Leadership and Innovation: The Needed Role for the Engineer and Scientist in Our Society

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Abstract-_The proliferation of new technologies, one of the primary keys to modern societal growth, relies on the development of two individual but highly interrelated competencies: leadership and innovation. These two are the basis for the successful development of most of the major technologies in production today and, at their best, they are also the genesis behind most of the large commercial and industrial organizations currently operating in the global marketplace. It is the state of health of these two linked competencies that often determine the longevity and profitability of these organizations. The question should then be what role does, and will, the engineer and scientist play in this leadership driven innovation play and how will we be the architects of our own future. Have we done enough and what will scientist and engineers need to do in the future to continue a growth-based legacy?_

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INTRODUCTION

I believe we should start off by addressing one of the more important and fundamental questions of the day. It is most likely one of those same questions that each succeeding generation asks: "What is it that the collective "We" intends to leave as a legacy for our children?" If you pay attention to the popular press, and especially many movie themes, what you get is doom and gloom. Plus, if you add to the mix the future role that advanced technology could play, then surely we will all perish in a ball of fire or maybe our heads will simply explode.

For the fun of it, let's look at a few of these past beliefs. It hasn't been that many centuries since we could have sailed off the edge of the Earth. In the 1800's, the prevailing thought was that a train moving faster than an animal could run would make us all go mad. In the last century, leaving Earth in a spaceship would alter us genetically, or worse punch a hole and let all of the air out. My favorite is: In this century I am convinced that social media will end life as we know it, or at least make my head explode.

The truth of the matter is technology serves us not only for our convenience and pleasure; it has also prompted our continued survival. It has allowed us to move the thresholds farther and farther from what could have been survived just centuries ago. It has also put to rest an ever-growing list of unrealistic and unsupportable beliefs, most likely a necessary part of the process.

With respect to our continued survival and societal growth, it is with the medium of energy and the driving forces of innovation and leadership that represent two of the key factors for our success. In addition to these factors is the concept of self-sufficiency, an essential ingredient that makes us stand on our own and reach for ever-increasing heights. It is through technology that we have allowed ourselves to develop creatively and intellectually along with immeasurable advances in our social order.

THE PRICE OF PROGRESS

Of course, this has come at a price that some say is too high and which has presented the following dilemma, at least for some: Should we continue to advance or maybe go back to a simpler time?

I, for one, know without question that that simpler time occurred during my childhood or, maybe from one of my fantasies, some medieval time where I could have been a knight in shinning armor ready on a moment's notice to rescue a local damsel in distress. I also remember that my Dad argued that that simpler time occurred while he was a child or when the Native Americans flourished here.

It turns out that each of us has a preferred simpler time that we reminisce about. The memories of those simpler times are normally devoid of the actual complexities of the day, either through selective memory or just plain dreamer's choice. These notions also make for great story lines in books and movies but the reality is much more complex and interwoven to stop and go back to a simpler time.

Think about the consequences of simply slowing down technological progress. It would have unparalleled and dire consequences on us, our society, the environment and the list goes on. In fact, the very people who suggest that we need to stop technical advances are the ones who use them to advance their causes. I would love to have those technical illiterates hand over their keys, sever their power lines and, once their batteries run out, shut off their social media.

THOSE WHO EMBRACE CHANGE

The reality is that few people understand the complete picture of the interdependencies that exist within our society and particularly the environment we live in, or the inventive pathways that allow us to move forward and to make progress in that complex system. Fortunately, there are a few amongst us who do see the bigger picture.

These are the few that truly embrace change. For them, it is with the embrace of change where innovative breakthroughs can and do occur. A large percentage of the more aware are the scientists and engineers who seek to solve the complex problems that society generates for us. Within this small group there is an even more specialized group of what are often referred to as the troublemakers, misfits and non-team players, at least that is what they are considered initially. They are most likely in large measure the innovators that move us forward and provide the timely breakthroughs that have been so historically necessary for our survival.

Key additions to these innovators, along with their passions, are the leaders who drive them into the marketplace. In fact, to be truly effective requires both sets of these characteristics. Thus, as is often the case, the stewardship of both innovation and leadership determines the rate of advancement of a society, the lack thereof its decay. All of society had best hope for their continued contributions, or at least they should try to get out of their way.

A large percentage of these troublemakers in both camps, let's call them visionaries, are technically trained often as engineers and scientists. They somehow see a different future than do most and use the tools of their trade to follow that vision. Most of these types "self-select" their careers and disciplines, as do most scientist and engineers. So, they often have little choice in how they react in and to their social environment.

Scientists and engineers and the leadership that drives them are for the most part:

- Less social (more introverted),
- Obsessively driven by visions of a better future (tendency to OCD characteristics),
- Less inclined to see the world as it is seen by the majority (with matching tunnel vision which is put down as folly by most of the uninitiated and as part of being overworked by those who care the most for them), and
- Even more unlikely to be happy with the final results of their work (they tend to get bored easily and start anew, probably on something totally unrelated).

As for those that care the most for them, I feel a special sympathy, and this is particular true for the significant others who share their lives. For instance, my wife constantly tells me that all scientists and engineers are weird, and impossible to live with, who just can't leave well enough alone. Then, in the next breath, she will ask me to go and fix something.

These visionaries are often called risk takers and seemingly independent or oblivious to mainstream thought. The truth is that they don't have an absence of risk; they just have a much higher threshold or even more likely they don't understand the term. As far as thinking outside of the box, well, they have been given way too much credit. Fortunate for all of us they just couldn't find the box.

THE TRUE VALUE OF INNOVATION AND LEADERSHIP

Can we, in fact, overstress the value of innovation and leadership and the role they play when combined for the benefit of mankind and nature? I don't think so. It turns out we are the most successful macro-species on the planet. As mentioned earlier, this is in a large part because we are inventive, innovative, and in our best state, self-sufficient with the leadership driven vision to push through to the end. We rise to the occasion when threatened and we continuously help to generate a pool of creative, intelligent, and consciously driven decision-makers, the next generation.

When these individuals are technical trained and the leadership is so inclined, we get changes and solutions at a rate to meet our problems and needs, albeit often not with the timing that we would all like. Some of their problem solutions are evolutionary and some are revolutionary. All will go through a maturation process to get to the

marketplace, or in many more cases, they just won't make it.

To be an innovation requires that the invention mature into a marketable solution. It also requires a level of leadership backing that idea, commensurate with the disruptive nature of the invention. Sometimes the key elements just don't come together. For instance some of the successes, and also the failures, are in the timing. More is in the heart and the passion of the creators, leaders, and sponsors. The rest is with consumer or end-user acceptance.

History shows how some of the most innovative technologies were from the start doomed to failure but for the persistence of the creators and their leaders and sponsors. Note that the more potentially disruptive the solution, the harder it will be to get to a successful market no matter how valuable the future will show the end result. So, if all of this is at least slightly true why are we in the state we are in? Are we even in a state that needs to be changed? If the innovation process is such that when we need change, the white knight will appear to save the day, then why all of the current fuss about innovation, or the lack thereof?

WHY THE CURRENT FUSS OVER INNOVATION

One of the contentions of this piece is that society and its needs are evolving at an ever-increasing rate. What used to be generational problems, those recognized in time for the youth to be educated about and then to spend their careers into retirement solving, are now problems that need to be fixed by at least Friday after next, just in time for the next crisis. We no longer have the luxury of waiting for visionaries to arrive to save the day; we now need to help find them and to provide the tools to encourage their growth and productivity. All the while we will need to stay out of their way, remaining ready to catch their next hair-brained idea, to drive it into the marketplace.

What we need to force recognition of is that the sub-set of the population that have the requisite attributes to be visionaries is much greater than is currently understood or accepted. They are all around us, and most of them are among the young. It turns out that the current system has not exposed or allowed them to develop the requisite skill sets they might need to breakout and do innovative things. What, you might ask, are some of the roadblocks we have thrown in front of our youth and the public in general?

A few of the roadblocks are:

- An educational system that celebrates and requires uniformity (encouraging mediocrity),
- A terribly uninformed and miss-directed media, and
- A technical trained but under-represented group in our governing functions, at all levels.

Fortunately though, a good many of these future visionaries will self-select into disciplines that might allow them to flourish. What we really have to worry about, then, is the inertia from the miss-information that constantly surrounds us, somewhat like the "sailing off the edge" statement earlier.

The failure to create a clear and technically accurate picture of our situation has fragmented our understanding of the number and severity of the problems that actually need to be handled. It has also diluted our attention and our willingness to rally support and to focus our energies as a united populace.

There are probably hundreds of additional reasons that could be added to this list, all equally important to someone, but outside of the scope of this discussion. What needs to be noted is that the general public is not the reason for a lack of innovation. They tend to embrace change, although the older among us may have more reluctance: back to the social media issue and my exploding brain.

We all want to have the next best thing, want to be fashionable, often unknowingly, we try to keep up with the Jones, plus, we always want to improve our lot and chances for survival. The reality is that features only buy us so much. It is the benefits that solve the problems and we are clearly due for some real change, most likely a long list of potential breakthroughs.

WE HAVE TO FIX THE PROBLEMS

How are we to get those changes and how do we make it happen on a timelier basis? The answer is buried in the question. The answer sits with the word "WE" as in "WE have to do it".

Sitting in hundreds of laboratories, shops, and offices all around the world are some of the most talented and technically skilled professionals that our current civilization has fostered. Getting to this skilled state, through the rigors of education and experience, and all of the constraints that had to be worked around, has provided us with immense insight. In other words, we have learned where all the minefields are. It would not be hard to argue that with all of these presented opportunities comes an even greater set of personal responsibilities and obligations, as if scientists and engineers don't already have enough to do.

Yes, I hear the complaints: there are too many rules and restrictions, no one listens and there are way too many problems, we are not paid enough and our job descriptions do not include that next "whatever", plus society expects too much, rewards too little, and often holds us too responsible for the outcomes.

Does any of this really matter?   Like the majority of the engineers and scientists, visionaries do self-select and they are who they are no matter how society tries to conform them.   While they may make drugs to help cover some of their symptoms, they really tend to be well-grounded (in their own way) and quite happy doing what they do, often indifferent of what goes on around them and independent of the accepted thoughts of the day.

The question: Is this enough?   I believe that with the rate of change that is running us to ground, we no longer have the luxury of expecting someone else to handle those things we currently think are outside of our purview. Scientists and engineers need to take a more aggressive role in our society in a variety of ways. The first is to recognize that the problems we see are most likely not seen or understood by the general public, who for the record are at the mercy of the media and their own limited perspective and understanding.   Second, the potential solutions visionaries might choose are also subject to the same scrutiny as above but they are also affected by special interests, their own personal prejudices, and the constraints of surviving the rigors of every day life.

It is because of what is expected, often demanded from them, that we should give society what they may not really want, but desperately need: the facts, the reality attached to those facts, and the process needed to implement the best solution.

On top of all of this, which could be considered a disruptive innovation in itself, is the need to bootstrap the next generation of leaders and innovators. They are all around us and need our help desperately.   I know because I have spent my career working with them.   Learning to mentor the next great visionary, and their contribution, is not only satisfying, it will also add perspective and a legacy moment to your own career.

On top of making an important contribution to someone's success there is an even more important use of scientist's and engineer's time: providing the factual information the rest of the world needs to make better-informed decisions that will, in the end, help us all.   Thus, I leave you with my version of an innovation/leadership challenge.

THE INNOVATION/LEADERSHIP CHALLENGE

First: Engineers and scientists must become the agents for change: adaptive, supportive, and disruptive.   Second: Engineers and scientists must incorporate innovation as their driver to be used as a tool to set policy for technological, cultural, and societal change.   Third: Engineers and scientists must learn to communicate effectively and to provide consensus based technical support for policy decisions. Finally, and for me the most important: Engineers and scientists need to find and mentor that next great set of visionaries: the innovators along with the leadership needed to make them successful.

The Innovation/Leadership Challenge:

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- Engineers and scientists must incorporate innovation as their philosophy to be used as a tool to set policy for technological, cultural, and societal change,
- Engineers and scientists must learn to communicate effectively and to provide consensus based technical support for policy decisions, and
- Engineers and scientists need to find and mentor that next great set of visionaries, the innovators along with the leadership needed to make them successful.

From my reference point, these individuals are most likely predominately within the ranks of our youth.   It is with them that we are leaving the problems that were created when we solved the problems from our days.   They are the ones living them and most likely they see them better and from the correct vantage point, for the future.   They also have the most energy and passion to address them but lack the experience and resources to easily face the challenges or to make the needed changes.

We can, and must, help them make that transition.

Authors' Biography

James E. Smith (PhD) received his Bachelor of Science and Master of Science degrees in Aerospace Engineering and Doctor of Philosophy degree in Mechanical Engineering from West Virginia University (WVU), Morgantown, West Virginia, USA in 1972, 1974, and 1984, respectively. He is currently the Director of

the Center for Industrial Research Applications (CIRA) at West Virginia University, where he is also a Professor in the Mechanical and Aerospace Engineering (MAE) Department.   He has taught at the University since 1976, before which he was a Research Engineer for the Department of Energy (DOE).   He was the 2009 SAE International President and Chairman of the Board of Directors, which afforded the opportunity to travel to the mobility and innovation centers of the world.

During his 40-plus-year engineering career, he has been the principal and/or co-principal investigator for various projects funded by federal agencies (Tank-Automotive Armaments Command (TACOM), Department of Defense (DOD), HEW, Department of Transportation (DOT), US Navy, Defense Advanced Research Projects Agency (DARPA), and Department of Energy (DOE)), international corporations, and numerous US corporations.   The work in these projects has resulted in the publication of over 250 referred journal and transaction papers.   This work has resulted in the granting of 32 United States Patents and numerous foreign patents on mechanical, medical, and energy-related technologies.

Dr. Smith, in his role as a professor and Center Director, has been actively involved in providing and/or enhancing technology solutions for the industrial marketplace.   Several of these solutions have resulted in proprietary technologies that have been instrumental to the continued success of these business efforts while others have resulted in the creation of several new business entities.

In his current role as a professor he has focused his attention on design related courses and a newly created program to encourage STEM focused students towards the creation of new self-created career directions, in contrast to just looking for a job.   In that role he has been instrumental in assisting these students in the formation of new companies in support of the new technologies and intellectual property they helped create in this program. Dr. Smith is a member of American Institute of Aeronautics and Astronautics (AIAA), Society of Automotive Engineers (FSAE) International, American Society of Mechanical Engineers (FASME), International Society for Computers and Applications (ISCA), American Society for Engineering Education (ASEE), Institution of Mechanical Engineers (FIMechE), and International Society for Instrumentation Engineers (SPIE).