

# NASA's fucked - Here's my vision

Oct 1, 2023 • Christopher Kalitin

## How'd This Happen?

In researching NASA I have come to the obvious conclusion that it is a horribly bureaucratic and political organization. I haven't seen anyone ardently dispute this point. As I am writing this post I see the Moon rising over the horizon. NASA has failed. We haven't colonized it yet.

"NASA hasn't made any good rockets since the 60's" - Geohot on a stream.

How do a few kilograms of Mars rocks cost \$10B? How does the SLS cost >\$40B before its first flight?

There are two core explanations:

1. Cost-Plus contracting
2. Politics

Cost-Plus contracting gained a lot of popularity during the Second World War. The government needed to build a lot of stuff quickly and cost-plus was the best way to do it.

This is the Cost-Plus process: Your company gives an estimated price for a contract. If you need more money, oh well, we're at war, you can have it. No one would dare overspend money if your coworker's son would die. [Update Dec 7 2024]

No one dies if SLS is delayed 5 years. So, the contractors can delay and get more money. Incentives are not aligned.

The other explanation is politics.

The Senate Launch System (SLS) and Artemis Program are prime examples of NASA's inefficiencies.

They were born out of the constellation program. [Ozan Bellik's blog posts have a lot of good info on this.](#)

The Constellation Program's plan to land on the moon involved two launches that docked in Low Earth Orbit. (1) An Ares 5 launches a lander and a TLI stage. (2) An Ares 1 launches an Orion capsule into orbit which docks to the prior launch's payload.

When Constellation was rightly cancelled by the Obama Administration in favour of Commercial Space (lots of info about this in Lori Garver's book) the Senators complained about all the government-funded jobs that would disappear from their districts with the end of the Shuttle hardware. So, the Senators came up with the Senate Launch System (SLS).

The SLS is an underoptimized rocket for its task: Landing on the Moon. A single-launch lunar landing is absolutely possible with it's 95-Ton LEO Capacity. However, the mass of Orion and its low-deltaV service module prevent this. Under the Constellation Program, the Altair lander would conduct the Lunar Orbit insertion burn. The Orion CSM is not designed to get into Lunar Orbit on its own.

The Constellation Architecture is not inherently flawed. But it takes NASA in the wrong direction, as I will explain later. In contrast, the Artemis Architecture takes a couple of parts of Constellation and a few parts of Commercial Space and joins them together in an underoptimized Lunar Program.

At least we get Reusable Lunar Landers out of Artemis.

My predictions for Artemis are the following:

1. The SLS will be cancelled when there is a suitable replacement.
2. These replacement(s) will be derived from the reusable landers.
3. The later Artemis missions will become more commercialized.

Artemis is far from the only example of NASA's deep inefficiencies.

I want to be clear. NASA is a net positive for the world. But it is horribly inefficient. Government agencies often are.

There are many examples of NASA impeding progress in space. Lori Garver's book *Escaping Gravity* has many examples of this. As Deputy Administrator of NASA, she was in a position to see this.

Who was against the commercialization of NASA? Who stands to lose if NASA becomes more efficient? The contractors and senators.

These are the people who spoke out against the COTS, CRS, and Commercial Crew contracts. It is debatable whether they truly believed the commercial companies would fail or if they were just trying to keep their funding [See Update Dec 13 2023]. The true answer obviously lies somewhere

in the middle. However, with the last decade of progress in commercial space, it is clear that the commercial companies were the right choice.

It is a testament to the senators and contractors power that they could overcome a directive from the President of the United States. President Obama was in favour of the Commercialization of NASA.

With the recent OIG report on the cost overruns of the Mars Sample Return program (MSR), [I saw a post from a former JPL employee that is very relevant to this discussion. Backup image in case the original is deleted.](#)

It shows how SpaceX pursued Red Dragon as a Mars Lander. This would be a more efficient platform for conducting science on the surface of Mars. There was intense pressure to not give funding to this program. From the post, it is not entirely clear where this pressure came from or the exact motive. But it is clear that the pressure was enough for SpaceX to cancel Red Dragon and shift over to Starship.

JPL currently conducts all the flagship missions to Mars. They are very good at getting small payloads to the surface of Mars. But they are not good at decreasing the cost - MSR is \$10B! Red Dragon could have decreased the cost per ton to the surface of Mars by more than an order of magnitude.

Who stands to lose from this? JPL and contractors.

This shows the common theme with NASA projects: entrenched interests that are not aligned with the goals of NASA.

If NASA could proportion funds to maximize science and exploration without regard to outside interests, it would be a much more efficient organization.

One of the factors that prevent this is how the US Federal Budget is allocated.

NASA cannot simply shift funding from one program to another. They must spend the money on the SLS that has already been allocated to it. Congress is not an efficient means of allocating funds. Mini-dictatorships are more efficient, also known as private companies.

Vivek Ramaswamy has spoken about how to fix this. When constructing the Federal budget we should work from the ground up to determine what resources are truly needed. Instead, we work from the top down. This means that the budget is not optimized for the best use of resources.

The system that created NASA's inefficiencies wasn't completely an accident. NASA's distributed nature was planned from the beginning.

Because NASA has centers in multiple congressional districts it has multiple Senators and Representatives that will fight for funding. This keeps NASA's funding high and stable. But it also means that NASA is a jobs program.

I thought NASA was meant to explore space and do science. Not be a jobs program.

## How to Fix NASA

What is the goal of NASA?

If you ask most people I hope they would say to do science and explore space.

There is a rhetoric that being a jobs program for people who work on out-of-date technology is a good thing. I disagree. Keeping people employed is good for those people and the economy, but not for science or exploring space.

It is very important to understand the goal of NASA: Science and Exploration. Otherwise, you get sucked into thinking NASA should be a jobs program.

Now that we have set the goal, we can use it as a framework to analyze NASA's current programs and predict its future.

Show me a single example where a government agency has been more efficient than private companies. I can't think of a single one off the top of my head.

NASA should be a customer, not a provider.

"One customer among many" - Jim Bridenstine, former NASA Administrator

Private companies have proven their ability to get to space cheaper and more efficiently than NASA. This is why for most payloads, NASA uses commercial launch providers. Private companies can also get people to space cheaper and safer than NASA could. This isn't purely SpaceX's doing, but they have been the most successful at it.

Is it too far of a stretch to assume that private companies will be able to build and operate space stations, rovers, bases, Moon landers, etc. better than NASA could?

Commercialization is inevitable either way. We might as well embrace it early.

The early voyages to North America were government-funded. How many are today? Almost none aside from the military. The early voyages to the Moon were government-funded. How many will be entirely government-funded in the future? None (ish).

I hope NASA never builds a moon base. They are bad at building big orange rockets, so it's not a stretch to assume a NASA moon base would be far over budget and behind schedule as well.

Commercial Space Stations are already in development and will fly in the next few years. They don't have a proven track record yet, but I am confident they will be successful in being cheaper and more efficient than the ISS.

If Space Stations are commercialized, why not Moon Bases? The technical challenges are not insurmountable for private companies.

Even with the commercialization of space, NASA still has a role to play in development programs. SpaceX would not be where it is today without NASA funding and collaborating with NASA on development. This is especially true for Crew Dragon.

In the next 10-20 years NASA will still need to be involved in private development programs. They will provide funding and expertise. This will allow for privately development programs that can be cheaper and more efficient than NASA could do on its own.

NASA is a stepping stone for commercialization.

The primary challenge in the future of completely commercializing space is the source of funding. How will companies make money if not from NASA? In-space manufacturing and mining offer a solution, but we will have to wait 10-50 years to see this play out.

What will NASA's role be in the commercialized future of space?

NASA will use technology and spacecraft developed by private companies to conduct science and exploration.

This is already happening with the CLPS program. NASA is paying private companies to develop Moon landers. NASA provides the experiments. The private companies provide the landers.

The Commercialization of space is already occurring as private companies are creating an economy in space. NASA should embrace this and use it to its advantage.

This is the first era of commercializing space. NASA provides funding, technical expertise, and the payload. In the next era, private space companies provide End-to-End solutions for missions.

The payloads of NASA missions will be commercialized. Currently, NASA is very much involved in the development of its own satellites and Mars landers. In the future, NASA will provide the mission requirements and private companies build the satellites and landers.

Commercialization has been the trend in all industries. It is inevitable that this will happen in

space. It is only a matter of time.

## Updates

[Update Dec 13 2023]

With [Smarter Every Day's latest video](#), it seems much of the personal push from engineers is good hearted. It's only when the government gets involved that degeneracy ensues. Also, Destin makes the mistake of simplifying the architecture at the expense of the mission.

[Update Dec 5 2024]

[Ozan Bellik summarized the insights](#) in this post well by saying systems engineering and project management should be moved to private companies, while NASA mainly does R&D, data analysis, and mission planning.

[Update Dec 7 2024]

The fundamental issue with cost-plus contracting now is that contractors are not incentivized enough to move quickly. In World War 2, the contracting paradigm didn't need to include incentives to move quickly because it was implicit in the national priorities of the time (not losing the war). Now, contracting paradigms need to include urgency to complete projects on time because there isn't this external signal to move quickly.

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# Applying the Law of Accelerating Returns

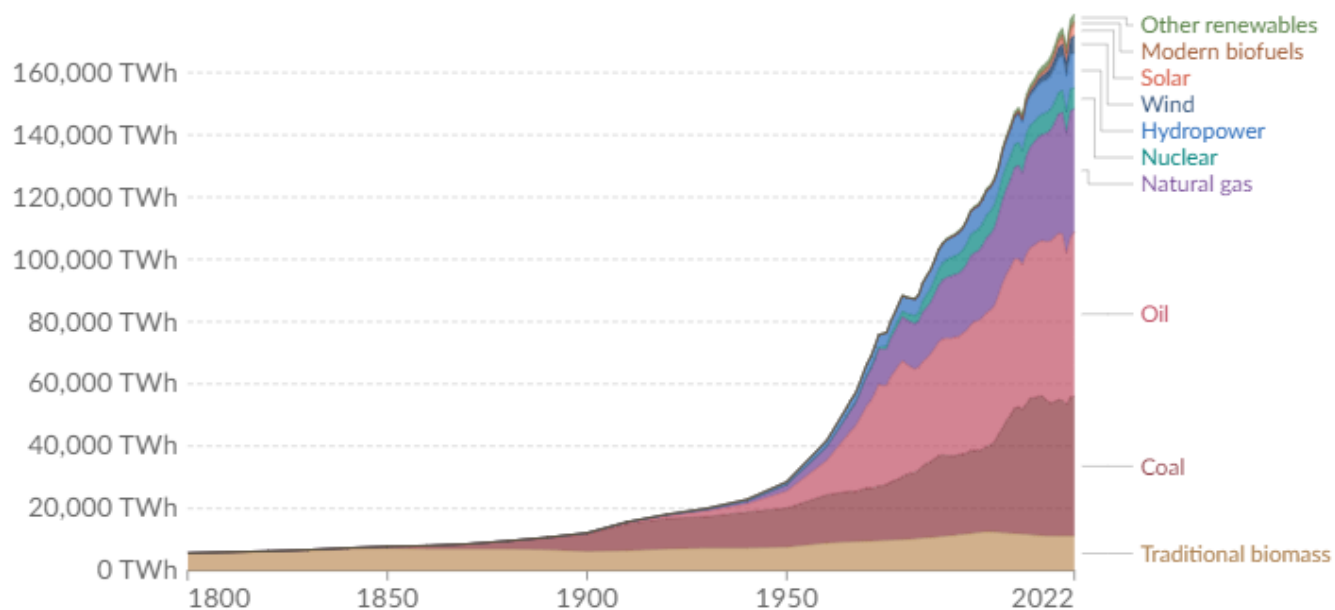
Sep 22, 2023 • Christopher Kalitin

I've read a few of George Hotz's blog posts. So I'm starting a blog. This is a first, late-night, attempt at a blog post.

In predicting any part of the future, I aim to be as accurate as possible. Emotions are the antithesis of this, emotions are not accurate. Predicting the future of humanity has nothing to do with my optimism or pessimism about it. I want to be right.

I do not solely aim to spend my life predicting what others build, but before you can build the future you have to know what to build. Kurzweil says it well, "As an inventor in the 1970s, I began to realise that my inventions needed to make sense in terms of the enabling technologies and market forces that would exist when the invention was introduced as that would be a very different one from the one in which the way was conceived."

The Law of Accelerating Returns is the most fundamental aspect of technology that everyone needs to understand. I have seen friends say "we won't have electric trucks for 20 years" or "AI cannot take over the world". These points fundamentally misunderstand the exponential growth of new paradigms, the S-curve. Furthermore, these points miss the exponentially increasing growth rate of humanity, see the energy chart. Humans are bad at understanding exponentials.



Source: Energy Institute Statistical Review of World Energy (2023); Vaclav Smil (2017)  
 OurWorldInData.org/energy • CC BY

Why is wood still used?

We need to use more energy. Energy consumption is closely linked to quality of life and life expectancy. Using more energy saves and improves lives.

Furthermore, I believe advancing up the Kardashev Scale is a moral imperative for humanity. I do not see any other goal for humanity than understanding the universe and becoming a galactic civilization helps us do this. The more energy we have at our disposal, the more can be learned about the universe. Put differently, we must use energy to meet god.

The only way to progress on the Kardashev scale is to produce more energy. How will we incentivize this increase in energy production? Simple, increase demand for energy. Use Air Conditioning when you're not home, run all the TVs in your house all day, the lights too, keep your stoves running to burn more gas, and keep computers running at full capacity at all times. This is a moral good for the future of humanity.

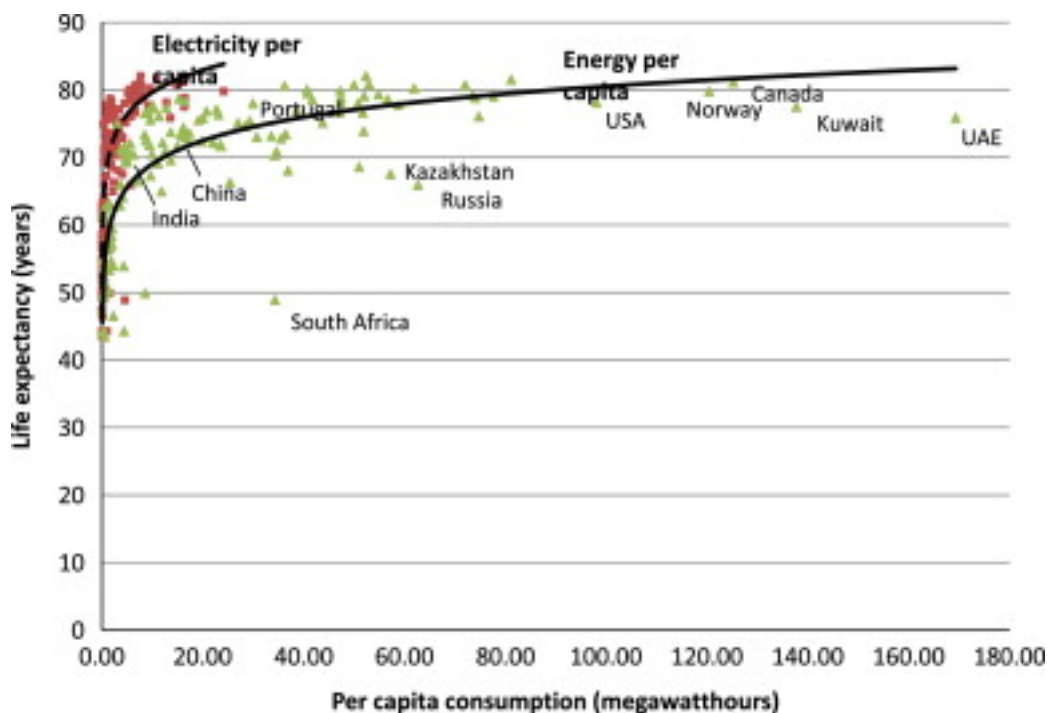
It is a damn shame the chart of energy consumption hasn't grown faster. Let's fix that together by using as much energy as possible. Damn the efficiency, the Kardashev scale only measures production!

A note on climate change: I don't care if some Pacific island nations get flooded. The Kardashev scale is more important. Also, I will personally kill every endangered species within 100km of Starbase if it means Starship launches 1 month sooner.

Climate Change will not kill us. The rapidly advancing paradigms of clean energy will take over the world and save us from climate change for a simple reason: they're cheaper. Installing new

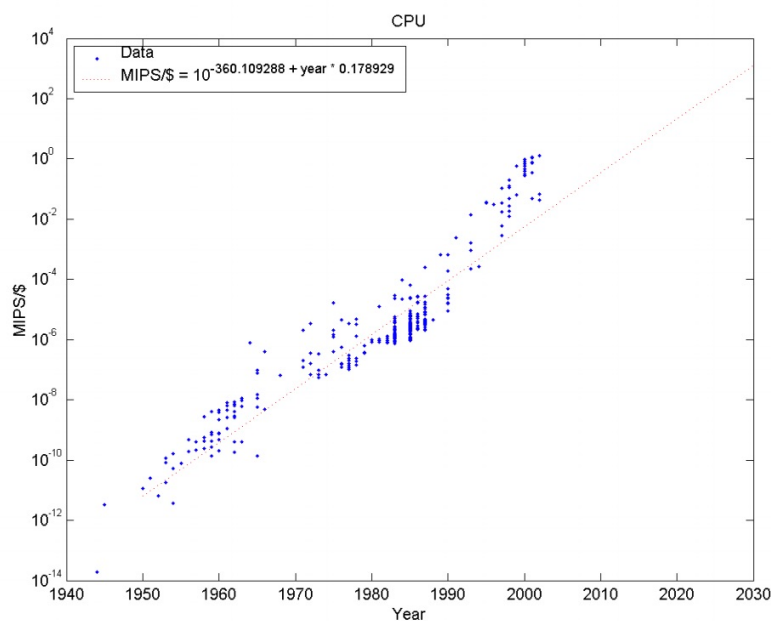


solar is cheaper than coal. EVs are cheaper than ICE. My prediction for EV new car market share is ~50% in 2026 and 90% in 2030. S-curves are easy to project into the future.



The long tail of life expectancy is not ideal. Hopefully, we'll start living longer soon.

I have seen no particularly eloquent and condensed definitions of the Law of Accelerating Returns in my Google search of the definition. This is my definition: The growth rate of technology is exponentially increasing. S-curves are getting faster. Our kids will grow up in a drastically different world than our own. Better have them quickly!



MIPS per dollar, Log Scale. Moore's law isn't dead. Strangely, it hasn't accelerated.

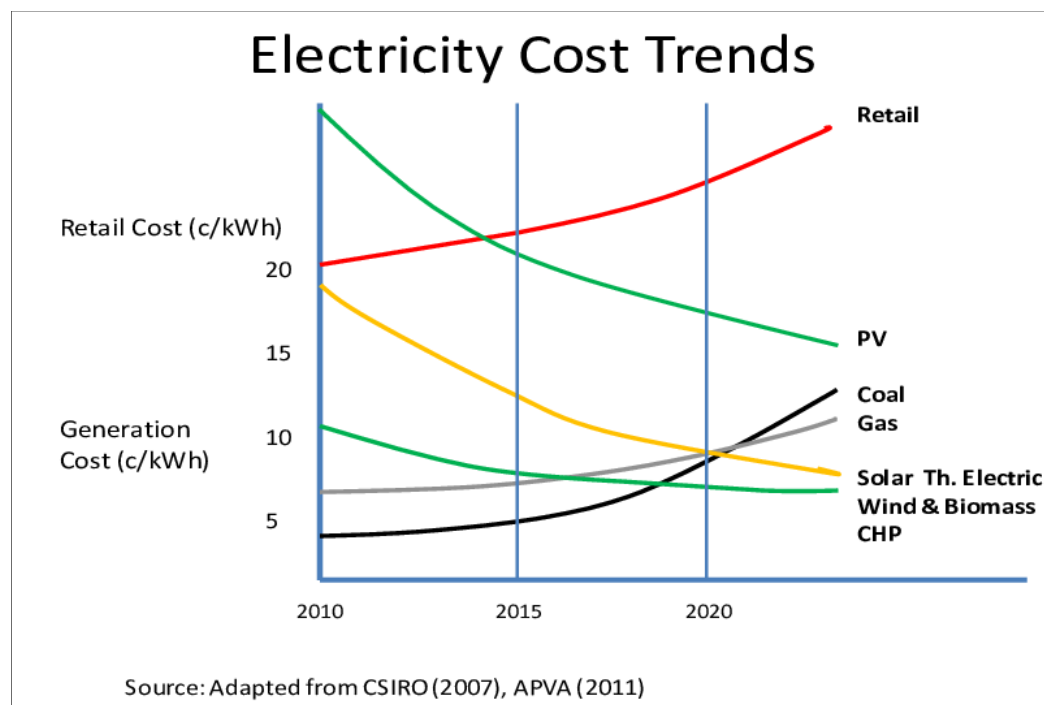
The accelerating growth of humanity and the accelerating pace of S-curves are certainties in my mind. Fundamentally, for a new and improved paradigm to take hold the legacy paradigm must come to an end. Energy is the prime example.

The stagnation of the cost of energy is described in *The Singularity is Near*. Coal, Oil, and Natural Gas produce most of our energy and they are evolved technologies. Their growth rates are so slow that the increasing fixed costs cause the price of energy to increase. Or maybe the companies just like money, Capitalism isn't always perfect.

Renewable energy fixes this. Solar and wind energy generation are on declining cost curves. We are currently at the inflexion point where installing new solar is becoming cheaper than fossil-fuel-based alternatives. Soon, Solar will take over the world. In some geographics wind or hydro will be more effective. But even in BC - where BC Hydro produces the vast majority of our energy - installing solar panels on your home is a profitable long-term financial decision.

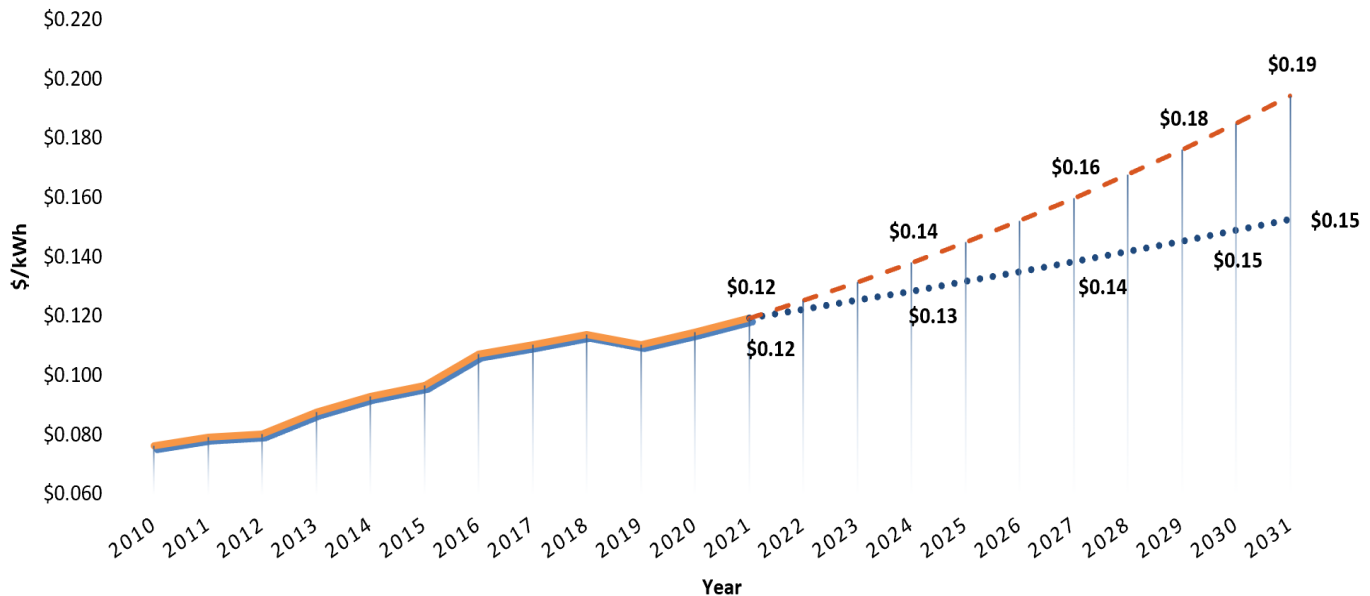
Other stagnant fields ripe for disruption are Internal Combustion Engine Vehicles, Healthcare, Education, Rural Telecommunications, Government, centrally controlled currency, etc.

Crypto is excellent for regulatory arbitrage and fighting authoritarianism. Take the power of printing money away from the government and give it to no one.

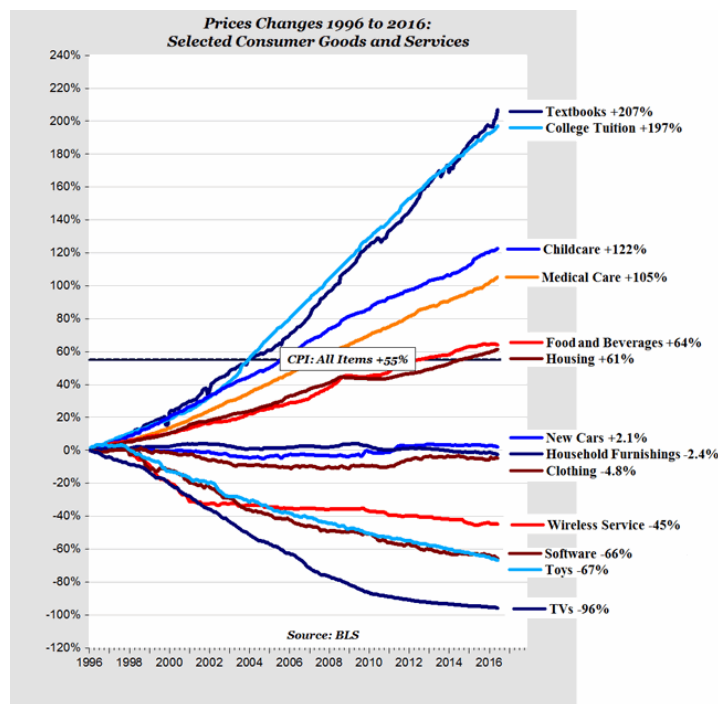


Solar ftw, retail cost explains BC Hydro graph below.

## HISTORICAL ELECTRICITY PRICES



BC Hydro is increasing energy prices. We will put them out of business with solar. Only evil people increase the price of energy.



Anything above the line should be disrupted. Housing too. Buy Tesla stock, not real estate.

The question of how exactly AI will impact our lives in 50 years is a very difficult one. The growth of AI is too fast to predict its impacts long into the future. Luckily I don't need to know the exact use cases of AI in 50 years to work on it today.

The exponential growth of AI should strike fear into everyone's hearts. ChatGPT did this for a

while, then it became normal.

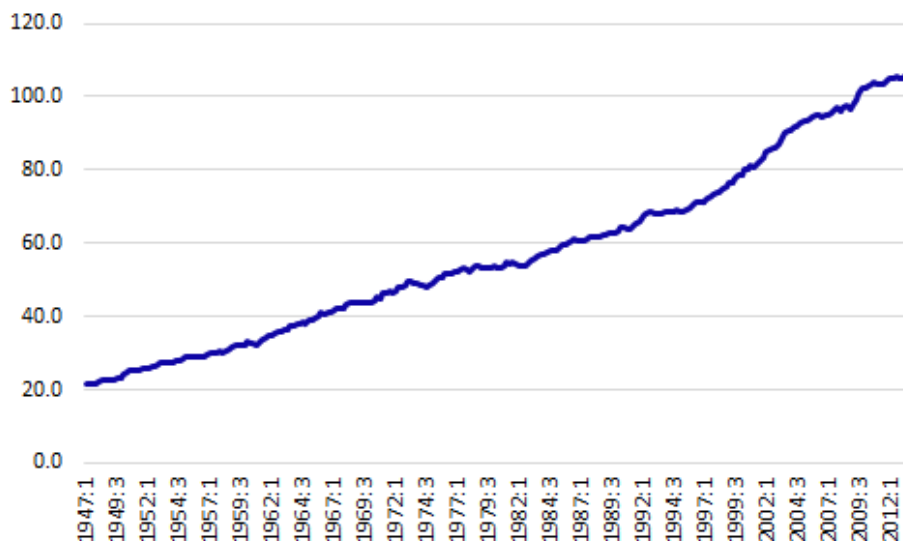
A very intelligent scholar on Twitter explained the recent progress of AI well, "In 2024, AI advancements will be more numerous and happen faster than in 2023." This will be true for every year long into the future barring any humanity-scale catastrophe.

The current paradigm of using AI systems as tools is fairly easy to broadly predict. AI tools will replace large parts of many workflows and allow for more output per hour in applicable fields.

Workers will become more efficient. This is usually put into one of two categories: companies will need fewer workers and fire those not needed or the productivity increase will allow for more work to be done. One of these scenarios increases the size of the economy, the other does not. I lean towards the scenario that increases the economy being more true than the alternative.

#### Labor productivity in the business sector, first quarter 1947–fourth quarter 2013

Index (2009 = 100)



Source: U.S. Bureau of Labor Statistics.

Increasing worker efficiency is not a new thing.

There is agreement between George Hotz and Elon Musk that Kurzweil is right in his 2029 prediction of a functional simulation of the human brain. The Singularity. I will use this 2029 date.

This means in 2029 silicon-based intelligence will be able to do the work of biological intelligence. It is not a perfect, overnight transition, but that is precise enough for my purposes.

What happens after this?

For many paradigms, it seems impossible to accurately predict AI's impact. So, I won't.

It is also impossible to accurately predict the colonisation of the universe. But the Kardashev scale

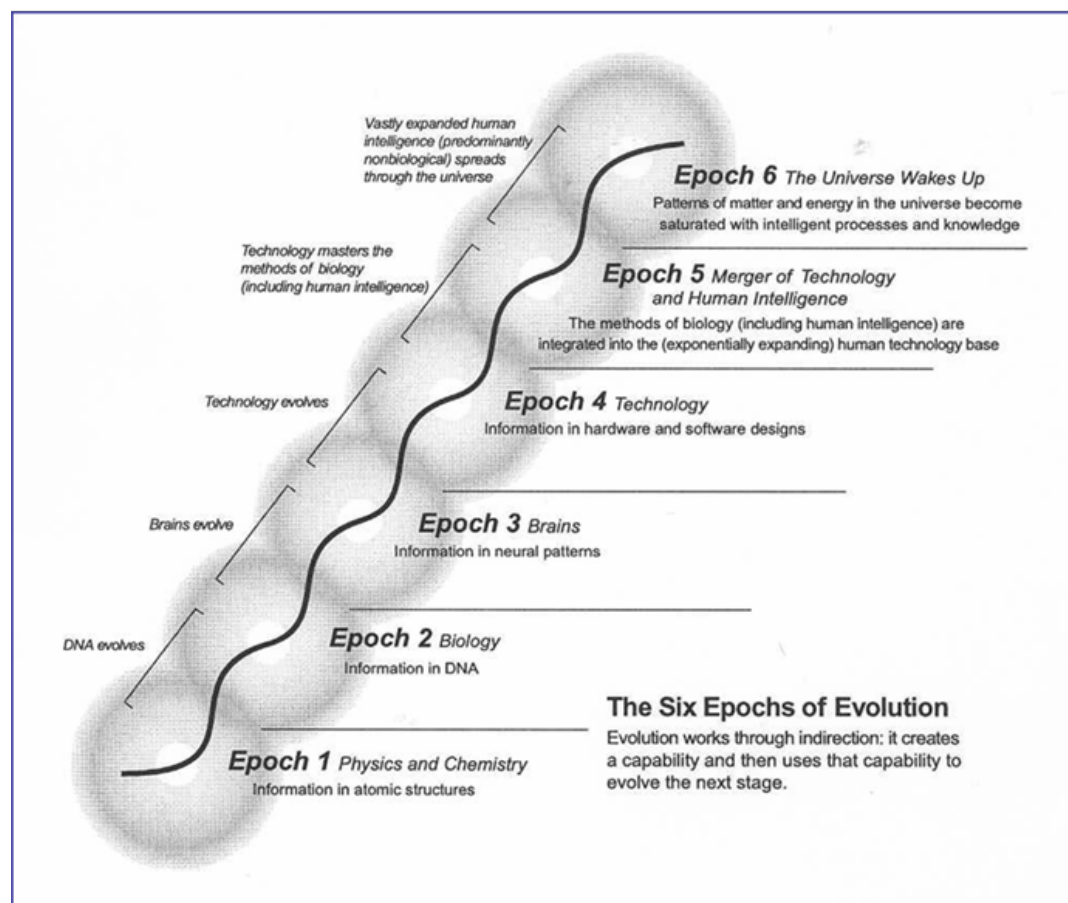
gives us a framework and the speed of light sets an upper limit.

What is the framework for predicting the rise of AI? I believe it is intelligence.

AI will greatly increase the amount of intelligence in our part of the universe. This will make progress on the tech tree much faster. This will allow us to meet God - whatever created the universe - faster.

This is the extent of my predictions on the future of AI. At the moment, I do not see any other accurately predictable outcomes.

If this is too abstract for you, read *The Final Question* by Issac Asimov.



Epoch 6 is the important one for meeting God.

Aside from a Yudkowsky-style Authoritarian halt to AI progress or a Butlerian Jihad I see no way to stop AI. The advancement of technology has never been stopped in the history of humanity, it has only been briefly delayed.

Slowing down AI progress is certainly a safer approach than progressing at full speed. 6-month moratoriums are not enough for this. Regulation helps to prevent our death at the hands of AI, but I am not a fan of increasing the power of the government. So, this is again an unsatisfactory

solution.

I currently have no concrete answer as to how to prevent the potential negatives of AI. The right people must be in charge. ClosedAI are not the right people.

To conclude I will summarise my beliefs/predictions.

1. The goal of humanity should be to uncover what created the universe. Meet God.
2. Advancing up the Kardashev scale helps us meet god.
3. If The Law of Accelerating Returns is understood, it is trivial to predict the growth of some paradigms. Clean Energy, EVs, etc.
4. The advancement of technology cannot be stopped.

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# Stoke Nova Cost Model - Will it Survive?

Jun 25, 1990 • Christopher Kalitin



Tim 30% hardware cost post: [https://x.com/Tim\\_X94/status/1802451587073225187](https://x.com/Tim_X94/status/1802451587073225187)

Whiteboard notes:

- Cadence impact
- Market addressability given mass (Eager space chart)
- 30% hardware cost? What?
- Model net company costs

Vulcan reuse numbers: <https://x.com/deltaIV9250/status/1878461890923217295>

Ozan, Reuse numbers for external parts like Upper stage, fairings, boosters, etc: <https://x.com/BellikOzan/status/1878602456537682227>



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Geohot made a blog too. <https://caseyhandmer.wordpress.com/2023/08/25/you-should-be-working-on-hardware/>>You should be working on hardware</a>





# The Bare Minimum Engineer

Jul 20, 1969 • Christopher Kalitin

Longer title: How To Become The Bare Minimum Engineer

This is partly a play on Casey Handmer's [The Well-Rounded Engineer](#).

Slightly a continuation of How To Teach Engineering, though that was mostly just yapping.

Potential Structure:

1. Get on the Positive Slope Side of the J Curve
2. How To Become The Bear Minimum Engineer
3. How Not To Become The Bare Minimum Engineer

## The Bare Minimum Engineer

1. Play on Handmer's The Well-Rounded Engineer
2. The MVP of an engineer, providing value
3. How to be a net positive in organizations

## How to actually learn things and why university is inefficeint

1. Just take the conversation with Prashant and formalize it
2. Work from first principles
  - Maybe note that I'm just a student? Open to iteration? Or just go for it? Just go for it.
  - Get Mischa's feedback?
1. The Well-Rounded Engineer is about how to maximize your productive output as an engineer
2. The Bare Minimum Engineer is about how to get to the positive side of the J curve
3. As an engineering student, or young person in general, or new entrant into an engineering organization, you are a net negative
4. You need to acquire knowledge and skills to start becoming productive, and then pay back your debt to the organization (UBC Solar)

5. Be extremely curious, the side effects/fundamental reasons for this are extremely positive and increase your net lifetime productive output (increased salary too in engineering)

phenolphthalein

## Prashant Conversation Notes:

- ○ ■ Hardest I've ever worked and not the most productive I've ever been
- ○ ■ You need to understand why you're studying something and what the goal is to know what information is important (Falcon 1 example toughness)
- ○ ■ Self motivation is extremely important. University's forcing function is extrinsic
- English class is low signal to noise ratio
- ○ ■ Projects that are useless in and of themselves are demotivating
- ○ ■ Complete focus = max productivity. Context switching is the mind killer (Joe Justice with Dr. Know It All Podcast)
- ○ ■ Feedback from people more intelligent than you is extremely important
- ○ ■ Classes mostly teach computations (maybe this changes in upper years) + tested on computations (MATH 120)
- ○ ■ Not incentivized to learn things from first principles
- ○ ■ Entry is based on grades
- ○ ■ First Principles give the side effect of being successful academically (mostly)
- ○ ■ No clue how to test. Do you even test? You have the real world, job interviews and portfolios are your test
- ○ ■ Back to the original point, you need to be able to integrate feedback
- ○ ■ First Principles and Projects show you why the things you're learning are important!
- ○ ■ High iteration rate is important and motivating, in contrast to fax projects
- ○ ■ Anecdotes? Nah fuck that I'm right. I am my father's son. Symptom of extreme self belief

## Prashant conversation:

[7:24 PM]Christopher Kalitin: The paradigm of work in university is very inefficient [7:24

PM]Christopher Kalitin: This is simultaneously the hardest I've ever worked and not the most productive I've ever been [7:24 PM]Christopher Kalitin: In about the last year of online school I figured out the proper schedule to maximize productivity, sadly now this can't be utilized

- ○ ■ Hardest I've ever worked and not the most productive I've ever been

[7:27 PM]Christopher Kalitin: We're studying the fundamentals without knowing why, which

greatly decreases efficiency

You need to know why you're learning something to properly learn it

Like the transformer architecture, you need to weigh certain facts more highly than others - if you don't do this weighting you're far less efficient

The only way to figure out what knowledge to put more effort into learning than others (weights) is to actually do something, to build, this is why design teams are important

- ○ ■ You need to understand why you're studying something and what the goal is to know what information is important (Falcon 1 example toughness)

[7:30 PM]Christopher Kalitin: You have to be self motivated to do it, this is the problem with university, nearly everything you do is externally motivated "oh no I need to study for this test or I'll get a bad grade"

- ○ ■ Self motivation is extremely important. University's forcing function is extrinsic
- English class is low signal to noise ratio

[7:48 PM]Pieman: It's more about the practice and learning how to form a significant and debatable claim on a unresolved scientific issue [7:49 PM]Christopher Kalitin: Learning on projects that are useless in and of themselves - you need to write real research to know how to write research papers!

- ○ ■ Projects that are useless in and of themselves are demotivating

[8:55 PM]Christopher Kalitin: You'll get good at writing papers when its all you think about - this doesn't happen in school

- ○ ■ Complete focus = max productivity. Context switching is the mind killer (Joe Justice with Dr. Know It All Podcast)

[8:56 PM]Pieman: The willingness to wrote papers is all your own [8:57 PM]Christopher Kalitin: in university its extrinsic, not intrinsic

[8:57 PM]Pieman: Right you could have great ideas, but presenting them on paper is something that requires alot of practice [8:57 PM]Pieman: It requires the feedback of people that are more educated than yourself

- ○ ■ Feedback from people more intelligent than you is extremely important

[8:59 PM]Christopher Kalitin: In chem & physics this is especially clear because all you're tested on and learning is how to solve equations - and if you have a good teacher many some first principle understanding

On projects, all that matters is first principle understanding of the systems you're working on, do chemists actually solve stoichiometry problems by hand? This is extremely clear on ubc solar

- ○ ■ Classes mostly teach computations (maybe this changes in upper years) + tested on computations (MATH 120)

[9:04 PM]Christopher Kalitin: Exactly I completely agree

Now the more fundamental issue is that the incentive in university is not to learn things from first principles, it's to get a good grade on the test

I have a few friends like this and it's immensely sad and unproductive

Like you're saying, its a personal responsibility to try to understand things from first principles - personal responsibility, not academic responsibility

Your academic responsibility is to get a good grade on the test

- ○ ■ Not incentivized to learn things from first principles

[9:05 PM]Pieman: If you see uni through only the lense of the goal of grades I doubt your gonna go far [9:06 PM]Christopher Kalitin: Thats the way the university sees it

Your entry into the university is mainly by grades You getting into the program you want is mainly on grades Etc.

- ○ ■ Entry is based on grades

[9:06 PM]Christopher Kalitin: There is the side effect of understanding things from first principles that you'll probably do well on the tests - but this is not a direct effect, only a side effect

- ○ ■ First Principles give the side effect of being successful academically (mostly)

[9:07 PM]Christopher Kalitin: Sure, but they're optimised for testing you on quantitative computational knowledge, not testing you on your first principles understanding of various systems, which is what actually matters on technical projects

[9:07 PM]Pieman: How would you propose unis test us then [9:08 PM]Christopher Kalitin: No clue yet! for now I've only identified the massive problem

- ○ ■ No clue how to test. Do you even test? You have the real world, job interviews and portfolios are your test

[9:08 PM]Christopher Kalitin: I think the only way to really learn the way I want to is more personalised I've learned far more about engineering from my design team than the intro to