Hard Knocks Episode-1: The First Cut is the Deepest

Formal Education Provided the Prerequisite Foundation But the School of Hard Knocks Taught Me How to Successfully Use It

(960 Words)

Series Preface

Year end is often a time to pause and reflect. I am sharing the stories in this short series because they are analogous to so many things that individuals and entire populations pursue that may not make as much sense with 20:20 hindsight as they seem to at the time. None of what I say here is new, which makes it all the more troubling because we all know it, and yet we sometimes still collectively behave as if we are oblivious to it. Hence we cannot be reminded of them too often.

Introduction

Once upon a time I was an early twenties engineer during the two oil embargos. Like many back then, I got caught up in the wide eyed optimism of the times regarding all that could be done to conserve energy and move to alternative energies. I even engineered and designed a passive solar/earth sheltered home that my wife and I had built, and lived in quite comfortably for almost 4 years while also monitoring the performance. We moved on but it remains a home for someone still today, over 30 years later.

The house was a thermal efficiency marvel. Fully 96% of all heat comes from the sun with only 1,500 watts of backup heat, the power of a hand held blow dryer (only $50-100/year). This was achieved despite being located just outside of Ann Arbor Michigan, one of the lowest percent sun locales in the U.S. with only 29% of possible sunshine in December and not much more in November or January. My singular goal was to come as close to 100% efficiency despite the poor conditions. I was singularly obsessed with maximizing that single metric to the exclusion of all others. If I could have eked out another 1% to get to 97%, I'd have done it. And therein lies one of the lessons and messages I am heading to.

The First Cut is the Deepest

Over the three decades since then I have evolved from the technical side to the business side, but with the benefit of technical knowledge and aptitudes that I acquired in those early years. I have worked on countless cost reduction initiatives, including a number involving energy. And I have worked on about an equal number of growth initiatives. One of the most important things I have learned the hard way, that I was oblivious to back then, is the law of diminishing returns.

> In the house example, it could easily have been 80-85% efficient for 20% less cost to build the house, yet only have increased annual heat bills by a couple of hundred dollars. The increased construction costs that were required to raise the thermal efficiency of that house from 80% to 96% efficiency would literally not even pay back in a hundred years. As a far more experience professional said to me at the time, which I dismissed out of hand, "the first unit of 'R-Factor' (R-1) in insulation is the most significant 'R-Factor'", e.g., every additional unit of 'R-Factor' added to it has increasingly diminishing benefit.
>
> In the same time period, at the building where I worked, I threw a sheet of heavy Visqueen at a cost of about $20 over the intake grate for half of the 'make-up' air system. It had been sized based on design standards from when the building was built in the mid-1960s, not the energy conserving 1980s. The heating bill dropped by thousands of dollars per month. But later we added insulation to the entire 40,000 square foot flat roof when reroofing it, but the incremental additional savings were far less significant while the cost of the insulation was thousands of times more, further emphasizing that "the first cut is the deepest".

We could write this passive solar/earth sheltered home example off as an aberration or occasional outlier in which one obsessed young engineer with no business background or exposure to the concept of business cases whatsoever ran amok, as I absolutely did. And write the Visqueen on the make-up air intake grate off as dumb luck, which it was. But in my experience, this type of behavior of doggedly continuing to try to push things far beyond the point of diminishing returns goes on around us every day from the individual level, to the local level, to the national level, to the global level.

Metaphorically, "the first 'R-factor' (R-1) is the most significant", "the first cut is the deepest", and likewise for thousands of other things. While we should not necessarily stop at that first action, how much further we should go beyond it are the judgement calls one needs to make with a strong recognition that we cannot repeal the law of diminishing returns. When we recognize that we are into diminishing returns it is time to move on and look for other low-hanging fruit. Where has the first cut not yet been made? Where has the first "R-factor" (R-1) not been applied? Where has the Visqueen not yet been thrown on the intake grate?

Episode-2 of 6 in a few days – (metaphorically) "There is Very Little New Under the Sun"

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Hard Knocks Episode-2: There is Very Little New Under the Sun

(968 Words)

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Every concept employed in the earth sheltered/passive solar home example described in Episode-1 has been well know and employed for thousands of years regardless of whether the ancients knew why it worked for them. Peoples in very cold climates often built their homes partially submerged in the ground for more temperate living. Many built their living quarters with orientation to the sun for passive solar warming. Many built their dwellings with major thermal mass in the structure, such as brick or adobe, to slow the heating of the day in hot climates and slow the loss of heat in cold climates. But what they didn't have was double, triple, and quadruple paned glass windows or fiberglass and foam board insulation to make the structure like a thermos facing south. Those more recent developments took the house from just preventing freezing to death to more comfortable than a standard home.

Looking at another set of examples, over the past decade there have been huge strides in the reduction in vehicle emissions and improvements in fuel economy without sacrifice to driving performance. There have been tremendous improvements in vehicle safety systems including anti-lock brakes, traction control, stability control, back-up

cameras, blind spot detection, collision avoidance, active cruise control, and moving on towards driverless vehicles. Not to mention hybrid vehicles and electric vehicles

Most people assume that these are relatively new ideas. But in fact, most are fifty to over one hundred years in the making. It just took until now for them to be brought the last mile on each of their many thousands of miles journeys. This is absolutely not because they were withheld or ignored, but could have been introduced earlier. In every case, one or more of the critical enabling technologies did not yet exist to take them from a great idea with many prototypes and test cycles under their belts, to commercially viable, affordable, safe and highly reliable products and features.

- Some of the earliest motor vehicle attempts by inventors at the dawn of the automobile were electric. But the batteries had very little range, made worse by the very inefficient electric motors of the times.
- Hybrids had been toyed with for at least 30-40 years, quite possibly much longer. But the same battery and electric motors inefficiencies of all electric vehicles also posed the same challenges plus the lack of cost effective sensors and controls to optimize the mix in the use of electric, internal combustion, regenerative braking in real time to make the whole system work optimally.
- Direct injection and very high specific horsepower engines have been in development for decades. But the engine control systems, fuel injection systems, not to mention robust enough materials for the engine itself to contain all that power without self-destructing, were not all available and affordable until now.
- In the area of electronic vehicle safety systems, sensors were not reliable enough yet, microprocessors were not high enough in capacity or fast enough yet, and none of them were affordable yet.
- And the list could go on and on and on.

As a final example, at the end of November I completed a three-month, full court press, research, analysis, and writing project on the subject of the global market for alternatively fueled commercial vehicles (That market research report will be published by BCC Research in the mid to later first quarter of 2016).

Just about every one of the ten most plausible alternative fuels for vehicles today was already being experimented with at the dawn of the automotive age. But for a wide range of reasons, only gasoline and diesel fuel were ready for prime time until recently. And one or two of those ten alternative fuels may never be ready, not at least for decades to come. The differences between then and now are in finally being able to make them more cost efficiently, or to use them more energy efficiently, or both. And generally, the missing enablers of cost affordability and reliability did not exist until recently. But with the more recent advances more and more of the alternative fuels are indeed viable today.

In every one of these examples, there is very little new under the sun in terms of the idea, the concept, or the overall approach. The difference is in the hard work that was

put into taking these long existing developments the last mile once the missing ingredients were finally available.

Likewise, the solutions and improvement to almost everything for the future will generally come from finally being able to take long existing developments the last mile, as opposed to primary research into the great beyond. Primary research is perceived to be more sexy and exciting. But it gives me great hope for the future that there are so many preexisting solutions that can be taken the last mile with far less lead-time and investment than chasing not yet even imagined ideas, most of which may never bear fruit. And those primary research ideas that could bear fruit will take decades to get there.

Episode-3 of 6 in a few days – “Conventional Wisdom is Powerful and Usually Correct, But Not Always”

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"And this is my cousin Dave, who handles the conventional wisdom."

Hard Knocks Episode-3: Conventional Wisdom is Powerful and Usually Correct, But Not Always

(1,042 Words)

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Over my life I have been regularly amazed at how valuable it has been to listen to the conventional wisdom and knowledge of those working most closely with whatever I was involved with. Taking the knowledge they shared with me to heart has saved me from big mistakes and many potential disasters over the years.

But now and then, my own knowledge and experience, coupled with my intuition, screamed out at me, that the conventional wisdom they were sharing with me simply did not make sense. I am confident that they truly believed it, and were well intentioned in sharing it with me. In my early days I of course debated them immeadialy, which obviously did not bode well for relationships. But as time went on, I learned to instead to sort out those that may be incorrect but harmless and do nothing, from those that were incorrect and could be harmful as a result, and my favorite, those that of incorrect and could provide tremendous opportunity if disproven. Of course, during the period that one is challenging conventional wisdom to potentially disprove it, one can become quite unpopular. But once the dust settles, after opportunities become visible, or previously unknown risks have been eliminated, it is amazing how most people buy-in and talk as if

they had known the newly revised conventional wisdom all along. A few examples genericized to protect confidentiality include:

- "We have 70% market share in the U.S. so we have no growth opportunities there. Our best opportunity is in developing country "X"". But every bone in your body says that their total sales can't possibly be 70% market share in the U.S. even though you don't yet know for certain. So you do the research and it turns out they have only 25% of the U.S. market and that the additional amount that they could feasibly capture in the U.S. exceeds the entire market size for their products in developing country "X".
- "If we raise the temperature in the furnace above 1775 degrees Fahrenheit we will get 'grain growth' in the steel and the parts will fail in the application." But you have heat treated those types of steels at temperatures up to 2000 degrees Fahrenheit previously with no grain growth. And you aren't certain that even if the gains did grow that it would change the durability and longevity of the product in its applications. Meanwhile the opportunity if you could raise temperatures is huge. For every one hundred degrees you increase the temperature, you cut process time in half. That is a very significant cost reduction in these processes that take 8-12 hours at 1750 degrees Fahrenheit. So you produce sample parts at the higher temperatures and put them on test and they match or exceed the performance of the prior products.
- "Our largest market opportunities are the small customers. We don't want to deal with the big ones." But you are pretty certain that the market has been consolidating at a rapid pace so the small customer segment is shrinking rapidly while the large customer segment is growing. So you piece together long-run historical data and show that there has been a complete reversal over the two decades from 75% of market in small customers to 75% in large customers. Due to the conventional wisdom they were wedded to they were pursuing a dying market segment with too many competitors, while intentionally avoiding the large and growing segment.
- "The aftermarket is where we want to go. The prices are increasing, the margins are excellent and volume just grows and grows." But you know that although this was true for product similar product types that you have past experience with 30 years ago, the situation t least for those has reversed. The multi-decade quality movement has increased durability, reliability, and longevity so much that parts that used to get replaced three times over the lifetime of the end product now almost never get replaced in any of the end products before they are discarded permanently (to the landfill, junkyard, etc.). After piecing together historical data on their markets you determine that they are shrinking at a 3-4% annual rate. At that rate their market would be 17% smaller in just 5 years. It certainly explained the price wars and margin compression that was being experienced in that sector.

In most examples of where some conventional wisdom just didn't make sense, someone in the past had tried whatever it was and it had not gone well. They may have been personally tarnished by it. It might have been the person sharing it with me that felt

that pain, or it was passed down through the years from person to person until one day it was shared with me.

In some instances it was clear that the reason for the conclusions that led to the conventional wisdom was that with whatever was available to them at the time it was true. In other cases it may be that the wrong conclusions were formed and then repeated for time immemorial until it become 'fact'. There is little doubt that I surely carry conventional wisdom in me from things I have concluded on my own that I don't know are incorrect.

Ask yourself, what conventional wisdom that doesn't make sense to you is limiting what could be achieved if it were reassessed and disproved? Then tread very carefully in any pursuit to invalidate it.

Episode-4 of 6 in a few days – "The Best Resource is the Resource that Was Never Needed in the First Place"

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Hard Knocks Episode-4: The Best Resource is the Resource that Was Never Consumed in the First Place

(413 Words)

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Another lesson from the passive solar/earth sheltered home example in Episode-1 is that the best unit of energy was the unit of energy that was never needed in the first place.

One can increase solar gain (the resource) by increasing the amount of south facing glass. But to do so also increases heat loss since the glass has the most heat loss of any of the materials in the shell of the building. So reducing the rate of loss of the solar gain through the use of insulating shades at night and adding more insulation to the rest of the structure (reducing the need for as much of the resource), was often a better approach than increasing the amount of glass to increase solar gain.

This applies to other resources like materials in which FEA (finite element analysis) is applied to product design to reduce the amount of material resource used in portions of the product that do not need it in order to still remain reliable and durable for their full lifetime.

And it applies back to vehicles as well. If one can get 20% more efficiency from gasoline and diesel fuels than was previously possible, without sacrificing performance, then that may reduce the incremental benefit of switching to some of the more complex and costly alternative power sources.

So before abandoning all incumbent technologies and rushing to alternatives, ask yourself if there are still things that can be improved or perfected on the incumbents that will render switching to alternatives less worthy of the costs and the risks. Find ways of using less of current resources rather than racing off to use the same amount of a different resource.

Episode-5 of 6 in a few days – "The World is the Sum of Thousands of Interacting Sub-Systems"

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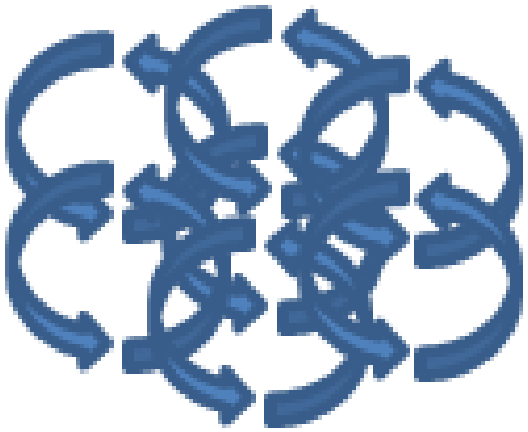

Hard Knocks Episode-5: The World is the Sum of Thousands of Interacting Sub-Systems

(732 Words)

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Thermally engineering a passive solar structure to optimize energy consumption is conceptually very simple (even though the devil is then in the details). It is closed system just like a “Bell Jar”, or even the entire planet. It is merely a matter of the difference between how much heat comes in the windows through the glass and how much heat escapes through the walls, windows, floors, and ceilings. The difference is the resulting temperature inside the structure. To ‘temper’ how much heat rise occurs when there is full sun, and how long we can keep the structure warm when the sun goes down or it is cloudy, thermal storage is added. The passive solar/earth sheltered home described throughout this series increased 6 degrees Fahrenheit in all day full sun on the coldest winter days, and only lost 2 degrees Fahrenheit per sunless cold winter day thereafter. Thus, over the period of 5-10 days all of the variables offset and compensated for one another systemically in combination to operate in a narrow cyclical band around a balanced average.

During that same time period at work, I was assisting a very gifted more senior engineer in developing improvements to an industrial heat treating process known as carburizing, the means that one ‘case hardens’ steel parts such as bearings and gears. The parts are placed in an enclosed furnace chamber at temperatures in the 1650-2000 degree Fahrenheit range and exposed to a gas atmosphere with a mix of six gasses. Our instrumentation could measure the portion of most of the gasses in the chamber. And we could change the amount of most of them that we injected into the chamber. Essentially for two years we manipulated the mixtures in the atmosphere, the temperature of the chamber, and the time that the sample parts were in the chamber,

over the full range of all the possible combinations. And then we tested the sample parts from each combination to match the outcomes with the parameters.

The catch here is that we could control the mixture of what we injected into the chamber, but the moment they were injected they then reacted with the other gasses, the parts themselves, and even the furnace chamber brick, converting to other combinations of the six gases. How the gas transformations played out depended upon a wide range of variables, principally the temperature of the chamber, the composition mix of the gasses before we made the change, what we changed, and in what proportions.

Here, just as with the passive solar/earth sheltered home, we had an enclosed system that is conceptually simple. But in this case, rather than being a little more complicated in the details, it was orders of magnitude more complicated because we have added interactive chemical reactions.

This plays out in marketplaces every day with each move by one competitor being matched by a counter move by another competitor. And in geopolitics each move by one player is offset by other players who in turn set off other players actions.

Over the decades since that experience I have come to realize that almost every action we take in anything in work or life is part of larger systems. Every action we take impacts the rest of that system, and the rest of the system also impacts whether our actions achieve what we intended. Unless we consider the entire system that is in play for the situation, we may not achieve the outcome we seek, and we may cause unintended consequences we did not want to cause.

Episode-6 of 6 in a few days – “Invention is 1% Inspiration and 99% Perspiration – Ideas are Things That only Work When You Do” and the Series Summary and Conclusions

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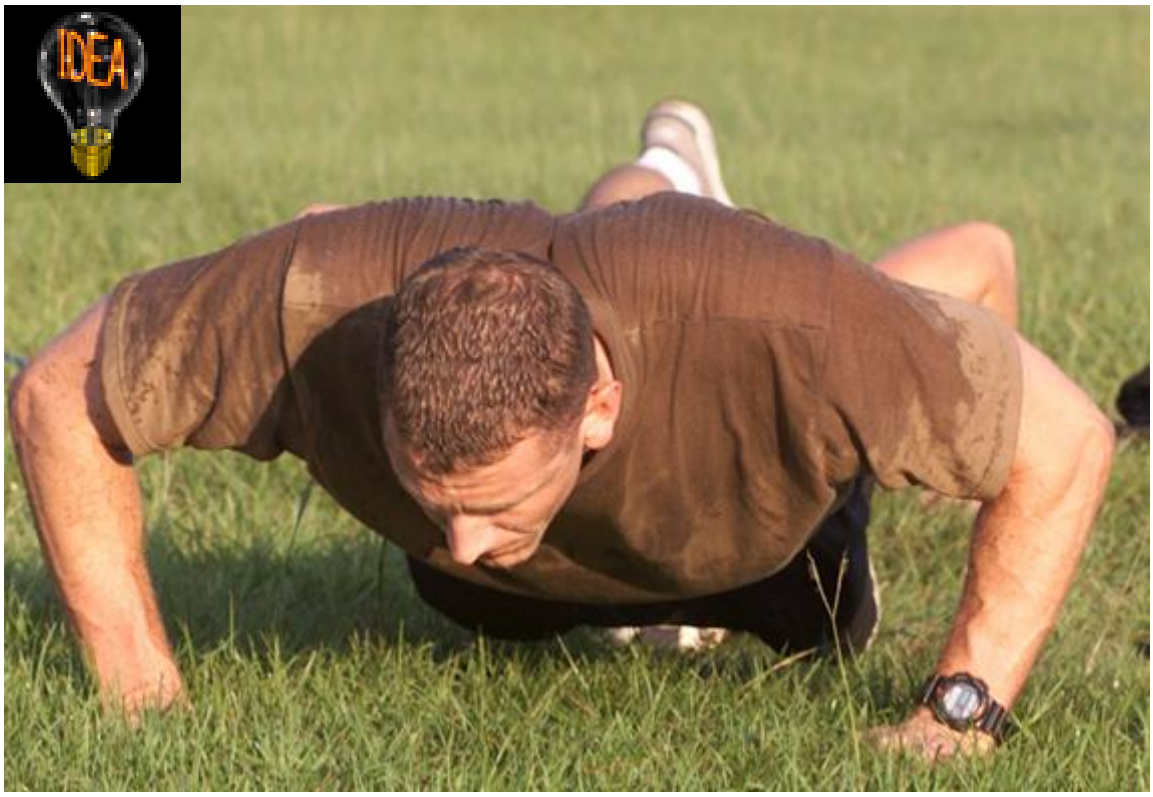

Hard Knocks Episode-6 (Finale): "Invention is 1% Inspiration and 99% Perspiration" – "Ideas are Things That Only Work When You Do"

(892 Words)

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Unfortunately I cannot take credit for either of those wise and insightful quotations. The first one is slightly adapted from Thomas Edison who said 'genius', not 'invention' and the second is from a Lipton Tea Bag tag shared with me by my tea drinking boss long ago.

In the passive solar/earth sheltered home example from Episode-1, it took very little time to recognize that the best means to build a very highly efficient solar home in the very low percentage of sunshine and quite cold Ann Arbor Michigan area climate, was to combine passive solar with earth sheltering. But to optimize the final thermal design took hundreds of hours of hand calculations using a first generation Texas Instrument engineering calculator prior to TI even having programmable calculators let alone personal computers. And every input had to be found in books at libraries (whereas today we can Goggle for absolutely everything). Then I hand constructed a ~20% size scale model with identical insulation, thermal storage, and south facing glass that sat at

the edge of a corn field for a full year while the inside and outside temperature was monitored on a windup strip-chart temperature recorder to ensure that the design concept would work as calculated. Happily it did, never dropping below 55 degrees F even when the outdoor temperature sometimes went below zero F at night.

During the carburizing research that my senior colleague and I were doing described in Episode-5, we kept getting a totally counter intuitive result at one extreme of the variable spectrums. It drove us nuts because it was the opposite of conventional wisdom and of logic as we understood it. We looked at everything including possible errors in sensors, errors in instrument readings, errors in how we tested the resulting samples, etc. And we re-ran the tests over and over. We found no flaws in the methods and processes and we always got the same results, they were just completely counter intuitive. It was maddening and frustrating.

Then one evening my colleague was soaking in a hot bath, and a 'eureka moment' hit him. What if we assume that the results are correct, even though we don't yet understand why? Because if the results are correct, then the possibilities for the process quality and cost improvements that could be achieved would be tremendous. At that moment, the "1% part of invention" occurred, the inspiration. That was then followed by two to three years of tedious laboratory trials and short production runs before finally the plant had a million dollar 70 foot long production furnace in place and operating smoothly that put out about 80% more production per furnace than those alongside it and reduced energy consumption in a very energy intense process by about half. And we ended up as co-inventors on a patent to boot, which always feels good.

Inspirational ideas are critical, for without them there is nothing to develop. But they are cheap, and of no benefit, if one does not follow through with the 99% of the time and effort required to take them to full commercialization.

Bonus Point: Counter intuitive results often provide the greatest opportunities for significant opportunities. So if you keep getting the same counter intuitive experimental results. And you have confirmed over and over that it is not experimental error. Consider if the counter intuitive results open up new possibilities. And if so, imagine those possibilities and pursue them vigorously.

Conclusions

Whether it is technology, economics, geopolitics or even climate, and a myriad of other global issues, or very local or even personal, we need to ask ourselves:

- Have we considered all the offsetting and magnifying systemic issues and implications of whatever we are planning to do?

- If acting further at all, may be only taking us further into diminishing returns suggesting we should be placing our efforts elsewhere, where they can do far more good in relation to the efforts and funds expended.
- If we are going to act at all
    - If we truly have we exhausted all possibilities to use less of current resources before switching to the same amount of alternative resources?
    - If we have we
    - Exhausted bringing incumbent solutions the last mile before we race off to chase far less developed ideas and search for new ideas that are not yet even imagined yet? What previously abandoned ideas might be winners today because of things available today that had not been perfected or refined when last they were attempted?
    - Are there any counterintuitive findings or results that we have dismissed a simply wrong, that if valid, may offer very promising opportunities?

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Hard Knocks Episode-1: The First Cut is the Deepest (12/14/2015)
Hard Knocks Episode-2: There is Very Little New Under the Sun (12/17/2015)
Hard Knocks Episode-3: Conventional Wisdom is Powerful and Usually Correct, But Not Always (12/20/2015)
Hard Knocks Episode-4: The Best Resource is the Resource that Was Never Consumed in the First Place (12/23/2015)
Hard Knocks Episode-5: The World is the Sum of Thousands of Interacting Sub-Systems (12/28/2015)

Year End 2014:
The Top 10 Keys to My Professional Success and Enjoyment (12/28/2014)
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