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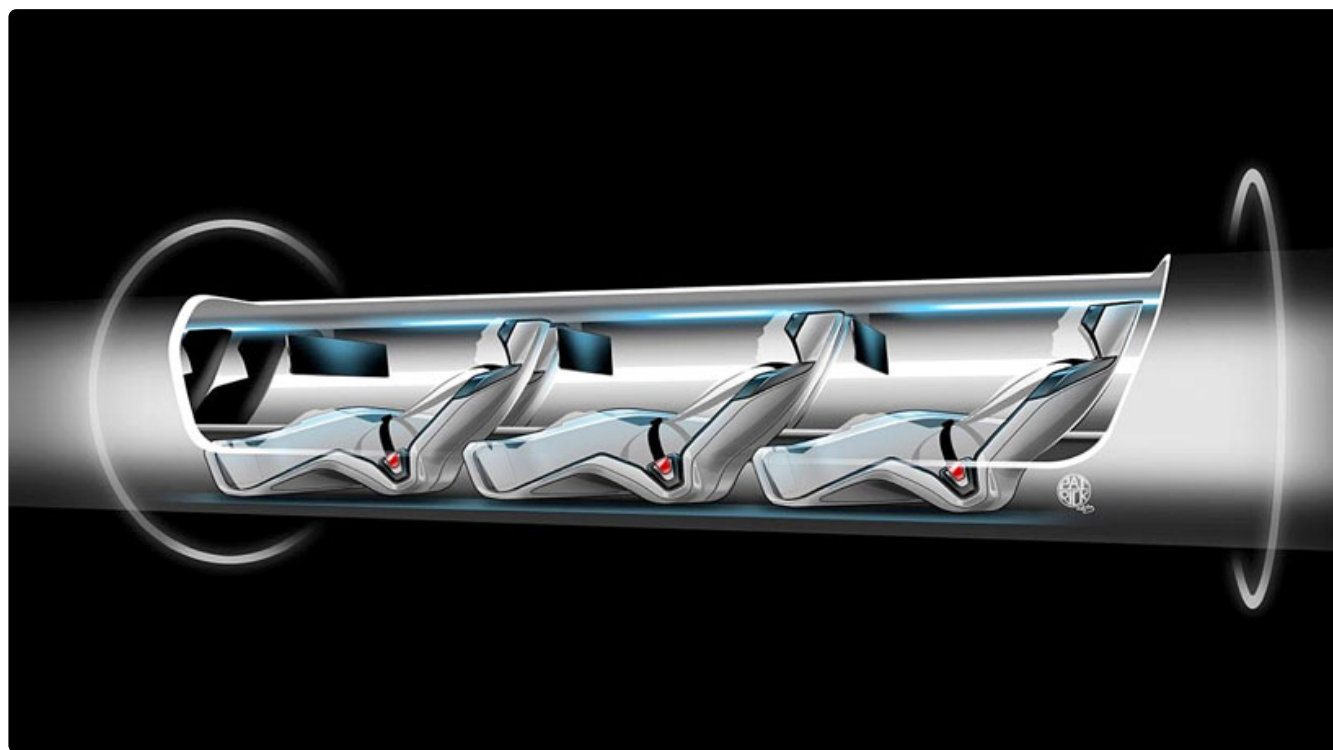HOME (HTTP://BLOG.MICROLANCER.COM/)   /

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Elon Musk's Secret Weapon: A Beginner's Guide to First Principles

Elon Musk is the CEO of **Tesla Motors (http://www.teslamotors.com/)**, an American electric car manufacturing company. The company has been responsible for technical innovations that many thought impossible, like producing battery packs more cheaply than ever before. Musk says these

Happy snaps.

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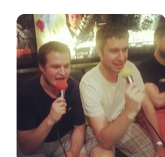
innovations are made possible by "reasoning from first principles". But what does that mean, and how can we apply it to our own lives, businesses and projects?

In a recent **interview with Kevin Rose (http://www.youtube.com/watch?v=L-s_3b5fRd8)**, Musk said the following:

> **I think it's important to reason from first principles rather than by analogy. The normal way we conduct our lives is we reason by analogy. We are doing this because it's like something else that was done, or it is like what other people are doing. Slight iterations on a theme.**

Meaning: we usually take something that already exists and innovate within that paradigm. In the startup world, entrepreneurs create "Pinterest for kids" or "Foursquare for hikers". In design, we put our own spin on whatever design patterns are in vogue right now. In programming, we code mostly in the same way that other programmers code, using the same tools.

This isn't a terrible thing. Reasoning from analogy tends to help avoid really bad ideas, since we're thinking in terms of what has worked well before. But it's not particularly useful when a problem requires deep innovation.

> **"First principles" is a physics way of looking at the world. What that really means is that you boil things down to the most fundamental truths and then reason up from there. That takes a lot more mental energy.**
>
> **Someone could – and people do — say battery packs are really expensive and that's just the way they will always be because that's the way they have been in the past. They would say it's going to cost $600 / KWhour. It's not going to be much better than that in the future.**

Meaning: throughout history, thousands of pundits have claimed that a certain industry, design pattern, object or idea had reached its peak. That it could never be improved upon, or produced more cheaply. And most who've made these kinds of statements have been proven wrong by the course of innovation. Alternatively, they had predicted only small improvements when drastic improvements were still within reach.

> **So, from first principles, we say: what are the material constituents of the batteries? What is the spot market value of the material constituents? It has carbon, nickel, aluminum, and some polymers for separation, and a steel can. Break that down on a materials basis, if we bought that on a London Metal Exchange, what would each of these things cost? Oh geez, it's $80 / KWhour. Clearly, you need to think of clever ways to take those materials and combine them into the shape of a battery cell, and you can have batteries that are much cheaper than anyone realizes.**

Meaning: rather than taking what already exists as the basis of our thinking, we break the problem down to its most fundamental truths and examine each piece. Even though a problem has already been solved, we start from the problem's most basic elements to reexamine whether a better solution might be possible.

Musk talks about breaking down the concept of a battery pack into its foundational, material elements: carbon, nickel, aluminum, polymers, a casing. These are the essential ingredients of a battery pack, the fundamental truths of the problem. From there, everything else can be optimized and improved upon depending on the smarts of the people tackling the problem.

We start from the problem's most basic elements to reexamine whether a better solution might be possible.

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In this case, reasoning from analogy would be to say "It currently costs about $600 / KWhour to create a battery pack. We need to budget accordingly." It means to set up machinery and acquire materials in the same way others have done because, well, that's what has worked so far.

Unless you're an engineer or deeply interested in battery packs, this example probably feels a little far from home. Here are a few more examples:

Entrepreneurship

Problem: Creating a website that allows customers to buy a new car at a low price and have it home delivered, sparing them the pain of a stressful dealership visit and price negotiation.

Reasoning from analogy: New cars are purchased from dealerships. Maybe the website provides an online way to communicate with a car salesperson and negotiate a price via online chat? The customer can pick up the car from the dealership, or have the salesperson deliver it.

Reasoning from first principles: If customers are purchasing new cars, we need to secure the cheapest possible source of new cars. What if we could manufacture the cars ourselves? Or, if that's impossible, or not economical, purchase them directly from the manufacturer, bypassing dealerships completely?

What if we could manufacture the cars ourselves?

Design

Problem: Create the world's most minimal, beautiful email app.

Reasoning from analogy: Gmail has an awesome email interface, but it's not very minimal looking. What if I created an interface similar to Gmail, cut out a few features, and used only black and white?

Reasoning from first principles: Email requires that one user can send a message to another and have it be read. The most minimal possible email app would do only these things. I'm going to need to use some clever design techniques to make sure the app is still fun and practical to use…

Programming

Problem: Create a login system for a web app.

Reasoning from analogy: Most apps require a user to provide a username, email address and password, with the password confirmed twice. That seems to be best practice, so I'll do the same.

Reasoning from first principles: What's the least information I need to collect from the user to make the app functional? The app creates a page for each user that is their online identity hub. I want their full name to be displayed at the top of the page, so I need to collect that. I won't display a username anywhere in the app, so I don't really need that. But if two users have the same name, how will I create a unique URL slug for each? I guess I could add a randomized number to the slug, and do a check before saving that ensures the number is unique…

I'll then need to collect the user's email in-case they forget their password. I probably don't need to verify their password twice, since the app will allow them to easily reset it as long as they have access to their email account.

Wrapping Up

Reasoning from first principles helps to ensure that you develop the smartest, leanest possible solution to a problem. It may even result in some astounding innovations. The downside is that it's a much harder path than reasoning from analogy. A one-question problem now becomes a 100 question problem. But when you're working on something that truly matters to you, this process of hard thinking will truly be worth it.

With so many other smart people working on similar problems, the easiest way to truly innovate, no matter what field you're in, is to reason from first principles.

(http://blog.bufferapp.com/productivity-poll-11-matters-choosing-service-buy/) (http://micromancer.com/eventwords/)

11 Comments.

rtdp (http://rtdptech.com)

Nice write up !

I too, was really impressed with his way of reasoning first principle.

Going that way, sometimes makes things look so easy and uncluttered. Thanks for write up, i have place for other to point while explaining this ;-)

Kyle

The first half of this post is weird, and I'm not sure if it's supposed to be funny or not. You repeatedly quoted Elon's own words, and then a "Meaning:" section after that which uses analogies to rephrase his stated principles.

I'm not sure if it's supposed to be mocking Elon, or yourself, or the state of tech journalism, or what. It didn't exactly come across as humorous, so I can't even tell if it's intentional.

Brad Neuberg (http://codinginparadise.org)

Great writeup. Sounds like a solid reverse engineering of Elon Musk's technique :)

Ben Sima (http://bensima.com)

> "I'll then need to collect the user's email in-case they forget their password. I probably don't need to verify their password twice…"

Why do you even need to collect a password? These are just used as an abstract identifier. What else can identify a person? Cell phone, facial recognition, vocal recognition, typing pattern [1], fingerprint (hold up finger to iSight camera)…

[1]: https://en.wikipedia.org/wiki/Keystroke_dynamics#Use_as_Biometric_Data (https://en.wikipedia.org/wiki/Keystroke_dynamics#Use_as_Biometric_Data)
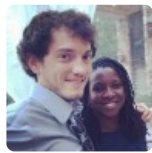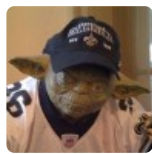
David (http://dbrown.net)
NOVEMBER 14, 2013 (HTTP://BLOG.MICROLANCER.COM/ELON-MUSKS-GREATEST-WEAPON-LAYMANS-GUIDE-FIRST-PRINCIPLES/#COMMENT-99) /

Nitpicking, but it's kW times hours (kW·hour), not kW per hour (kW/hour): http://en.wikipedia.org/wiki/Kilowatt_hour (http://en.wikipedia.org/wiki/Kilowatt_hour)

Cade Roux
NOVEMBER 15, 2013 (HTTP://BLOG.MICROLANCER.COM/ELON-MUSKS-GREATEST-WEAPON-LAYMANS-GUIDE-FIRST-PRINCIPLES/#COMMENT-100) /

The examples you give are not great.

Reasoning from first principles about what people use email for email gives us things like Google Wave, Hangouts, DropBox etc. what you are giving us is a minimal email app that assumes email is what the users want and not something else that they happen to use email for. Because what you have outlined could be the same as SMS and would meet the needs of a user who really just needs SMS.

Reasoning from first principles would be thinking about what people need to do and why and solving the underlying problem.

In fact, your example about the battery is not a first principles reasoning. First principles would not assume that a battery was necessary.

Fred Johnson

Hiya.

I liked learning about this concept. Great that Musk thinks this way.

So, you said, repeatedly: "$600 KW/hour". That's actually a nonsensical quantity. What you most likely meant was something like "$600 / KWhour".
A kilowatt-hour is a unit of energy, and this is typically what batteries are measured by.

Alan

Whats weird is the choice not to reason from first principles about this but instead attempt to reason like some existing example reasons.
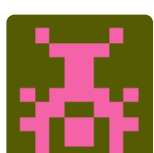
Jimit Shah (http://iamjimit.com)

I like your "Reasoning from first principles" things. It is saying divide the problem into pieces and analyze each piece preciously. Extract required information from it and implement those things only. Nice way to visualize the problem.

Thanks for writing.

Lelala (http://www.lelala.ch)

The solely answer to smart-ass Elon is very simple:

He studied physics, a hardskiller discipline – not a mickey-mouse-discipline like "business administration" :-)

Math & physics are the basic principles of the whole universe, these are universal rules & skills (and because of that you need a lot more "mental-energy" as he was quoted above).

People like him have a very deep and fundamental perspective on how the world is working…

Cheers

Mike Friedrich (http://www.cenano.de)

Great, true but not new.

Important is if prospects will accept an evolution rather than a revolutionary new product.

However a clear and simple revolutionary big vision of the future is crucial . I differentiate the BIG thing and start from the creation of adequate new materials. Further evolutionary product and marketing steps to positioning and sales are important.

By Elon Musk's Secret Weapon: A Beginner's Guide to First Principles | Enjoying The Moment (http://jeremiahtillman.wordpress.com/2013/11/14/elon-musks-secret-weapon-a-beginners-guide-to-first-principles/) on November 14, 2013 at 6:49 pm

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(http://www.cloudjetsolutions.com/blog/2013/11/15/elon-musks-secret-weapon-a-beginners-guide-to-first-principles/) on November 15, 2013 at 3:16 pm

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