

Useful Intermediary Steps Are Fundamental To Startups And Large Novel Projects

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Christopher Kalitin Blog (<https://ckalitin.github.io/posts/useful-intermediary-steps/>)

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Several years ago I saw [this clip of George Hotz](https://youtu.be/_L3gNaAVjQ4?si=timvK1RTGQ4UDSr7&t=3199) (https://youtu.be/_L3gNaAVjQ4?si=timvK1RTGQ4UDSr7&t=3199) in which he described the mission of Comma AI as “solving self-driving cars while delivering shippable intermediaries.” In that clip and elsewhere he describes how actually shipping products to customers is a fundamental test of a startup that allows you to course correct quickly and prove your right to capital.

In this blog post, I'll describe how we can take the slightly more fundamental idea of useful intermediary steps and apply this to large-scale projects, startups, and capital allocation.

The George Hotz Idea

George Hotz mainly focuses on the idea of shippable intermediaries in the self-driving car space where so many companies don't follow this principle and end going bankrupt after wasting billions in capital.

At Comma AI, they sell the Comma 3 device to customers that allows level 2 autonomous driving and they release updates of their [openpilot software on Github](https://github.com/commaai/openpilot) (<https://github.com/commaai/openpilot>). They sell a product to customers and update it to get feedback on new releases. With a large developer community (openpilot is open source), they get good useful feedback quickly.

In contrast, there are a surprising number of companies that spent billions developing self-driving car software that never actually shipped a product to customers! Examples include Argo AI (\$3.6B raised), Aurora (\$2.9B), and Cruise (\$10B raised, recently shut down after offering some rides in SF).

Given the poor trajectories of these companies, they clearly didn't buy down enough technical risk early during previous funding rounds but regardless were given billions in capital to continue development. On the other hand, Comma AI has raised around \$10M and has produced more value for customers than all the companies mentioned above combined (Comma has on the order of [10k active users](https://comma.ai/openpilot) (<https://comma.ai/openpilot>)).

Focusing on Useful Intermediary Steps Allows For Course Correction

"Instead of charting a course that allows them to take smaller steps, rapidly iterate, and demonstrate measurable progress, we tend to see most companies instead devoting resources to extended solicitation of massive investments with technology and teams that are simply not prepared for it."

- [Kyle Adkins of Terraform Industries](https://terraformindustries.wordpress.com/2025/03/25/no-excuses-how-to-build-scale-and-win-in-hard-tech/) (<https://terraformindustries.wordpress.com/2025/03/25/no-excuses-how-to-build-scale-and-win-in-hard-tech/>)

The fundamental principle behind the shippable intermediary is that useful intermediary steps allow for course correction. By extension, this allows for learning the topology of the problem space and error correction.

Intermediary steps allow for course correction before sunk costs build up because they are incremental steps on the course to a larger goal. Through each intermediary step, you learn the topology of the landscape your project is moving through and can optimize your path to the final goal. This constant course correction is particularly important for large new R&D projects where each new piece of information has the potential to have a great impact on the course of a project. This allows for new information to be gathered and used to correct the course of a project before sunk costs build up and you end up with a \$10B company with no useful product.

Error correction is important to a greater set of projects than learning the topology of the problem space. Novel projects are the subset of projects where you must learn what lies ahead. In the larger set of all projects, error correction is important to ensure that you are on the best path to achieving your goal. This includes projects with well-worn paths. Building another skyscraper doesn't require fundamental research into the properties of concrete, but it does require error correction when not every human is working in the same direction and you get desyncs.

We can consider the development of early rocket propellants to illustrate the importance of intermediary steps. The A4 rocket engine (V2 missile) had an ISP of ~215 seconds and was fueled with liquid oxygen and a mixture of 75-25 ethanol-water. Without dozens of intermediary steps between the development of the A4 and the Saturn V, we would have optimized the Kerolox or Hydrolox rocket engines required to get to the Moon (just imagine trying to get to the Moon on 215 seconds of ISP!). Or, without the iterations between the A4, XLR50, LR-105, and H-1 engines (among many others) the F1 could not have been built to the standard it was.

In nearly every successful novel project in history, you find intermediary steps. For example, the Hoover Dam could not have been built to last many millennia without many previous smaller dams and massive concrete projects to learn the characteristics of the [heat of hydration of concrete](https://youtu.be/4EdMlmlZE2s?si=3UJYCRIURTB5jtSX&t=2277) (<https://youtu.be/4EdMlmlZE2s?si=3UJYCRIURTB5jtSX&t=2277>). The early monumental [Oppau](https://en.wikipedia.org/wiki/Oppau_explosion) (https://en.wikipedia.org/wiki/Oppau_explosion) and [Leuna](https://en.wikipedia.org/wiki/Leuna_works) (https://en.wikipedia.org/wiki/Leuna_works) Haber-Bosch plants could not have been built without Bosch's earlier 8-foot tall oven tests where BASF discovered many metallurgy edge cases when working at 200 atm and 600 degree celsius to synthesize Ammonia (this is

actually a completely fascinating story and you must read [The Alchemy of Air](https://docs.google.com/document/d/178mx6r7ClbddQZY09mZ4dCBUmYg97o4XSDJwmtkx7ME/edit?usp=sharing) (<https://docs.google.com/document/d/178mx6r7ClbddQZY09mZ4dCBUmYg97o4XSDJwmtkx7ME/edit?usp=sharing>)).

At the top of this section there's a quote from [Kyle Adkins' blog post](https://terraformindustries.wordpress.com/2025/03/25/no-excuses-how-to-build-scale-and-win-in-hard-tech/) (<https://terraformindustries.wordpress.com/2025/03/25/no-excuses-how-to-build-scale-and-win-in-hard-tech/>) about Terraform Industries' plan to succeed in large-scale hydrocarbon synthesis. Among many insights in his blog post, he describes how Terraform's strategy is to ensure each step on the path to dominating the hydrocarbon market is useful, and a great way to demonstrate you're doing something useful is through generating revenue.

"The companies that succeed start by dominating a valuable niche and scaling from there. Terraform follows this principle by ensuring that each deployment of synthetic fuel production generates revenue, avoiding the trap of infinite fundraising cycles."

It's not too difficult to consider a situation in which a larger company would take fewer intermediary steps and fail at large-scale hydrocarbon synthesis. [Casey Handmer recently wrote a blog post](https://caseyhandmer.wordpress.com/2024/11/09/solar-and-batteries-for-generic-use-cases/) (<https://caseyhandmer.wordpress.com/2024/11/09/solar-and-batteries-for-generic-use-cases/>) about which electrical loads are best suited to the Terraform strategy of using solely intermittent solar for industrial processes. He made sure to get the point across that if you don't consider something like the capex per unit power of your process, you could easily fall in a situation in which you are terribly underoptimized for cost. The intermediary step towards large-scale hydrocarbon synthesis is having a Casey Handmer do some fundamental research into the most cost-effective source of hydrocarbons in 20 years. As [Handmer's experiences at JPL illustrates](https://podcasts.apple.com/ca/podcast/energy-economics-and-rocket-science-with-casey-handmer/id1753399812?i=1000665423662) (<https://podcasts.apple.com/ca/podcast/energy-economics-and-rocket-science-with-casey-handmer/id1753399812?i=1000665423662>) (timestamp: 44:45 and 55:12), large organizations are not always effective at facilitating this kind of research. Really, I'm just making the case for Polymaths.

Prove Your Right To Capital

Above I described why intermediary steps are important for course and error correction. An extension of this is that you prove your right to capital through successfully executing on intermediary steps.

Except in edge cases or ZIRP phenomena, raising capital requires that you prove your ability to execute on your project. A small step size between intermediary steps allows for a gradual increase in the scope and scale of operations while moving towards a larger goal. With too large a step between intermediary steps, you risk failing and not earning the right to more capital.

The goal of each intermediary step is to prove your ability to execute and hence earn more capital. Now comes the tradeoff of step size between intermediary steps. Too small and you waste time and resources on too many small steps, but too large and you risk failure. Success at each intermediary

step is a condition of the next step, so continual success is required (again, except in edge cases like the self driving car companies mentioned above).

Another benefit of raising capital - as opposed to self funding - is it's a way to accelerate progress towards a larger goal without focusing too much on the intermediary steps. It is not a requirement that each step is a sustainable business, only that it buys down risk for the next step. This allows you to focus on the larger goal while still proving your right to capital.

During [Destin Sandlin's talk in which he criticized aspects of the Artemis program](https://youtu.be/OoJsPvmFixU?si=RCo10HyKo1Zf8UWi&t=2530) (<https://youtu.be/OoJsPvmFixU?si=RCo10HyKo1Zf8UWi&t=2530>), he shared this quote from George M. Low - former NASA administrator - about the strategy of steadily increasing the scope of the Apollo missions:
"Too small a step would have involved the risk that is always inherent in manned flight, without any significant gain - without any real progress toward the lunar landing. Too large a step, on the other hand, might have stretched the system beyond the capability and to the point where risks would have become excessive because the new requirements in flight operations were more than people could learn and practice and perfect in available time."

[Casey Handmer has often quoted Nat Friedman](https://x.com/search?q=%22slow%20is%20fake%22%20(from%3A%40cjhandmer)&src=typed_query&f=top) ([https://x.com/search?q=%22slow%20is%20fake%22%20\(from%3A%40cjhandmer\)&src=typed_query&f=top](https://x.com/search?q=%22slow%20is%20fake%22%20(from%3A%40cjhandmer)&src=typed_query&f=top)) saying "slow is fake." Beware of too small intermediary steps!

Revenue Generation on the path of the Master Plan

The concept of useful intermediary steps can be applied on many scales. Before you drop out of university you should make sure your small business can actually generate revenue and before you colonize Mars you should be able to make it to orbit.

For extremely large and long-term grand plans - like colonizing Mars - revenue generation and profitability is often a required intermediary step. This is because profitability is a prerequisite for sustainable survival. If you can't generate revenue, you are [default dead](https://www.paulgraham.com/ord.html) (<https://www.paulgraham.com/ord.html>), and in the limit you are not in business.

Revenue generation also means you actually provide value to customers. For technologies that promise cleaner or more efficient energy, manufacturing, etc. this is a fundamental prerequisite for world domination of your particular addition to the tech stack of humanity.

For a technology to become ingrained in human existence it must provide value. If your invention is extremely good for the environment but not for the economy, it will not be adopted. This is why we won't be driving [Hydrogen Fuel Cell cars in 20 years](https://ckalitin.github.io/technology/1961/04/12/transition-to-robotaxis.html) (<https://ckalitin.github.io/technology/1961/04/12/transition-to-robotaxis.html>), and also why [solar panels will be the source of the world's energy](https://terraformind) (<https://terraformind>

stries.wordpress.com/2024/06/24/how-terraform-navigated-the-idea-maze/). Value generation is a required intermediary step (and final step) for any technology to be adopted on a global scale.

Elon Master Plan for all the Musk companies fundamentally revolves around finding a grand vision for the future of humanity and figuring out which intermediary steps are required to get us there.

The [Tesla Master Plan Part 1](https://www.tesla.com/en_ca/secret-master-plan) (https://www.tesla.com/en_ca/secret-master-plan) was to accelerate the world's transition to sustainable energy through creating desirable electric cars. The first intermediary step was creating a sustainable electric car company and to do this they started at the high end of the vehicle market with the Tesla Roadster before steadily progressing down to the Model 3 and soon Robotaxi.

The SpaceX Master Plan is to colonize Mars and make humanity a multi-planetary species. This requires a cheaper rocket to transfer vast amounts of mass to Mars which requires a company that is capable of building such a rocket which requires Elon founding SpaceX to build the Falcon 1. The SpaceX Master Plan was always to get to Mars, so once an intermediary step had served its purpose, it was no longer required. This explains why the Falcon 1 was retired and why Falcon is still on the critical path to Mars while it launches Starlink satellites.

Conclusion

In summary:

- Useful intermediary steps allow for course correction on large novel projects
- For projects with known problem spaces, they allow for error correction
- They prove your right to capital and allow for gradual increases in scope and scale of operations
- Revenue generation is an intermediary step that is a prerequisite for global adoption of a technology