creative time for innovation.
- **E** Entrepreneurship is accepting failure as the path to success.

Contributors

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