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Battery Council INTERNATIONAL

2018 INNOVATION AWARD WINNER

INNOVATION FOR IMPACT

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Every day, we hear how innovation is changing the world. But not every company innovates in the same way, and not all ways of innovating are effective.

Today, I'll share with you a few leading academic theories on why some companies win while others lose at the game of innovation and how we can apply these winning strategies to extend market share and increase the growth of our industry.

Hopefully you will take away a new perspective, a different framework, or at the very least get a refreshing reminder of best practices.
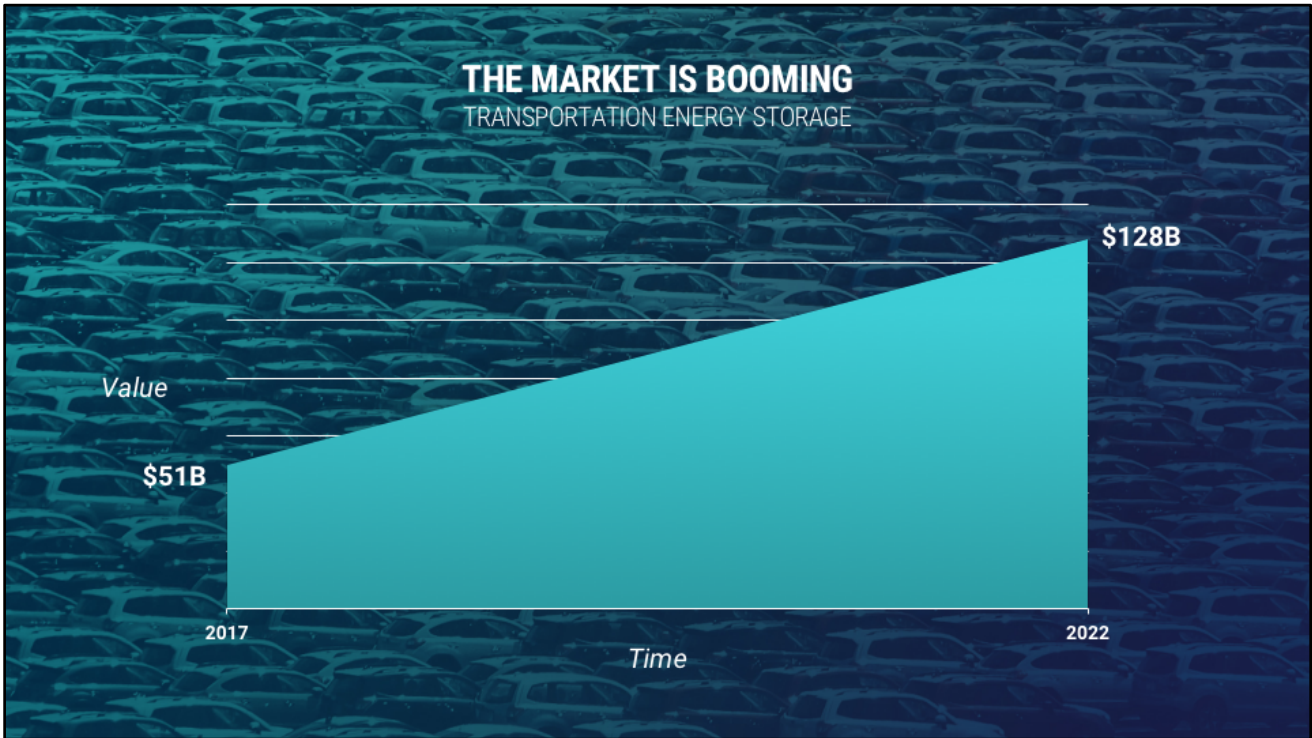
The good news is the transportation energy storage market is booming!

Some of you might recall this forecast presented by Ray Kubis at BCI earlier this year. The transportation energy market, which currently dominates the overall energy storage market, is expected to more than double between 2017 and 2022. This is quite impressive, especially when you consider that we are starting from an existing $51B base market.

But the news is not all good.

The bad news is that we are just not capturing the growth.

While the overall energy storage market is growing tremendously, the market share for lead-based products is forecast to experience a material decline on a percentage basis. The lead based market isn't expected to contract in dollar terms, but with a market that is growing to 250% of its current size in a few short years, it is disappointing to see the lead battery market expected to experience only modest single-digit annual growth.

WHY NOT?

Source Joe Skipper for Reuters

So in an exploding market, why aren't lead battery solutions capturing more of the growth?

There are a number of people that suggest that we are simply being out-marketed. I am sure many of you have seen the ILA opinion chart indicating that 85% of those polled see Lithium as innovative, whereas only 7% see Lead in that same vein.

While I do believe it is clear that we are facing a headwind of public opinion and an industrywide need for improved messaging, there are a few additional compounding factors that are limiting our ability to capture our fair share of the growth. One of them, ironically, is linked to a tremendous amount of industry …

WHOM THE GODS WISH TO DESTROY, THEY SEND 40 YEARS OF SUCCESS

- Aristotle

Success.

In fact, I believe the main issue we face could very well be a natural byproduct of having built successful companies. This success presents us with a paradox.

A TALE OF TWO ENGINEERS

THE EXPLORER

THE EXPLOITER

Frank

Tom

However, before we talk about this "paradox of success", I'd like to introduce you to a couple of my colleagues.

First, I'd like you to meet Frank.
Frank is a fantastic engineer. He is a real idea man. In fact, I would say that Frank has a nearly encyclopedic knowledge on any number of topics. Frank has built products that have landed on Mars, invented technologies that made cameras in cell phones possible, and is now developing robots that perform surgery. Frank has a million ideas and is an invention junkie. He likes to make neon signs at home in his garage and in his spare time he repairs vintage steam locomotives. There are only a few things that I would never trust Frank to do, and those are: to meet a schedule, stay on a budget, or do exactly what I asked. I absolutely love Frank, except for the one time that I asked him to present in a board meeting and he showed up in sandals and a Hawaiian shirt. Frank is a classic explorer.

Now, I'd like you to meet Tom.
Tom is the kind of guy that likes all of his pencils sharpened and organized on his desk from shortest to longest and from darkest to lightest. I first met Tom when I brought him in to clean up Frank's mess. Tom is an executor. Tom came in, and right away understood the major issues, came up with a timeline, resource plan and schedule, and started daily meetings to get everyone on track. Tom took the idea that Frank had and brought it into production in a very controlled way. Tom is very sharp technically, but I wouldn't call him an idea guy. What I would say is that Tom never passed up an opportunity to create a new spreadsheet or implement a new control procedure. The downside of Tom is that he believes too much in the premise "you can't manage what you can't measure". Before I knew it I had 26 daily reports indicating how everything in my operation was running. Tom is a classic exploiter.

These two people are quite different, but both are quite necessary to make my operation work. I'm sure you know people like this in your own organizations. So let's see how they map into the normal growth trajectory of a company.

THE PARADOX OF SUCCESS
ORGANIZATIONAL EVOLUTION
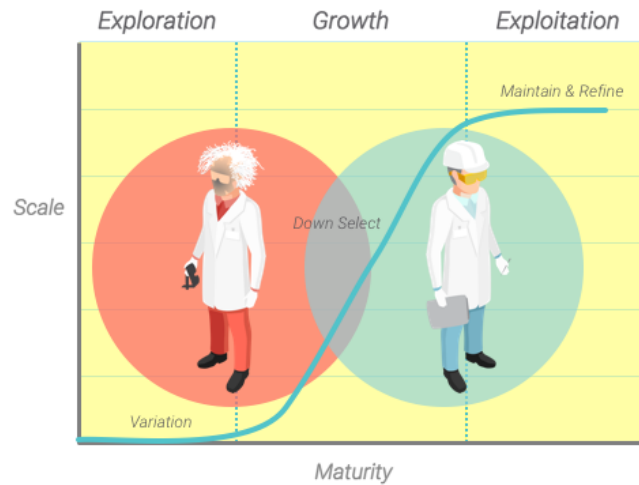
Source O'Reilly, Tushman "Lead and Disrupt" (2016)

This chart from Evolutionary Organization Theory basically breaks down a company's maturation cycle into three phases; the exploration phase, the growth phase, and the exploitation phase. These concepts apply to entire companies. For illustration purposes we can also look at this evolution through the lens of new product development.

The first, or exploration phase, is focused on creating opportunities. This could be identifying technologies, unique business models, new markets and customers. The key attributes for success here are ideation, experimentation and flexibility. An organization in this phase should structure incentives around discovery and capability development, with an emphasis on initiative and speed. This type of organization is the perfect place for Frank**.**

As ideas take off and the organization grows, we enter into the second phase of evolution, growth. I'm sure many of you have experienced this phase. This is when your product takes off and you're just trying to keep the wheels from coming off the wagon. In this phase, the product adoption is increasing and you're trying to reduce variation. This is the phase when a lot of decisions need to be made and selection is key: locking down the product performance, technology utilized, manufacturing processes and applications. It becomes just as important to decide what you're NOT going to do as what you ARE going to do. Usually, this is when companies will start implementing data driven decision-making and also the beginning phase of collecting operating metrics that will be used to run the business in the future.

The third phase of evolution is the exploitation phase. This is the phase where predictability, stability, and control are the most important factors. Key success in this stage is related to efficiency improvements, incremental performance enhancements, and standardization. This is where your key performance indicators (KPIs) come in. There may be some variation introduced, such as a supplier that doesn't meet specifications or machinery going out of calibration. This phase is about maintaining control and refining the product. This is a perfect place for Tom.

You will see that in the middle is the place where Tom and Frank meet. In a well-balanced organization, both skill sets and close collaboration are necessary to optimize the environment for innovation.
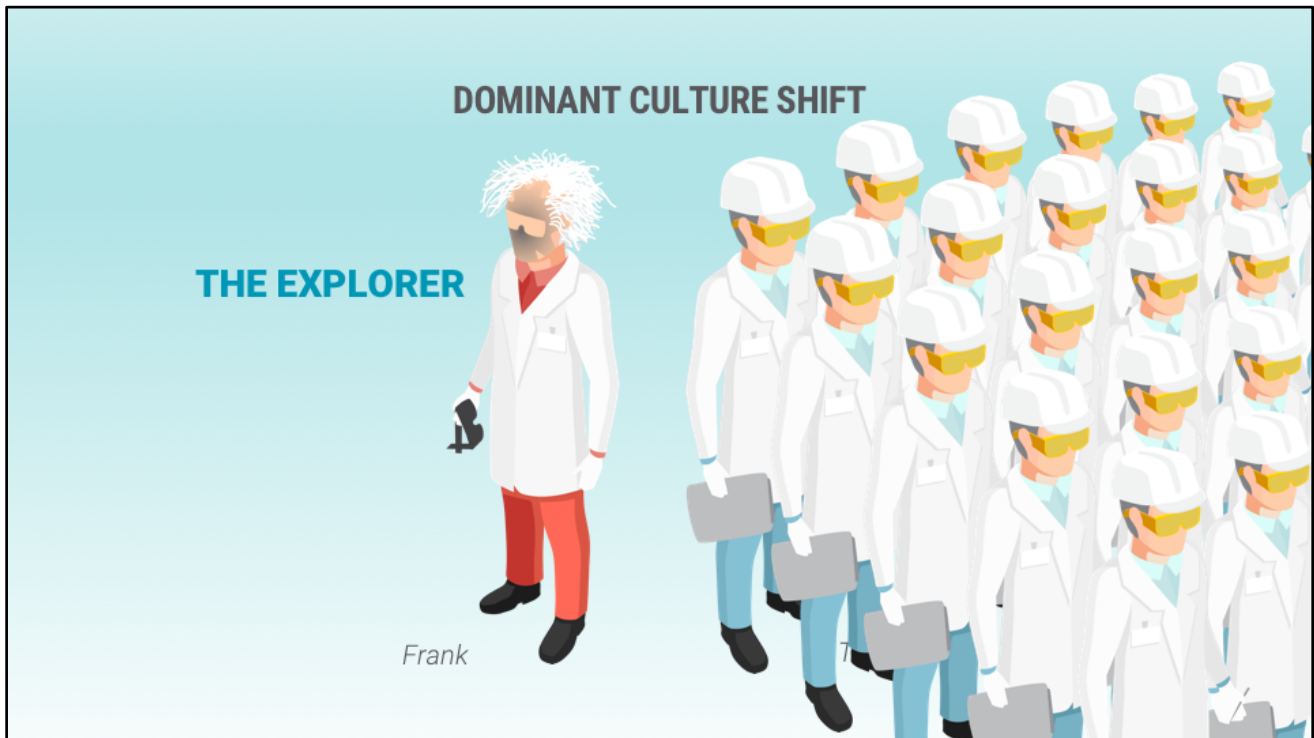
However, the researchers assert that in many instances this balance doesn't last long. As companies navigate their growth phase and experience success, they identify a number of additional opportunities for improvements. They learn how to create better metrics and implement new procedures and processes based on lessons learned. All of these changes drive performance improvements in the organization.

In terms of people, Tom was critical to getting the product launched and into production. He has a list of follow-on projects that will generate a predictable ROI and you know he will deliver them on time, on task, and on budget. So the company invests in Tom and his plan. Tom could bring in Frank, but he knows that would be a mistake. So, Tom hires more people like Tom and the cycle continues. As more and more exploiters come in, the company begins to experience an organizational alignment shift. The dominant DNA rewards execution and results. You still keep the explorers around, but they generally operate with a lower budget, smaller staff, and less influence on the organization. In the short and medium term, this dominant culture of operational excellence leads to great quarterly results, but it also leads to cultural inertia which makes change difficult. In the longer term, however, a firm can be overly committed to structured ROI-based management and decision-making which can lead to the pursuit of more and more incremental projects and their diminishing returns.

IS IT JUST GETTING HARDER TO INNOVATE?
THE LAW OF DIMINISHING RETURNS OF R&D
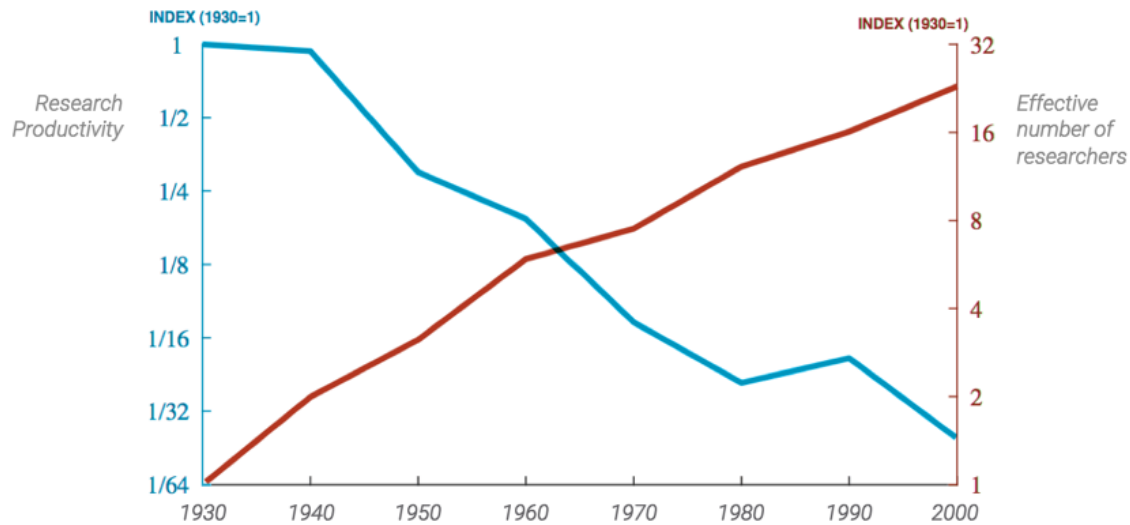
Source Bloom, Jones, Van Reenen, and Webb (2017)

So, maybe that's just how it is. We have all heard of the law of diminishing returns applied to production which says that at some point, adding labor or capital will no longer increase output. Does the same thing happen for innovation? This was the conclusion of Chad Jones, the Stanford economist who developed a parallel theory on the diminishing returns of R&D.

This chart, plotted over 70 years, shows on the left axis, that over time, research productivity has been on the decline. On the right axis, it also shows that an increasing number of researchers are required to maintain positive research productivity. So, more people are required to generate positive, but declining results.

A great example of this is Moore's law, which I am sure most of you have heard about. Moore's law predicted that the number of transistors on a computer chip would double every two years, equating to a continuous 35% growth rate. This "law" held up for nearly half a century. However, the latest doubling effort required 18x the numbers of researchers than it did in the 1970s … clearly a sign of diminishing returns.

So, what Jones says is, effectively, for any given industry there are a limited number of good ideas, and early on they're easy to find. Then, as time goes on, it takes more and more effort to find the few innovations remaining.

So, one might stop there at the inevitability that returns will be fewer and fewer and come to the depressing conclusion that it is simply getting harder to innovate and getting incremental advances is all we can hope for.

INNOVATION: GROWTH VS DECLINE
MATURE INDUSTRIES HAVE RIPE OPPORTUNITY FOR INNOVATION IMPACT
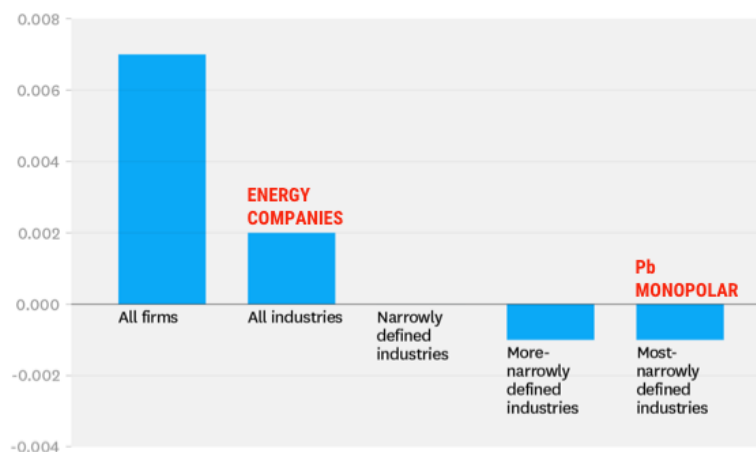
Source Anne Marie Knott (based on data from Compustat)

Fortunately, researcher Ann Marie Knott at Washington University, decided to explore company innovation at a more granular level. In Knott's work, she developed a model called RQ, or research quotient that studied output of a firm, similar to Jones' work, but with two important differences. First, she strengthened R&D as direct input to the model and second, she broke down company innovation into to different industry segments using the US government's Standard Industrial Classification (SIC) codes. The SIC coding system is made up of four digits. The first digit indicates a high level sector, such as manufacturing, the second specifies an industry, (e.g. dental and medical) and then narrower and narrower categories until at four digits we are much closer to the product level (e.g. dental drills).

What Knott found was that Jones theory held at the most narrowly defined industry segment level (close to product level). However, it did not hold at the higher categorical levels. So, broadly speaking innovation is improving, but at a very narrowly defined level, innovation is declining. This suggests that as an industry segment's growth declines, the best opportunity for innovation could likely come in the form of creating a new industry segment, based on looking at the broader market. In the best cases, that broader market would still be served by leveraging some of the core assets of the company, but with an offering different enough to address entirely new applications. In our case, Knott's work explains how it is reasonable for the Pb monopolar battery segment to see declining innovation while the broader energy resource market is growing. The takeaway for us is that as the industry matures, rather than tighten our focus on incremental product improvements, we should consider broadening our focus to find the best opportunities for innovation impact.

SMARTPHONES WON BY INNOVATING BROADLY
GLOBAL SMARTPHONE SHIPMENTS FORECAST
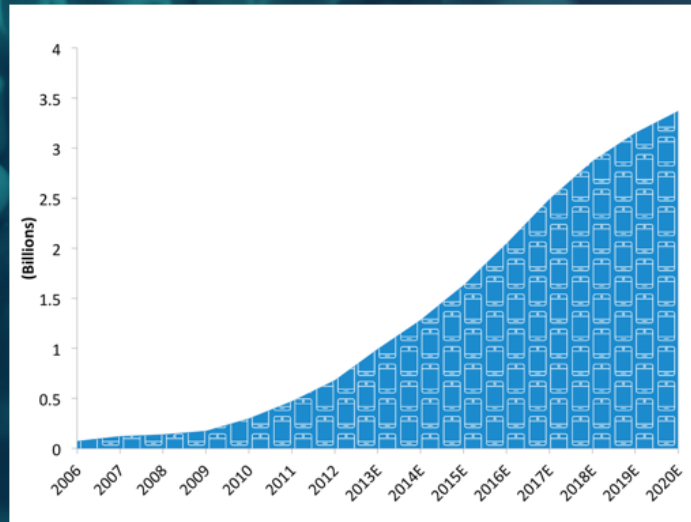
Source BI Intelligence Estimates

Here is a great example of an industry that has continued to broaden its focus - Smartphones. Everyone is familiar with the explosive growth of mobile phones. The mobile phone started out as a simple voice communications device. You could almost think of it as a wireless home phone with extended range.

In order to continue to innovate and capture more and more value, the mobile phone didn't double down on voice quality – in fact, I think it is amazing how frequently I get dropped calls with a thousand dollar phone. Instead, the mobile phone industry expanded their product applications into a high-level personal services category, offering voice messages, e-mail and text messages, personal entertainment, calendar services, photography, etc.

By comparison, let's think about the home phone market. How did their strategy pan-out?
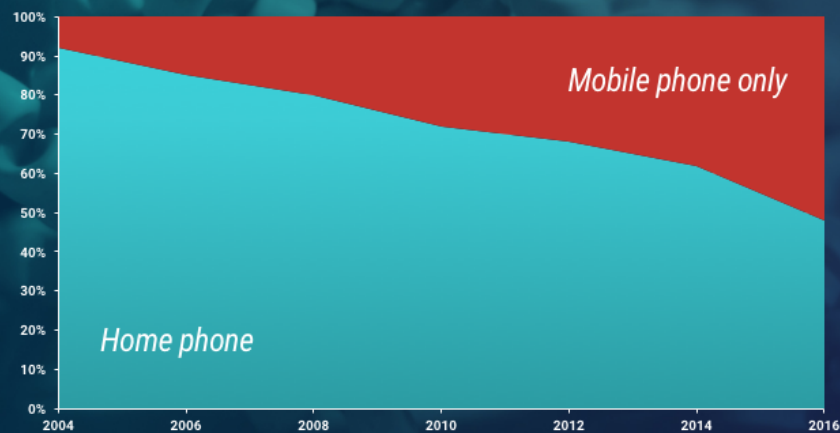
Not well.

Here is a chart showing the declining share of the home phone market. Note that this isn't the penetration of mobile phones (which would be nearer to 100%), this is simply the number of households with a home phone versus households that have stopped using a home phone entirely in favor of only having a mobile phone.

The home phone industry has made tremendous incremental advances, for example, caller ID, remote access voicemail, extended range, intercom features, but it never broadened out to truly innovate beyond basic uses.
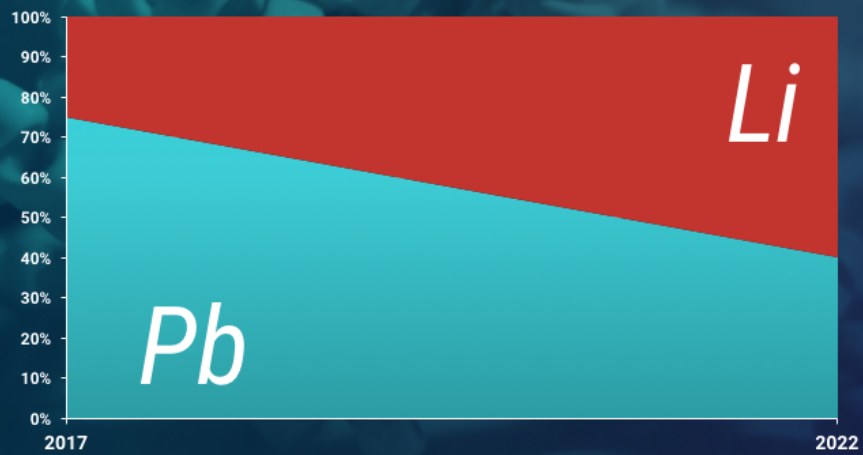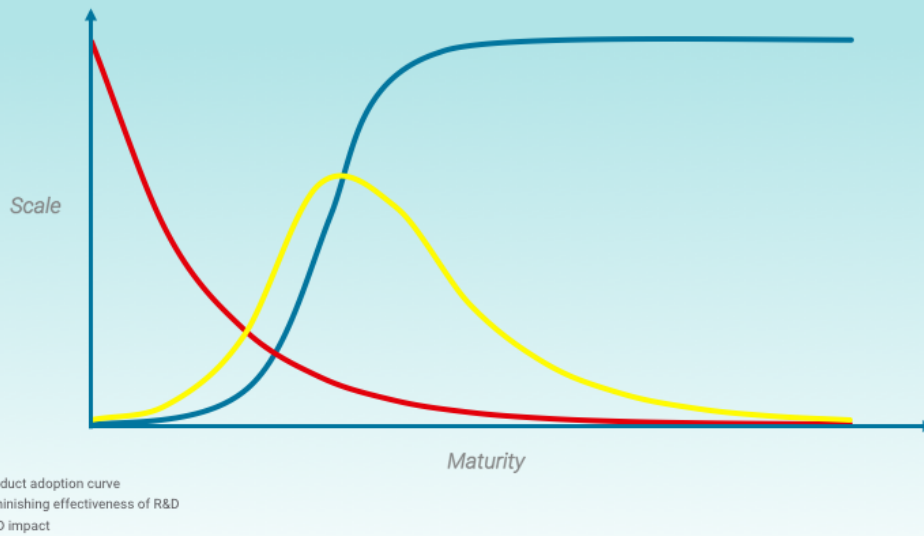
This slide is deliberately intended to be a provocative comparison, but the similarity is stark. I'd rather not draw a conclusion as to whether we are destined to be the smartphone or home phone in this example … let's just plan to innovate broadly and be the smartphone going forward!

So, now that we have looked at the natural evolution of the company, met our explorers and exploiters, and learned some recent academic theories about innovation, let's step back and integrate these concepts.

First, let's start off with a standard product adoption curve

Now, let's apply Chad Jones law of diminishing returns at a narrow product level.

As we can see, early in a product cycle, while there is a lot of potential R&D impact, there is no product revenue.

Similarly, after the product has achieved a sustained period of maturation the law of diminishing returns takes over and there are no more incremental returns available.

So, let's combine these concepts into a third line to look for the optimal impact. We will call this "the R&D impact line".
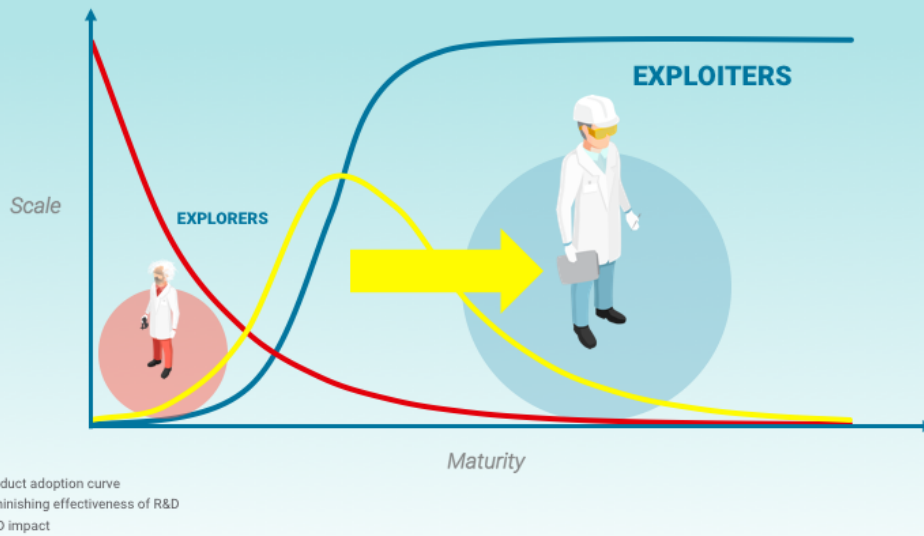
Now let's bring in the team.

WHERE SHOULD WE ALLOCATE OUR INNOVATION RESOURCES?

EXPLORERS   EXPLOITERS

Scale

Maturity

— Product adoption curve
— Diminishing effectiveness of R&D
— R&D impact
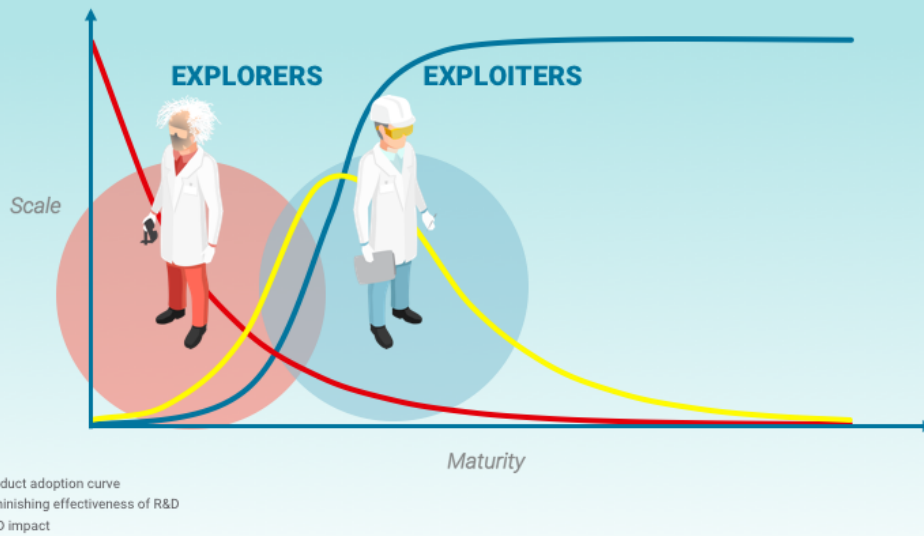
In a balanced organization, there is a normal flow of disruptive innovation going from explorers to exploiters. And, while not all Franks ideas are disruptive, those ideas that do break through create a huge opportunity to realize value as the product achieves scale. These breakthrough ideas generally start with higher margins, a new set of opportunities for cost reduction and performance optimization.
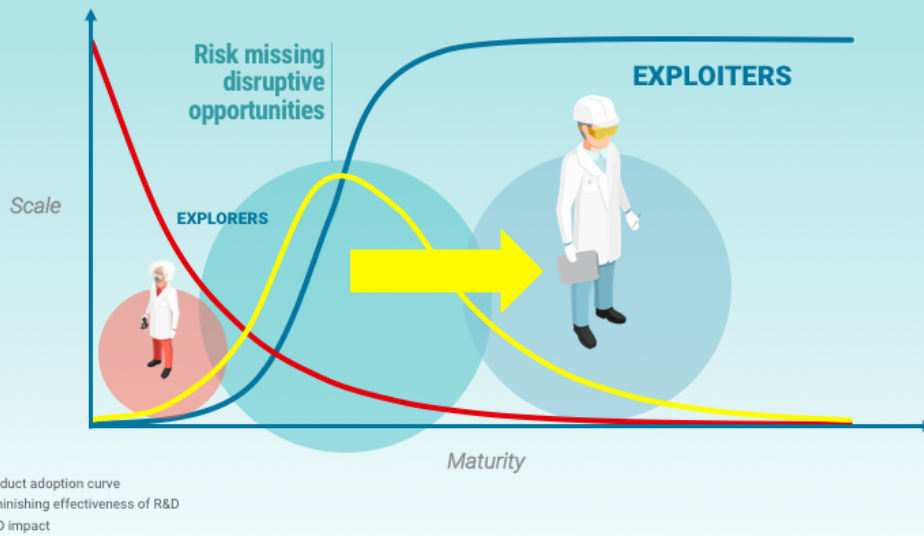
The exploiters then focus on harvesting the high-return, low-lying fruit created by new innovative products, and also continue to increase return through incremental productivity and performance improvements.

However, in companies that have diminished the role of the explorers, there is no longer a constant stream of disruptive innovation. While the explorers continue to work on ideas, the bulk of the exploiter work shifts out to cost reduction and productivity improvements and the focus increasingly becomes largely on incremental returns.

Perhaps the most worrisome part of this trend is the opportunity gap it leaves in an organization. When your organization does not have the capability to disrupt itself, it is open to be disrupted by more aggressive competitors, or new market entrants.

This is exactly what happened to both Nokia and Kodak. Nokia missed the impact of the iPhone and Android operating system which came from new market entrants. And Kodak, while it had great digital imaging technology, was overconfident in its commitment to legacy products and couldn't overcome the cultural inertia.

ARE YOU INCREMENTING OR INNOVATING?
INCREMENTAL TO DISRUPTIVE
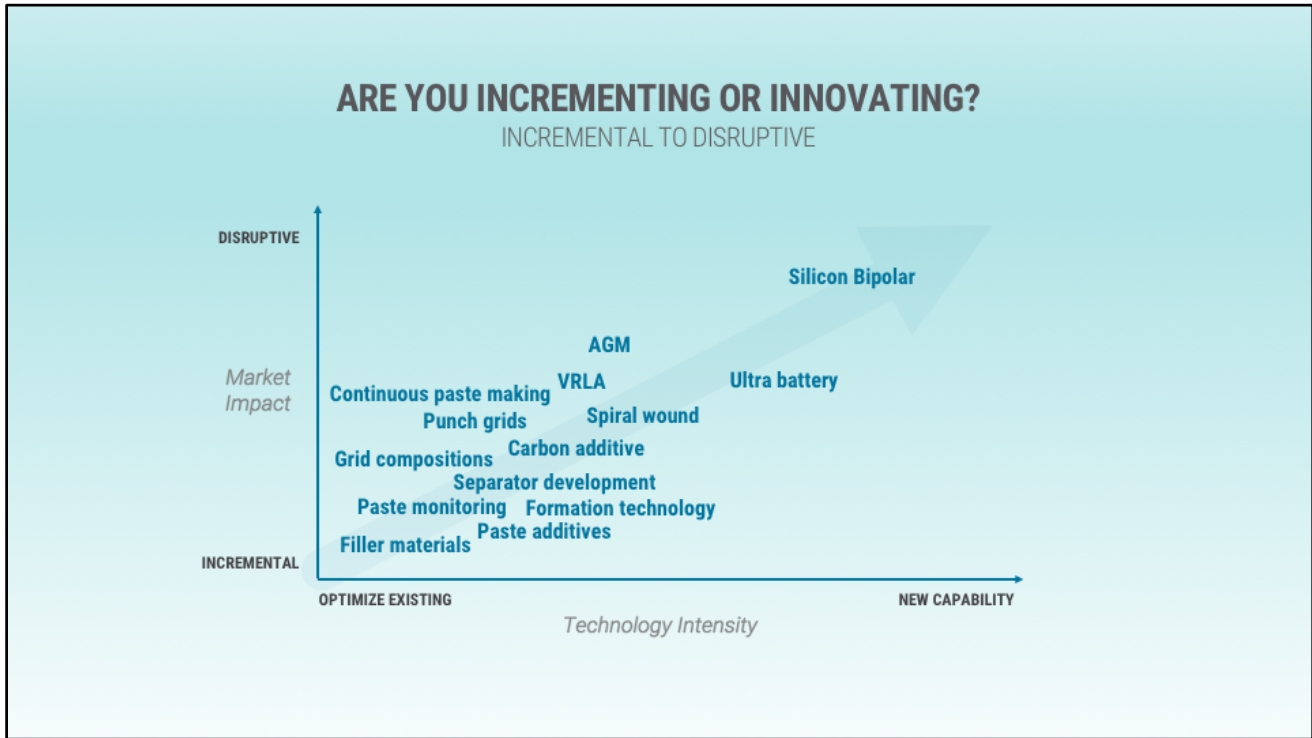
So, when we look towards our own industry, I think it is important to reflect on whether our R&D efforts are incremental or disruptive. Are you trying to disrupt yourself? Or, are you leaving yourself open for a competitor or new entrant to displace you?

I realize in putting this chart together I am inviting debate on the rank order of these developments. In fact, if you want to debate the merits or impact of one technology over another and their potential for disruption, I think we would be having exactly the right conversation.

The unfortunate truth is, after speaking with a number of you, the majority of engineering efforts aren't even going towards anything on this chart. In aggregate, I believe that there are more engineers working on SKU rationalization, Value Engineering or Performance Tuning than any of these or possibly all of them combined.

So, as a litmus test, in an industry that is doubling, what are you developing that could double the size of your company?

INNOVATION STREAMS

Now that we have looked at the natural evolution tendency for successful companies and seen some compounding effects, let's switch gears and look at ways to think about strategic innovation. One simple framework is Innovation Streams.

DIMENSIONS OF BEST-IN-CLASS INNOVATION
3 PATHS TO DISRUPTION
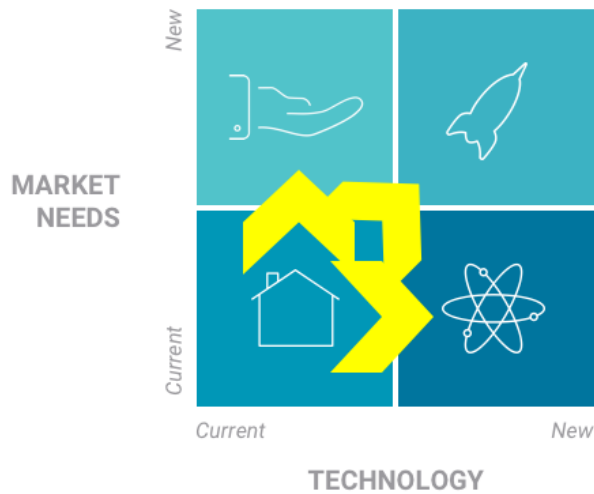
Innovation streams framework is a simple way to categorize your companies potential innovation paths.

On the vertical axis we have market and on the horizontal axis we have technology. Technology can also be thought of as organizational capability. The range of each axis is simply "Current" or "New"

 In this framework, there are three ways to innovate:

1) First, Current Capability, New Market. This is simply taking your existing products and entering into a new market. An example of this would be an airline getting into the low-cost airline business. Perhaps the seat spacing is reduced, luggage and meal service is restricted, but overall it is within the organization capabilities to provide this.

2) The second category is to add a New Capability that addresses your existing customer base. Most likely in this case you are cannibalizing an existing product in order to vet and mature a new technology. I'll go into greater detail on this approach momentarily.

3) The third category is the place that we hope all paths lead and is considered the location of disruption. This category is a New Capability in a New Market. This is considered the most disruptive move, however, it is also the most likely to fail if you move there directly through internal programs - notably because, as indicated by the type change, you don't truly understand the market and you don't have the existing capability.

TWO STEPS TO DISRUPTION FROM WITHIN
LEVERAGE EXISTING CAPABILITIES, THEN DISRUPT
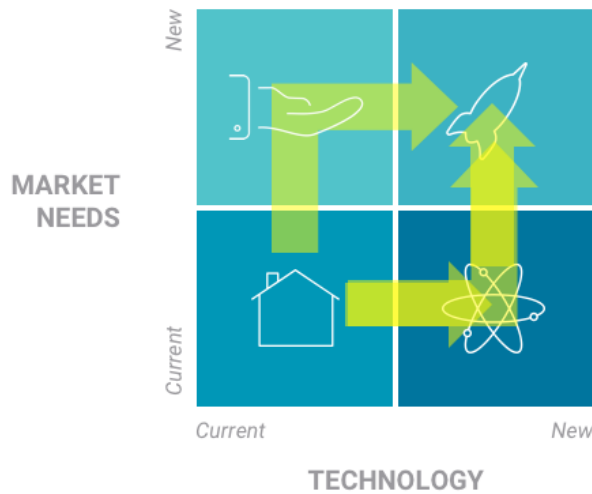
For internal efforts, the most effective way to innovate is a two-step process. First to establish a new technology or market position and then to disrupt a new segment with a new technology. As I just mentioned an airline moving into the low cost airline business would be an example of a company addressing a new market with existing capabilities and from there they would develop capabilities to optimally address that market.

As an example of a company that developed a new capability first, let's take Netflix. Netflix started out as a DVD by mail company. They were web-based, had content agreements, an online ordering system and a DVD mail fulfillment operation. Netflix first innovation was to add the online streaming capability, cannibalizing it's DVD by mail business and offering both as a bundled service. Once they established the online streaming capability, they were able to change their service offering and capture the consumer surplus by separating the services and charging more for the combined services. They also extended their reach to consumers who didn't have DVD players. Netflix used this strategy again in leveraging their market position to add content development and the results speak for themselves.

NETFLIX OUT-INNOVATES THE INCUMBENTS
NETFLIX SUBSCRIBERS vs PAID TV SUBSCRIBERS (in millions)
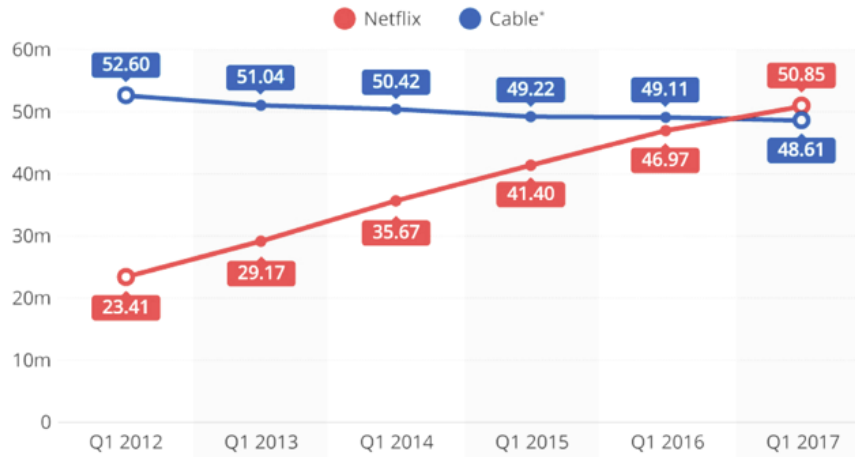
Here is the impact of Netflix using a two-step innovation strategy. Clearly, if Netflix started on a path of direct to disruption and telling their content providers and cable operators that they intended to develop and distribute content themselves, they would never have succeeded. Also, if they weren't willing to cannibalize their existing business, they wouldn't have succeeded. As a counter example, Blockbuster, the video rental behemoth, wasn't willing to risk cannibalizing their existing business by offering DVD by mail or streaming …they were worried that they would lose the incremental in store sales of popcorn and candy. Their fate is well known.

MOONSHOTS ARE OUT, FIND A PARTNER INSTEAD
LEVERAGE OUTSIDE CAPABILITIES, THEN DISRUPT
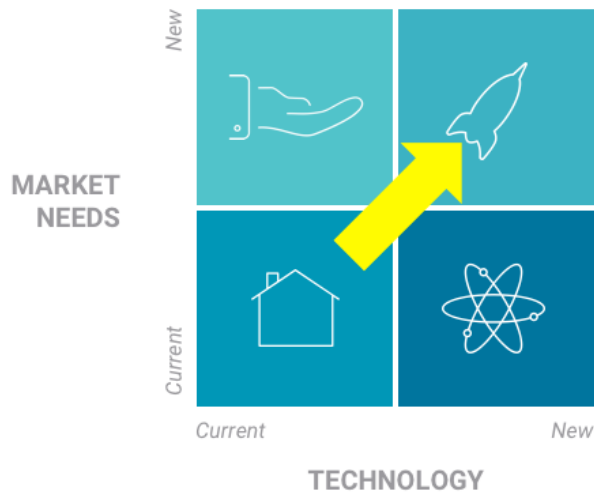
Finally let's circle back to companies that want to go directly into a white space of new markets with new capabilities. 15 years ago, this was a widely popularized approach, often referred to as Moon-shot, blue sky, Out of the box. It turns out, however, that the result shows that in aggregate this is a terrible strategy.

The research now indicates that if a company wants to enter into a disruptive market, the best approaches are to acquire a company with traction in that space, or partner with a third-party innovator.

This makes sense when you reflect that this category by definition is a market you don't know and a capability that you don't have.

Many leaders recognize that this leap represents too much of a stretch for their organizations due to the lack of appropriate resources, but, there is another reason that companies often decide to go outside for disruptive innovation.

A TALE OF A THIRD PARTY INNOVATOR

THE EXPLORER

"Amazing, this silicon bipole is going to allow me to create an entirely new class of high performance batteries."

"We don't need any help. I tried bipolar before and have a couple of really good ideas."

THE EXPLOITER

"By adopting bipolar and eliminating our strap and weld process, I could double the productivity of my floor space."

"Can you demonstrate a high volume, mature bipolar battery today?"

Frank

Tom

Many times the company has the insight, but can't seem to push radical development projects through due to cultural inertia, not invented here (NIH) syndrome, or lack of leadership mindshare and bandwidth.

Our company, Gridtential Energy, as a third party innovator bringing a new technology to the industry, sees this firsthand. We see the excitement and the roadblocks, from both explorers and exploiters. We know that the explorers will be excited by the performance benefits they get from unique materials and architecture. We know that the exploiters like that this leverages many of their production tools and in fact can save factory floor space. We also hear from sales people that they see the new markets that this technology can open and that it gives them a tool to compete with Lithium, but they're also feeling the pressure to produce results on a short-term basis.

So, with all of this excitement and all of the pressures to deliver short term results, how can we drive disruptive innovation? In our experience, the best predictor of whether a company has what it takes to radically innovate comes down to one and only one factor – LEADERSHIP.

The leadership that allows the explorers to succeed in their organizations in the face of a series of disappointing results.

The leadership that believes the exploiters will find a solution, even though the problem can't completely be defined

The leadership to know that the organizational tension that is inherent in groundbreaking developments can be destructive if not managed, but can drive the company to new heights if embraced as a developmental tool.

Gridtential Energy sees this factor in all of our successful partnerships. At East Penn, Crown Battery, and Leoch, leaders are driving the message of innovation from the top. They are taking on the difficult challenge of demanding operational excellence from their exploiters, while providing their explorers the tools and support required to bring truly unique products to market.

REALIGN YOUR ORGANIZATION FOR INNOVATION SUCCESS
HELPFUL HINTS
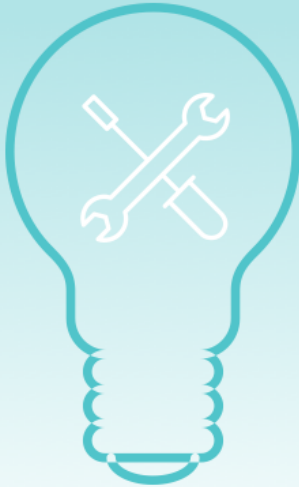
01 Separate explorers and exploiters
But don't isolate! Explorers need to leverage core capabilities to be most effective.

02 The ostrich is a poor strategist
Acknowledge and manage intrinsic tension between Toms and Franks. Own the tension as a leader or keep it within a team.

03 Implement dual reward system
Exploiters: plan and incremental improvement
Explorers: market or technology milestones

04 Support must start from the top
Culture isn't something on a poster in the employee break room. Top management is required.

So, hopefully at this point I have convinced you to reflect on the opportunity and benefits of doubling down on your innovation efforts.

Now, I would like to offer you some suggestions on how to best align your organizations for success.

First, separate your explorers and exploiters. While they may have a common set of high-level values, they are not aligned in many of the tasks that they are asked to do. It is important to establish a critical mass of those that think within explorer mindset, separate from those who think within an exploiter mindset. It is very important, however, that you do not isolate these individuals. One of the keys for successful innovation at an established company is to leverage existing core assets into new markets or capabilities. So, you will want to ensure that there is good communication and collaboration between the groups.

Second: there will be tension between Toms and Franks. This tension Is largely due to the differences in alignment and value of the groups. For example, in certain cases, you will be asking Frank to disrupt Tom. At the same time, you will be holding Tom responsible for results. Similarly, Tom may ask for more resources to deliver results, and he will be looking at Frank's budget as noncritical. It is very important that this tension be acknowledged explicitly and held at either the executive or group leadership level. Not addressing this tension will almost certainly lead to destructive results. Challenging the groups to step up and see the value of each others contributions also offers a great organizational growth opportunity.

Third: Individuals will respond to what they are incentivized to produce. Explorers and exploiters are asked to produce different things. It is important to make sure that the explorers are rewarded for experimentation, discovery, insights, speed, and adaptability. Exploiters should be rewarded for producing predictable results on task, on time, and on budget. In order to get everybody aligned, one option may be to increase the overall corporate performance in both group's incentives so they're focused on a blend of short-term and long-term results.

Fourth: I should probably add fifth, sixth, seventh, and eighth as well… leadership. This type of organizational realignment will only be effective if it is driven from the top. This is not something that can be sent out as a memo. It is not something that can be delegated to a lower part of your organization. This is something that will reflect not just the words but the actions of the company's leadership. You have to live the talk. Otherwise, you can't expect an organizational change to overcome the dominant values and inertia.

THE ROAD AHEAD...

To wrap up,

1) The good news: The industry is growing.
        The bad news: Lead Batteries are not capturing the growth.

2) The paradox of success drives us towards an exploiter mindset.
        Most companies overinvest in incremental exploiter initiatives and underinvest in radical innovation.
        Cultural inertia is a very powerful reinforcing mechanism that helps maintain routines, but can undermine progress.

3) For internal developments a two-step process for disruption leveraging core assets is the most likely to succeed. For moonshot approaches, find a partner or make an acquisition.

4) Realigning a company requires a change in incentives, organizational structure, and culture.
        Change only takes hold when driven from the top.

I'd like to leave you with a final thought. I am extremely optimistic about the industry. The forecast we viewed may be troubling, but it is just a forecast. The data shows that we have a fantastic opportunity in front of us. We can more than double the size of our entire industry, and that growth is open to anyone, but currently slotted to go to an industry a fraction of our size. With your commitment to increasing radical innovation, I believe that you can double the size of your company and not settle for single digit returns.

So, thank you for exploring with me! I look forward to seeing the impact of your innovation.

About Gridtential Energy

Gridtential Energy's cutting edge Silicon Joule battery architecture combines the traditional benefits of lead batteries – low cost, recyclability and safety – with the performance and life-cycle usually associated with lithium batteries. Gridtential is focused on applications ranging from hybrid automotive to grid storage, back-up power for cloud computing, material handling equipment and many others. Collaborating with a 600GWh-scale global manufacturing base and a near 100% recycling infrastructure, Gridtential and its licensing partners are planning beta and then commercial production of the Silicon Joule enabled batteries across the next two years.

To become a Gridtential partner email licensing@gridtential.com or to learn more visit http://www.gridtential.com/.