An endangered species

David A. Fullerton, MD

I am indebted to many people for the opportunity to be a thoracic surgeon. First and foremost, I thank my family. My parents, Peggy and Charles, met as undergraduates at the University of Colorado and will celebrate their 58th wedding anniversary in September 2009. They taught me the importance of responsibility, perseverance, and hard work. I am grateful for the support they gave me as a student trying to go to medical school. My wife's parents, Neill and Miriam Farrington, have been an inspiration and strong role models. They will celebrate their 59th wedding anniversary in October. I am particularly grateful to my wife, Chris. Chris and I met as teenagers and have been married since the beginning of medical school. As my love and my best friend, she has always provided unwavering support and has been the bedrock of our family. Our sons, Patrick and Danny, have been incredibly understanding of the demands that our profession places on any family.

I have benefited from priceless mentorship throughout my professional career. When I was a surgical resident at the University of Washington, Drs Tom Marchioro and Jim Carrioco taught me the importance of being intellectually honest with myself to improve as a surgeon. Both were truly gifted surgical educators. Despite the rigors of their own careers, they made the education of residents their highest priority. Dr Marv Pomerantz (Figure 1, A) has been my friend and confidant for almost 20 years. Marv provides an excellent example for all to follow and inspires those around him to be the best they can be. His sage and calming advice is always welcome. Dr Fred Grover (Figure 1, B) has been an excellent role model with an unwavering commitment to the education of students and residents. He is the most patient and kind person I have ever met and is able to find the best of any situation and the best in people. The world needs more people like Fred. Like everyone who has ever worked with him, I wanted to be like Dr Alden Harken (Figure 1, C). His intellect, energy, charisma, and humor have combined to make him the world's greatest surgical educator. His passion for academic surgery has launched the careers of hundreds of young investigators. His unselfish desire to bask in the glory

of those around him makes his friends and followers intensely loyal to him. He is one of the finest academic surgeons of our time. I owe him a great deal for the opportunities that he gave me.

I have always had the privilege of working with truly talented colleagues and great residents. I have personally learned a great deal from working with them, and I thank them all.

THE IMPORTANCE OF STRATEGIC ACTION

History teaches many valuable lessons for the present. One such lesson is that strategic action is required in difficult times. Such was the case in 1776, during the early phase of the American Revolution.¹

The war started gloriously for the Americans. In the spring of 1775, the colonists routed the British at Lexington and Concord and claimed victory at Bunker Hill. Thereafter, the new Continental Army led by George Washington kept the British isolated in Boston with a successful siege for 6 months. Washington was victorious in the siege of Boston through a brilliant move of military strategy. He dispatched Henry Knox to retrieve abandoned artillery from Fort Ticonderoga in upstate New York and then secretly moved the cannon onto the Dorchester Heights, now part of South Boston. This gave the Americans military control of the city of Boston and forced the most powerful military force on earth to evacuate Boston by ship on March 17, 1776. Washington correctly anticipated that the British would next attack the city of New York. He therefore rapidly mobilized his forces to race to New York to arrive before the British.

Bolstered by their victory at Boston, the colonists were flush with pride and overconfidence. Washington's men were cheered by the population, and legions of volunteers joined the Continental Army as it crossed the countryside en route to New York. While waiting in New York for the arrival of the British, Washington's army felt invincible and was eager to engage the British on Manhattan Island. But this glory was short-lived. With the arrival of 200 British warships in New York harbor in August 1776, the British gained control of the surrounding geography. By the end of August, the British had routed the Americans on Long Island; 2 weeks later, on September 14, 1776, the Americans were forced to evacuate New York City and Manhattan Island. The battles for New York were a disaster for the colonists. Nonetheless, knowing that the British would next move to take Philadelphia, Washington gathered his remaining troops and forced them to move as quickly as possible to protect that city.

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FIGURE 1. A, Marv Pomerantz, MD; B, Fred Grover, MD; C, Alden Harken, MD.

It seemed that the American Revolution would come to an end. Not only was the American army demoralized, but the defeat of the Americans at New York brought despair to the colonies. Assuming that the British would win the war, many prominent citizens renounced their allegiance to the patriots and signed oaths of loyalty to England. Included in this group were several members of the first Continental Congress. For a time, it seemed that the state of Maryland would renounce the Declaration of Independence. Americans turned away from the cause, and hundreds of American soldiers deserted daily.

The British pursued the American army as it retreated from New York southward through New Jersey. In so doing, the British conquered the territory they covered. By the end of November 1776, the British controlled all of New Jersey. The only thing that separated them from Philadelphia was the Delaware River. With the British in pursuit, and his army dwindling, Washington escaped New Jersey by crossing the Delaware River into Pennsylvania on December 8, 1776. Brilliantly, he took all the boats on the New Jersey side of the river with him as he crossed the river. Knowing that the odds were very much against him, he did everything possible to position his army between the British and the city of Philadelphia. The British were confident that they had broken the back of the rebels. Unable to cross the Delaware River without boats, the British army halted their advance in New Jersey and hoped that the Delaware River would freeze so that they could then take Philadelphia. The American revolutionary cause was near extinction.

December 1776 was a desperate time. Washington's exhausted army was starving, naked, and demoralized. The commissions of those soldiers who had not already deserted were set to expire 3 weeks hence on January 1, 1777. Very few indicated an intention to reenlist, and there were even fewer new recruits; Washington would have no army in a matter of days. The population had lost faith in the cause of the revolution and acquiesced to British rule. Washington knew that soon the Delaware River would be frozen, allow-

ing the British troops to cross easily to take Philadelphia. At that juncture, the Americans would be defeated.

The Americans were clearly at a point when the Revolution could fail. Considering his options, Washington decided that he must do something differently. He rejected the advice of his council to continue his retreat further into central Pennsylvania in the hope of attracting more recruits. Instead, he chose to be proactive. He made the astonishing and bold decision to divide his small force and to attack the British. I have come to believe that Washington came to this particular decision in large part because he recognized that unless he changed his course of action, he was doomed. Acknowledging his predicament, he chose to take the situation head-on and with an eye toward the future. This allowed him to determine the details of his situation and to recognize that he actually had necessary strengths. He recognized that the Germans mercenaries stationed at Trenton arrogantly thought that the Americans were no longer capable of putting up a fight. He knew that the British were so overconfident that they chose the comforts of the town of Princeton, away from the front. And he knew that on Christmas night, his opponents would be drunk and sleeping after their feasting.

On Christmas night of 1776, he shuttled his army of 2000 men, along with horses and cannon, back across the Delaware River and defeated the British at the Battle of Trenton. This victory gave a renewed sense of hope to the Americans. Thousands of men enlisted in the army, and once again the citizens believed in the cause. This strategic action was arguably the turning point of the war, and of American history.

THE SITUATION IN THORACIC SURGERY TODAY

Today, it is thoracic surgical education that is in a difficult situation. I believe that we in thoracic surgery have arrived at a time in our history when we must act, and act now.

Like the American Revolution, thoracic surgical education had a glorious beginning. Thoracic surgery was the

next new thing, and everyone wanted to do it. Competition for thoracic surgical residency positions was keen; only the best and the brightest surgical residents were chosen. In any given hospital, the thoracic residents were the best doctors in the hospital. Not long ago, pictures of the thoracic surgical chief residents at Massachusetts General Hospital even hung in the lobby.

No more. Today, as said by Winston Churchill during World War II, “the news from the front is bad.” We recognize our situation. We in thoracic surgery have had a growing sense of despair. As the threats to our specialty have progressively become tangible over the past decade, we have gone through Kübler-Ross’s stages of grief: denial, anger, bargaining, and depression. I now fear that we have been desensitized to our situation and have reached the fatal level of acceptance of our fate.

We are all familiar with the data: the number of applicants to Thoracic Surgical residencies has fallen steadily since 1995. This year, in fact, there were 97 total applicants for 118 positions, and only 67 were graduates of U.S. medical schools. The thoracic surgical resident is now an endangered species, and if this trend continues, it will become extinct.

The decline in thoracic surgical residents has in turn led to a loss in the number of institutions with thoracic surgical training programs, down more than 20% since 2002 (Figure 2). This represents an erosion and ultimate loss of the infrastructure needed for thoracic surgical education. Once this infrastructure is gone, it will be extremely difficult, if not impossible, to regenerate. In my opinion, the endangerment of the thoracic surgical resident is the single greatest threat to our entire specialty.

Many reasons have been put forward to explain our endangerment. Professional reimbursement has changed, suggesting to some that that society no longer values what we do. New technologies may now be used to treat diseases of the chest, and our specialty lacks the skills necessary to embrace the technologies. Student debt is excessive. People don’t want operations, and some infer the end of days for surgery. The job market is tight. Although there is certainly some truth to each of these statements, I think that it has become all too easy to use them as excuses.

In my opinion, these factors and others must be acknowledged, and we must take them head-on. But these same factors apply to all specialties. They are not unique to thoracic surgery, yet it is specifically the thoracic surgical resident that is endangered. In fact, while the number of first-year thoracic surgical residents decreased 24% between 2002 and 2007, the corresponding numbers increased by 15% in plastic surgery, 21% in urology, 31% in vascular surgery, and 52% in neurosurgery.²

We in thoracic surgery must begin to take responsibility for this situation and to act proactively. To attribute our problems to someone else or to circumstances that we simply cannot control is the hallmark of defeat. We have dedi-

FIGURE 2. Since 2002, number of institutions with thoracic surgical residency programs has decreased by more than 20%. A, Institutions with thoracic surgical residency programs in 2002. B, Institutions with thoracic surgical residency programs in 2009.

cated our professional careers to the greatest field in all of medicine, and we have arrived at a turning point. We must act now.

THE GREAT IRONY

I find this decline in thoracic surgery applicants to be ironic. Thoracic Surgery will certainly change, but it is not going away. The facts of the matter are these. First, the number of Thoracic Surgical procedures continues to grow. Second, by all accounts, a shortage of thoracic surgeons is on the immediate horizon.

First, the surgical data. It is true that during the past decade, the number of coronary artery bypass grafting operations has decreased by approximately 25% nationally. Medicare claims data indicate that this trend has slowed significantly during the last 6 years, however, suggesting that the decline in bypass volumes may be ending. At the same time, the number of aortic valve operations has increased by 28%. The number of mitral valve operations has increased by 24%. The number of pulmonary resections has increased by 25%. The number of aortic procedures has

risen by 28%. The number of mechanical assist devices is up at least 100%. With the exception of coronary artery bypass grafting, billing for virtually every thoracic surgical *Current Procedural Terminology* code has increased in volume during the past 5 years.³⁻⁶

Yes, the case mix of thoracic surgical practice does look different, but these changes offer exciting opportunities for continued growth. Furthermore, advances in the molecular therapies of thoracic malignancies will almost certainly increase the number of pulmonary and esophageal resections by converting the unresectable into the resectable. New endovascular techniques have already expanded the ability to treat diseases of the thoracic aorta. Clearly there is plenty of work to do, and it seems to be growing.

Second, all workforce projections suggest a significant undersupply of thoracic surgeons within the next 10 years.³ According to the Association of American Medical Colleges, more than 50% of currently practicing thoracic surgeons are older than 55 years, and at least 15% are older than 65 years. Survey data from the Society for Thoracic Surgery and American Association of Thoracic Surgeons strongly imply that more than half of the currently practicing thoracic surgical workforce will retire within the next 12 years.^{3,4}

The seriousness of this decline is exacerbated by the fact that the population is aging. Thoracic surgical diseases tend to increase in prevalence with age. In 2010, approximately 13% of the U.S. population will be older than 65 years. By 2030, this figure will grow to 20%.⁴ Thus the demand for thoracic surgical procedures will continue to grow. With the need for thoracic surgeons strong, growing, and projected to grow even more as the populations ages, all workforce projections predict a significant shortage of thoracic surgeons within the next 10 years.

So not only is there plenty of work to do, with the amount of work growing, but there will soon be no one left to do it. The economic laws of supply and demand suggest that market forces will dictate rising professional opportunities for those practicing thoracic surgery as the workforce shrinks. Today is the perfect time to get in. These data should be seen as a tremendous opportunity for young physicians. Why, then, are so few interested in pursuing it?

WHY NOT THORACIC SURGERY?

To answer this question, I think we need to take a hard look in the mirror. In my opinion, there are 3 major reasons. First, thoracic surgery is hard. I am reminded of a conversation that I recently had with a medical student, who scrubbed in during a valve operation. At the end of the procedure, I asked the student what he thought. "That was the coolest thing I have ever seen," he exclaimed. Postoperatively, as we sat together in the intensive care unit talking about the patient's physiology, I said "Have you thought about being a heart surgeon?" He replied, "I don't think so—it's too

much work. It's too hard". Without thinking, I reflexively responded to him with the lines spoken by the actor Tom Hanks in the movie *A League of Their Own*. I said, "It's supposed to be hard. If it wasn't hard, everyone would do it. The hard is what makes it great." Thoracic surgery is hard, and in my opinion we need to stop apologizing for that. The truth of the matter is that it has always been hard—this is nothing new. If anything, it is easier today than ever. The inherent nature of thoracic surgery lies in dealing with difficult problems, and it will therefore always be hard. Despite recognition of the rigors of thoracic surgery, unfortunately, our collective approach has been to try to water down the specialty to avoid this criticism. The right people to do our specialty are out there. Somehow, we've begun to act like victims and to wait for applicants to come to us. Instead, we need proactively to seek out and find the right people.

Second, there is strong evidence that thoracic surgical education in its current form is not working well. There is widespread dissatisfaction with the product of our residency programs among thoracic surgical faculties. These subjective feelings are supported by the data. The recent performances of the graduates of our programs on the qualifying and the certifying examinations given by American Board of Thoracic Surgery have been poor. For each of the last 4 years, at least 20% have failed the written examination. Among those who passed the written examination and went on to take the oral examination, nearly 30% have failed in each of the last 3 years. This year, 31% of those taking the oral examination for the first time failed. When speaking of such Board score performance as a parameter of the quality of Thoracic Surgical education, it is easy to blame the students. I actually think, however, that it reflects more on the teachers than on the students. This speaks to the third reason, which is the most important.

As Winston Churchill said, "We occasionally stumble over the truth, but most of us pick ourselves up and hurry off as if nothing had happened." At the core of the problem is the fact that we collectively have lost our moral compass as teachers. It has become far too easy in too many programs to view the thoracic surgical resident more as an indentured servant than as a student and a future colleague. Years ago, Dr Shumway said, "The hardest thing about cardiac surgery is getting to do it." Judging by the research presented at last year's meeting in Hawaii by John Doty, this statement holds more truth today than ever.⁷

The teachers of thoracic surgery are the "keepers of the flame" of the specialty. We should be the champions of the future generation of surgeons. Sadly, the feedback from our residents about the job we are doing as teachers of thoracic surgery is disheartening. Associated with the decline in the number of thoracic surgical applicants, the feedback from those residents who have entered thoracic surgical residencies has been damning. Surveys conducted by the Thoracic Surgery Resident Association have indicated that

as many as 70% of respondents believed that the program director did not help them in finding a job. Forty percent said that they would choose a different program. More than 25% of thoracic surgical residents said that they would choose a different career. Fifty-two percent said that they would not recommend cardiothoracic surgery to potential resident applicants.^{8,9} Because our residents that should be the greatest pride of our profession, and therefore the best advertisements for our residency programs, it should be no surprise that applications are falling. I believe residents' lack of enthusiasm is the root cause of the declining applicant pool. Why would anyone choose a specialty in which the current residents did not feel supported, were demoralized for 2 to 3 years, and then went on to fail their Boards?

In his book *How the Mighty Fall*,¹⁰ Jim Collins described the characteristics of great enterprises that fail. He contrasted these with the actions of those enterprises that prevent themselves from failing. He has found that the road to failure begins with the loss of an understanding of the factors that created success in the first place and of what it takes to remain successful. Instead, success becomes regarded "as an entitlement." In other words, failure begins with the loss of a corporate moral compass. His research further indicated that the decline of an enterprise is typically self-inflicted; however, great enterprises do have the capacity to self-correct. When poised to fall, they can prevent failure and in some cases recover to become even greater than they had once been. In my opinion, these principles apply to thoracic surgical education.

STRATEGIC INFLECTION POINT

Not only must we collectively regain our moral compass, we must reengineer the way we train people to be thoracic surgeons. For a long time, the essence of thoracic surgery has remained fairly constant. But as Andrew Grove¹¹ wrote, "Sooner or later something fundamental in your business world will change." This process of change has been manifest in industry forever. Successful enterprises must be able to see and understand such changes to adapt. When the environment changes, an organism, company, or surgical specialty must change its phenotype to survive. Failure to do so leads to extinction.

Whether in nature, the corporate world, or a surgical specialty, it is ultimately forces of competition that drive the changes in the phenotype of an enterprise. Thirty years ago, Porter¹² described the major competitive forces that are exerted on a business enterprise that force a phenotypic change.

According to Porter,¹² a business enterprise is subjected to external forces such as the vigor of a business competitor or the viability of a business supplier. All corporate entities must reach some steady state as these forces are balanced. If one or more of these external forces reaches sufficient magnitude, it threatens the viability of the enterprise.

Phenotype Change

FIGURE 3. When external force of competition is sufficiently large, it will threaten enterprise viability. In turn, enterprise must change how it does business to maintain its viability. In other words, it must change its phenotype.

When this happens, the enterprise must change the way that it does business, its phenotype, to remain viable (Figure 3). The mechanisms by which this process of transition from one phenotype to the next occurs determine whether the enterprise thrives.

In his book *Only the Paranoid Survive*, Andrew Grove¹¹ describes this transition process from the old way of doing business to the new as a "strategic inflection point." He describes this as a time in the life of an enterprise when its fundamentals are about to change. After this change, the enterprise will either flourish or fail. According to Grove, such a strategic inflection point leads to a full-scale change in the way that the enterprise conducts its business. Grove also notes that it is difficult to know just when a strategic inflection point occurs, even in retrospect. The recognition may take place in stages. As Grove indicated, first, there is a sense that something is different. Customers treat you differently. Trade shows are weird. Competitors who you once ignored take business from you. When the early signs of a strategic point are noted, one can't be sure that they are necessarily important.¹¹ At some point, however, the existence of the strategic inflection point is incontrovertible.

Whether an enterprise lives or dies after a strategic inflection point is determined by how it manages this transition. Because it is by definition difficult to know just what to do to become the "phenotype of the future," the transition from the old to the new can be perilous. According to Grove,¹¹ dissenting ideas about the right direction to go split people on the same team. There is a growing ferocity, determination, and seriousness surrounding the views of various participants. Divergent views are held strongly, like religious tenets. Wars erupt between long-term friends and colleagues.

FIGURE 4. Traditionally, treatment of thoracic disease was vertically integrated. It was done sequentially by thoracic surgeons. *Post Op*, Postoperative; *ICU*, intensive care unit.

THORACIC SURGERY IN TRANSITION

I believe that thoracic surgery education is going through such an inflection point. As Grove described, it is difficult to pinpoint just when it began. But clearly and unmistakably, things have changed. To understand why thoracic surgical education is of paramount importance, we must first address thoracic surgery as a specialty.

Thoracic surgery is big and powerful. It financially drives the American hospital system. Like all big, powerful businesses it has attracted the attention of people who want a piece of that business. This fact motivates the development of one of the most potent external forces of phenotypic change, the threat that the business you are doing can be done differently.¹¹ In thoracic surgery, there are many examples of this threat manifested in a variety of different ways. To name a few: thoracoscopy done by pulmonologists, pneumothorax treated by emergency department physicians, esophageal cancer treated without resection, thoracic aortic aneurysm treated by endovascular stents, lung cancer treated with radiofrequency ablation, coronary artery disease treated with coronary artery stents, valvular heart disease treated by percutaneous techniques.

These are examples of external forces that are driven primarily by technologies and skills possessed or acquired by

other medical specialties. In addition, however, our specialty is changing from one of vertical integration to one of horizontal integration. From its onset, and through its heritage, the treatment of thoracic surgical diseases was vertically integrated. Each step in the care of a thoracic surgical patient came sequentially, and each function was performed by a thoracic surgeon. Thoracic surgeons made the diagnosis of chest disease, staged it, and determined whether an operation was indicated. Only our specialty performed the operative procedures. Postoperatively, thoracic surgeons cared for thoracic surgical patients in the intensive care unit setting, cared for them on the postoperative ward, and provided longitudinal follow-up of thoracic diseases. Finally, the quality of thoracic surgical care was completely within the domain of thoracic surgeons; thoracic surgeons alone decided what was and was not good quality thoracic surgical care (Figure 4).

Whether we like it or not, the treatment of thoracic diseases is changing to become horizontally integrated (Figure 5). The diagnosis of chest diseases is made not only by thoracic surgeons but by cardiologists, internists, and radiologists. The preoperative evaluation and staging of the thoracic surgical patient is now conducted not only by a thoracic surgeon but by an internist, cardiologist, pulmonologist, or anesthesiologist. No longer are thoracic surgical procedures the exclusive domain of the thoracic surgeon. Vascular surgery, cardiology, interventional pulmonology, interventional radiology, and emergency department physicians routinely perform procedures that 10 years ago fell squarely within the exclusive domain of thoracic surgeons. Postoperative care of thoracic surgical patients is now provided not only by thoracic surgeons but by nonsurgical intensivists and hospitalists. Longitudinal follow-up by thoracic surgeons has largely been abandoned in many centers and delegated instead to nonsurgical disciplines. Finally, the quality of thoracic surgery is no longer exclusively within the domain of thoracic surgeons. Instead, what determines the quality of thoracic surgery is largely determined by a state or regional database, displayed on the front page of a regional newspaper without an understanding of its flaws by the press or the public.

TREATMENT OF THORACIC DISEASE

	Thoracic Surgery		Lay Process		
Quality	Thoracic Surgery	Internists	PCP	Cardiology	Oncology
Long Term	Thoracic Surgery	Hospitalist	Cardiology	Internists	Other
Post Op Care	Thoracic Surgery		Intensivists		Cardiology
ICU Care	Thoracic Surgery	Cardiology	I/R	Vascular	Pulmonology
Procedure	Thoracic Surgery	Cardiology	Oncology	Radiology	Pulmonology
Diagnosis	Thoracic Surgery	Cardiology	Oncology	Radiology	Pulmonology

FIGURE 5. Today, treatment of thoracic disease has become horizontally integrated. Each step in treatment of thoracic disease is conducted not only by thoracic surgeons but by other specialties. (Figure is not intended to represent scale of all specialties involved). *PCP*, Primary care provider; *Post Op*, postoperative; *ICU*, intensive care unit; *I/R*, interventional radiology.

Just as Grove¹¹ describes, it is difficult to recognize just when this strategic inflection point in thoracic surgery began. It did not begin at a precise moment. In retrospect, however, there have been many indications of a change. For me, two milestones stand out. First, our strategic inflection point became crystal clear the first time I saw a thoracic aortic endograft successfully deployed, signaling a change in the treatment of aortic disease with techniques possessed by other specialties. This revealed that for thoracic surgeons to continue to treat aortic diseases, we would need skills that we did not have. This in turn has triggered a surge in hybrid operating rooms across the country. In these hybrid operating rooms, thoracic surgeons team with other specialties to treat difficult thoracic diseases. This is an example of the horizontal integration of the treatment of thoracic diseases that I mentioned earlier.

The second milestone was the appearance of position papers published in the scientific literature that espoused the need for intensivists, rather than surgical specialists, to care for the patients of surgical specialties in the critical care setting. It has been a cry for intensivists to supplant the role of the thoracic surgeon in the care of critically ill thoracic surgical patients. This, in turn, has triggered the “closure” of some intensive care units, precluding some thoracic surgeons from direct postoperative patient care.

The only way by which the specialty of thoracic surgery can effectively change its phenotype is through the educational paradigms of thoracic surgical education. Our educational enterprises must collectively provide the flexibility and the educational fundamentals to allow surgeons to function in new ways.

And this is where we are trapped (Figure 6). Thoracic surgical education in the United States is now affected by tremendous external factors. Examples of these factors include the changes in the current prerequisite for thoracic surgical education which is a general surgical residency. One might persuasively argue that general surgical education no longer prepares one for thoracic surgical education in an effective manner. Another external force is the 80-hour work week; few have any doubt that work hour limitations have significantly diminished the quality of thoracic surgical education. Another example of such external forces is that our specialty lacks effective mechanisms of postgraduate education. It is extremely difficult, if not impossible, for many practicing surgeons to acquire and implement new surgical techniques.

We cannot let these circumstances determine our outcome. I have no doubt that to secure the future of the specialty of thoracic surgery we must first secure the future of thoracic surgical education. That is my message today. It is true that thoracic surgery as a specialty is in transition. In my opinion, to successfully navigate this transition we must successfully navigate the transition of thoracic surgical education.

FIGURE 6. Specialty of thoracic surgery can change its phenotype only through mechanisms of thoracic surgical education. Currently, educational paradigms are adversely affected by many external factors, including changes in general surgical training, work-hour limitations, and deficiencies in thoracic surgical postgraduate education.

THE STRATEGIC INFLECTION POINT OF THORACIC SURGICAL EDUCATION

Because the specialty of thoracic surgery is changing, thoracic surgical education must change. The future of the specialty of thoracic surgery depends on whether or not thoracic surgical education is able successfully to navigate this strategic inflection point, rise to new heights, and reenergize our specialty. Failure to do so clearly jeopardizes thoracic surgery as a specialty.

Yet we have been slow to change our educational process. John Alexander created the first thoracic surgical residency at the University of Michigan in 1928. For the past 81 years, the structure of thoracic surgical education has consisted of 1 year, and later 2 or 3 years, of training after completion of a general surgical residency. During these same 81 years, thoracic surgery as a specialty has emerged as the leader of the medical world. Like the leader of any business, we in thoracic surgery got to where we are by being good at what we do, including our educational paradigms. So I think that it is natural for our specialty to want to keep doing the things that have historically worked for our specialty. And when the environment changes, it seems human nature to cling to the security of the past. Today, however, we recognize the changes in our environment. We see our specialty changing from vertical to horizontal integration. We recognize the changes in the requisite surgical skills and the fund of knowledge for the treatment of thoracic surgical diseases. We recognize that there are a growing number of ways that what we do can be done differently. We see objective evidence that our educational phenotype is maladaptive to these environmental changes in the declining number of resident applicants in thoracic surgical programs. Why are we slow to respond?

It is perplexing that we struggle to react to these changes. I believe some of this struggle can be explained by irrational psychologic forces that undermine our specialty’s perspective

of our world. In their book *Sway*, the Brafman brothers¹³ describe certain psychologic forces that explain the irrational behavior of individuals, industries, and medical specialties. Such forces determine our perception of the world and our responses to these perceptions. Two powerful forces affecting thoracic surgery are loss aversion and commitment.

We in thoracic surgery have a self-image that is based in a wonderful history. We have done things a certain way for a long time. We are proud of our positions in society, in our hospitals, and in health care as a whole. Understandably we don't want to lose any of this, and we therefore don't want to change anything that might lose it for us. We have what the Brafmans refer to as "loss aversion."¹³

When combined with a second powerful force of emotional sway, that of commitment, the drive to continue our current mode is potent. We were all drawn to thoracic surgery by its image. As an individual, one can't get into our specialty without a very strong sense of commitment to thoracic surgery. Once in it, one can't function in our specialty without commitment. As a group, we are absolutely committed to our specialty and more importantly, to our self-image from what our specialty has historically done.

It is this combination of commitment with loss aversion that makes it difficult for us to change. It makes it very difficult, if not impossible for us to see alternatives to our current educational paradigms. Our specialty is not unique in experiencing these emotions. Corporate history is filled with examples of business enterprises that were either able or unable to overcome these forces. Those that have been unable to overcome them, such as General Motors (GM), have not fared well. On the other hand, those companies that have been able to do so, such as Intel, have succeeded.

GM was a global corporate icon. It rapidly came to represent the supremacy of American manufacturing. It was the largest and most important company in one of the most important industries in the world. It produced products that provided a sense of identity for the individuals who bought them. Throughout the 1950s and 1960s, it dominated the American automobile market with more than 50% of the market share. It became a company with a confident self-image and corporate culture that it did not want to lose and was committed to maintain.

By the late 1970s and early 1980s, issues of fuel economy and quality control resulted in a progressive loss of market share to Japanese car makers, especially Toyota. By 1990, it was becoming clear that GM needed to change; the way that it had conducted business for decades was not going to work indefinitely. It did not completely ignore those signs. In the mid 1990s, GM introduced an electric car, the EV1. In 1996, GM proudly announced that the EV1 would be in showrooms in the fall of 1997. But in the end, GM did not change its phenotype; the company withdrew its plans to release the electric car. Instead, GM remained committed to its established phenotype, the sport utility vehicle (SUV). That

same year, hybrid cars were widely available from Japanese manufacturers and seen by many as the automobile phenotype of the future. While the Japanese industry expanded its innovation into fuel economy and hybrid vehicles, GM made a strategic decision instead to remain committed to its SUV phenotype; it bought Hummer in 1999. In an interview given to *CNN/Money* in January 2004,¹³ a senior executive for GM was quoted as saying, "Hybrid cars make no sense economically or environmentally." When asked why GM continued to rely on the manufacture of the SUV in lieu of more fuel-efficient vehicles, this same executive was quoted in a 2007 interview with *The New York Times* as saying that rich people "don't care about the price of gas"; GM remained committed to its SUV phenotype. GM did introduce its first hybrid car, a Saturn, in the spring of 2008, just before the price of gasoline hit \$4 per gallon. But it was too late; the high price of gasoline finally killed the SUV market. The world's economy was flattened in the autumn of 2008, and automobile sales fell worldwide. Unable to withstand huge financial losses, GM filed for bankruptcy in June 2009. Clearly, its reluctance to change its phenotype led to its collapse.

On the other hand, the corporate history of Intel provides an important contrast. Intel was founded as a company that made memory chips, and its self-image was that of "the memory company." As the computer industry became horizontally integrated in the 1980s, its memory chips were an important component of all computers. By the early 1980s, it had risen to be the world leader among makers of memory chips. At the same time, however, the Japanese were developing chip manufacturing technology that quickly surpassed Intel's ability to compete in the memory chip world. By November 1985, Japanese memory chip manufacturers began to surpass Intel in market share; it became clear to the leadership of Intel that their company had rapidly fallen from the world leader of an industry to a distant follower. Former Intel chief executive officer, Andrew Grove,¹¹ described the decision by Intel to change its phenotype in his book *Only the Paranoid Survive*. Grove recounted his 1985 conversation with Intel co-founder Gordon Moore. He asked Moore, "When we get kicked out of Intel, and the Board brings in a new CEO, what do you think he will do?" Immediately, Moore responded, "He will get us out of the memory chip business." The answer was obvious; they needed to change. He then asked, "Why shouldn't you and I walk out the door, come back in, and change it ourselves?" This is how Intel overcame the sway of loss aversion and commitment to its self-image as a memory chip company and became a microprocessor company. This change was not accomplished easily. As a result, however, Intel survived, regained its former glory, and remains one of the most successful companies in the world.

By this analogy, what would each of us do if we approached the door of a current thoracic surgical residency without the bias of our existing self-image? Would we go

in? I am willing to wager that many would not do it. The fact is, the young people of today approaching the door of a thoracic surgical residency are simply not crossing the threshold. Thoracic surgical education requires change, and we should change it ourselves.

We must look into the future of how thoracic surgical education should be done, rather than the past of how it has been done. As advised by the Brafmans,¹⁴ only by forward thinking can we avoid the force of loss aversion. Thoracic surgical education is clearly trying to navigate itself through its strategic inflection point. Whether it thrives or not after this strategic inflection point will be determined by how it manages this transition. Because it is by definition difficult to know just what to do to be the phenotype of the future, the transition from the old to the new can be perilous. Andrew Grove's description¹¹ applies to the transition of thoracic surgical education. Ideas of what the right direction should be have split people on the same team. There is a growing ferocity, determination, and seriousness surrounding the views of various participants. Divergent views are held strongly, like religious tenets. Wars erupt between long-term friends and colleagues."

No single idea, no single person, and even no single training program will provide a solution for the specialty. But people do follow answers. And The Western Thoracic Surgical Association is providing answers. While I do not wish to overlook the contributions of anyone, I do wish to draw attention to several members of The Western Thoracic Surgical Association who are leading the way.

Craig Miller has been a driving force behind an effort to examine thoracic surgical education. He played an important role in helping to bring all corners of the specialty of thoracic surgery together to reengineer the Joint Council of Thoracic Surgery. He and his colleagues at Stanford established the first 6-year integrated thoracic surgical residency in the United States. Three more programs have since followed.

The first study to document the decline in thoracic surgery resident operative experience since the implementation of work hour limits⁷ was the recently published study by John Doty. These data played a prominent role in the discussions at the recent Accreditation Council for Graduate Medical Education summit on resident work hours and were among the only data available documenting the duress of thoracic surgical education.

Without question, it is necessary to develop methods of simulation for thoracic surgery. Simulation will be the single most important element going forward in thoracic surgical education at all levels, and Jim Fann has emerged as a national leader in this regard.

The education of congenital heart surgeons has undergone a metamorphosis with the establishment of an accreditation process for the first time. The first such accredited program was established by Vaughn Starnes and Win Wells at the

University of Southern California. Today, a third of all of the Accreditation Council for Graduate Medical Education-accredited programs in congenital cardiac surgery are in the west: the University of Washington, the University of Southern California, and the University of Colorado.

Members of The Western Thoracic Surgical Association have been recognized for their educational efforts as recipients of national teaching awards from the TSRA. Ed Verrier is a past recipient of the Socrates Award. Joe Cleveland and Mike Mulligan received the McGoon Award for 2009.

The new and reengineered Joint Council is now a reality and will help to shape the phenotype of the future of thoracic surgical education. Doug Wood was instrumental in helping to provide the vision for the future of the Joint Council and in helping to recruit its education leader.

Ed Verrier has been recruited to lead the Joint Council and is already making an impact as the organization helps to shape Thoracic Surgical Education at the graduate and post-graduate levels.

For more than 35 years, The Western Thoracic Surgical Association has led by example. Its scientific meetings have been a consistent forum for the expression of innovative ideas. Many of the concepts of modern thoracic surgical practice have been derived from the membership of the Western Thoracic Surgical Association. As the phenotype of thoracic surgical education changes, we may be confident that it will be members of The Western Thoracic Surgical Association that lead the way.

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