

Are The G - Force
Regulations Safe
Enough in F1?

Camryn.S

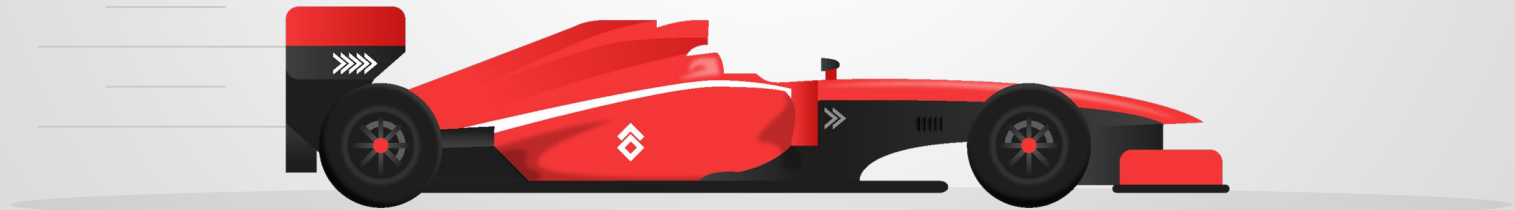


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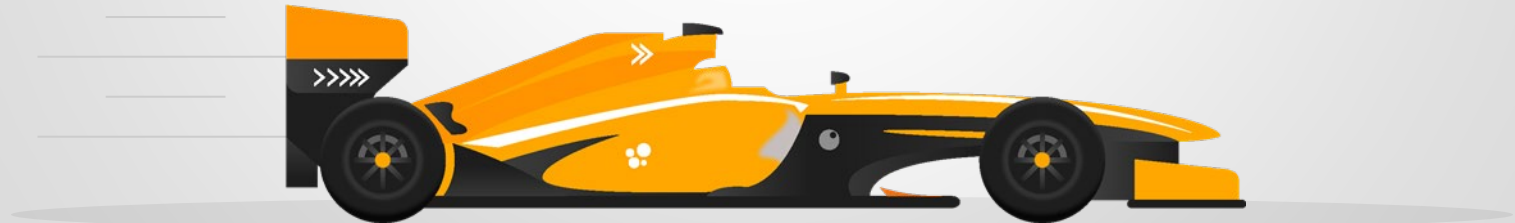
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Physics

Concepts

What is G-Force as a Physics Concept? How does it affect the body while driving and during crashes?



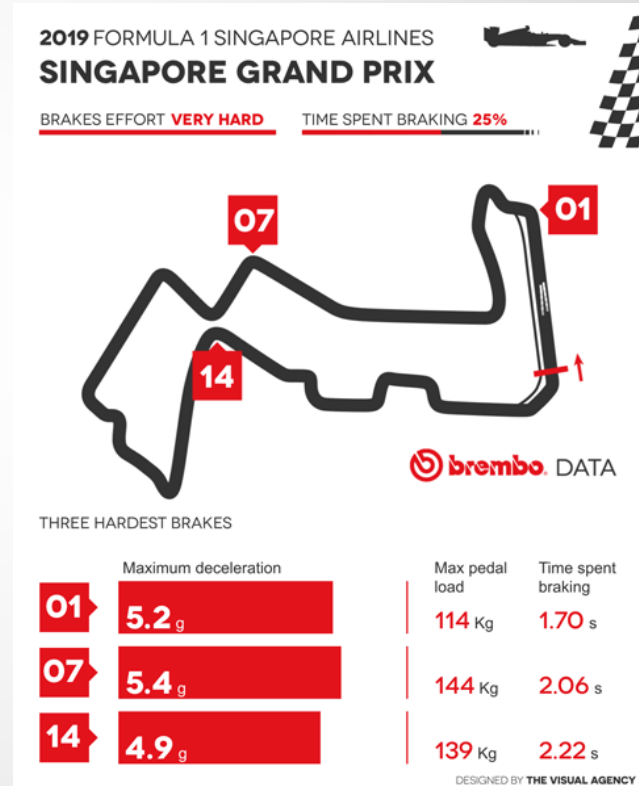
How Is G - Force Calculated?

- G-force is a unit of acceleration, it is the gravitational force acting on an object.
- G-force is the initial velocity subtracted by the final velocity, which is then divided by time, then this is all divided by gravity.
- 1 g is the acceleration of gravity that we feel and is what keeps our feet on the ground. It is a force equivalent to one unit of gravity. For example, if you experience 5 g 's it is five times the force of gravity.
- Most humans can withstand 2-5 g s, however, if it is just in a localised location for a second it can be safe up to 100 g 's. (Pearce 2023) Most fighter pilots experience around 9 g 's but only for split seconds, during a straight in a track for an fl car, they can experience around 5 g 's. The tolerance can be trainable. (Holm 2023)
- There are two types of g -force, vertical, and lateral. Fighter piolets experience vertical g -force, so they wear special pants that keep pressure in the legs so that blood continues to flow. In F1 most of the g -force experienced is lateral as the body moves around during cornering, accelerating, and breaking.



Effects of G - Force on the Body

- A prominent effect is that it moves your blood around, as F1 experiences lateral *g*-force the blood can travel from the head into extremities like the eyes which can cause dizziness and unconsciousness. (Holm 2023)
- Going around a sharp corner or braking can cause drivers to feel like they are being squished and in a heavy braking area can cause organs to move around.
- The drivers constantly feel *g*-force however it isn't the driving that is the issue but the crashes that start at speeds as large as 397.36km/h to 0km/h in just a split second (Duxbury 2022)



What Happens During a Crash?

- In F1 the car is designed to absorb the impact instead of the driver, safety devices have reinforced this, these include:



HANS Safety Device

- Is the Head and Neck Safety Device, It is a carbon fibre shoulder collar, that prevents the drivers' vertebrae from being stretched and their head from hitting the steering wheel. (Media 2019)
- Shown to reduce head motion in an accident by 44% (FIA 2019)
- It keeps a driver's head in line with the rest of their body and absorbs most of the shock into the shoulder reducing the chances of a skull fracture or neck injury, it connects to the helmet to keep the head steady and reduce movement. (FIA 2019)



The Halo

- Became mandatory in 2018
- Made of grade 5 titanium and can carry the weight of a London double-decker bus (12 tonnes) Aesthetically, it was controversial however, it has saved lives and allowed drivers to continue racing, and is now one of the best safety devices as cars are hit upside down or cars driving on top of each other. It keeps the head safe and protected. (Shashwatn2022)



Carbon Fibre F1 Cars

- Carbon fibre is a fine filament of carbon rods and comes on a roll, like material, and then it is cured into certain shapes so it can be used on cars, it is layered so it remains strong. (Ellis 2023)
- It is known for being extremely light allowing the cars to get faster and to be super strong allowing crashes to be safer for the driver, and for the cost of the car as it stays in shape.



Helmets and Race Suits

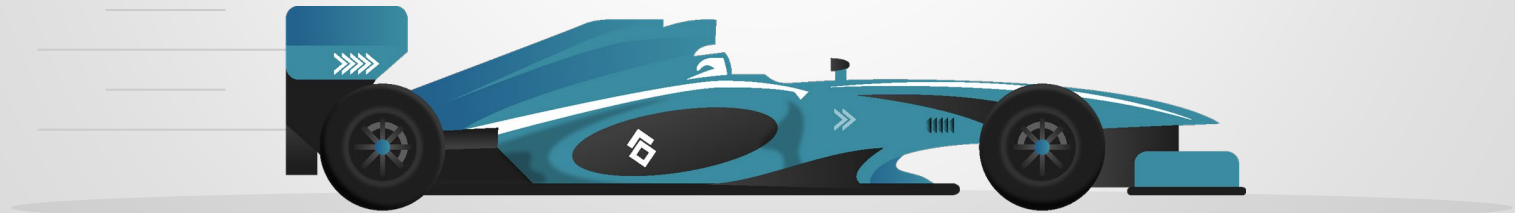
- All up the race suit, helmet and shoes weighs 50kg, so f1 drivers have to stay within a certain weight range so that they don't make the car any slower by adding more weight to it.
- The race suit and shoes are all fireproof and then underneath the suit they wear fireproof long sleeves to protect them as well.



02

The Issue

How Does GForce have a Negative Impact on Drives? And the Approach the FIA has Taken



What is Gravitational Force (G - F o r c e) ?

- As the F1 cars travel faster, the more force that is pulling against the driver as they are travelling huge speeds of up to 354km/h and 0-100km/h in 2.6 seconds (Duxbury 2022)
- These gforces start to become dangerous when crashing, it isn't the driving that is dangerous but stopping from top speeds to 0 in a split second. (Gilboy 2023)
- When crashing gforce can crash the driver around the car and cause a heavy resistance that can break bones or go as far as claiming a life. (Holm 2023)
- To withstand the gforces drivers have to train their neck muscles to hold their head up while driving, the average amount of gforce felt by the drivers is around 5G which equals around 24kg of weight on their neck, most can hold over 40kg with just their neck alone. While the average person can hold around 8 14kg (Opong 2022)



What have the FIA done?

- FIA stands for the Fédération Internationale de l'Automobile and is the governing body of motor sport that make rules and regulations for fair and safe racing.
- Some safety and regulations are:
- Gravel Traps
- Regulations
- Medical check-ups- in association with the regulations
- Safety in the car- as seen in previous slides

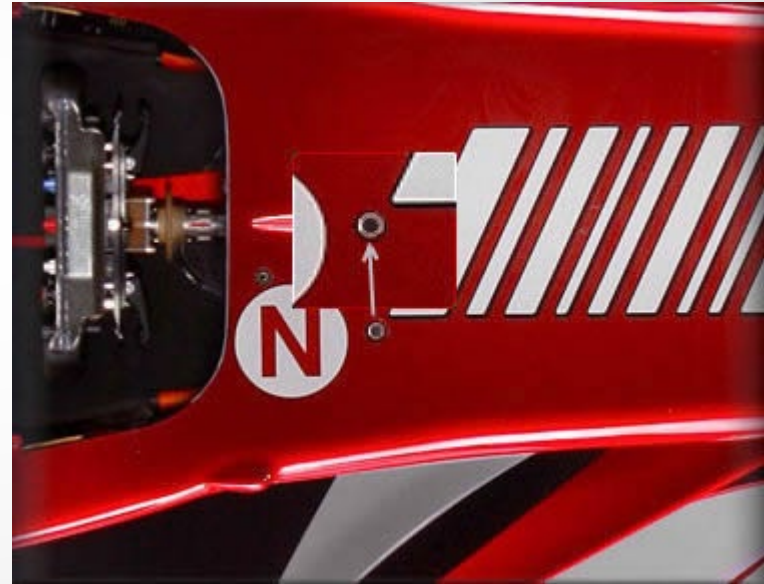
Gravel Traps

- Gravel traps are in place to slow down the car if they run off the track. Instead of going full speed to the wall, the gravel acts as a way to slow down the car.
- They are usually around 25cm deep. With 5-16mm pieces of gravel. (Facey 2023)
- They aren't as commonly used anymore as the cars can gain control of their cars, but the gravel stops them, as the cars sink into the gravel. (Lindqvist 2023)
- When Crashing, drivers can feel from 20 200G of force, to limit this Gravel traps have been put in place to slow down the car and make the crash longer so there is less force exerted on the driver.



Regulations

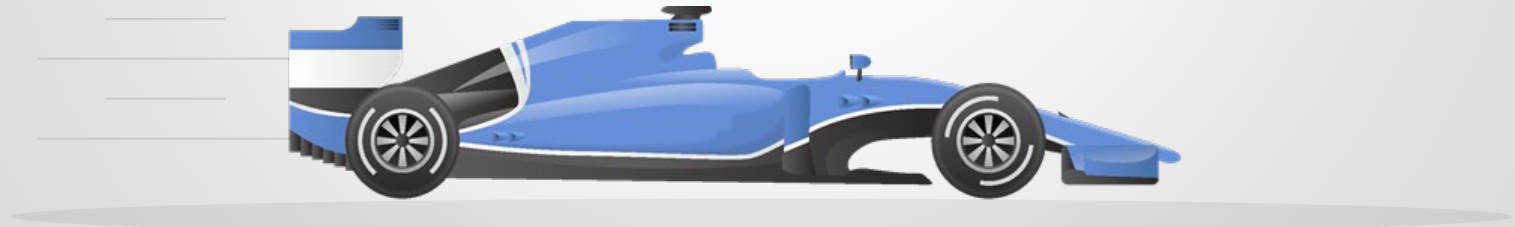
- There is a gforce limit that the car and driver can face
- If a certain amount of gforce is reached a medical light, lights up indicating the driver will need attention, even if they are feeling fine it is part of the regulations. It lights up with a force of over 18g's (SEAS 2015)



03

Evidence

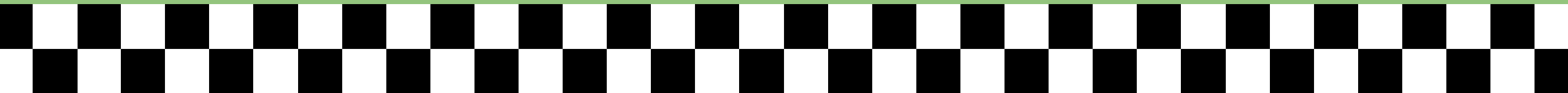
Crashes F1 Drivers Experience, and First Hand Accounts on the Effects of the G Force



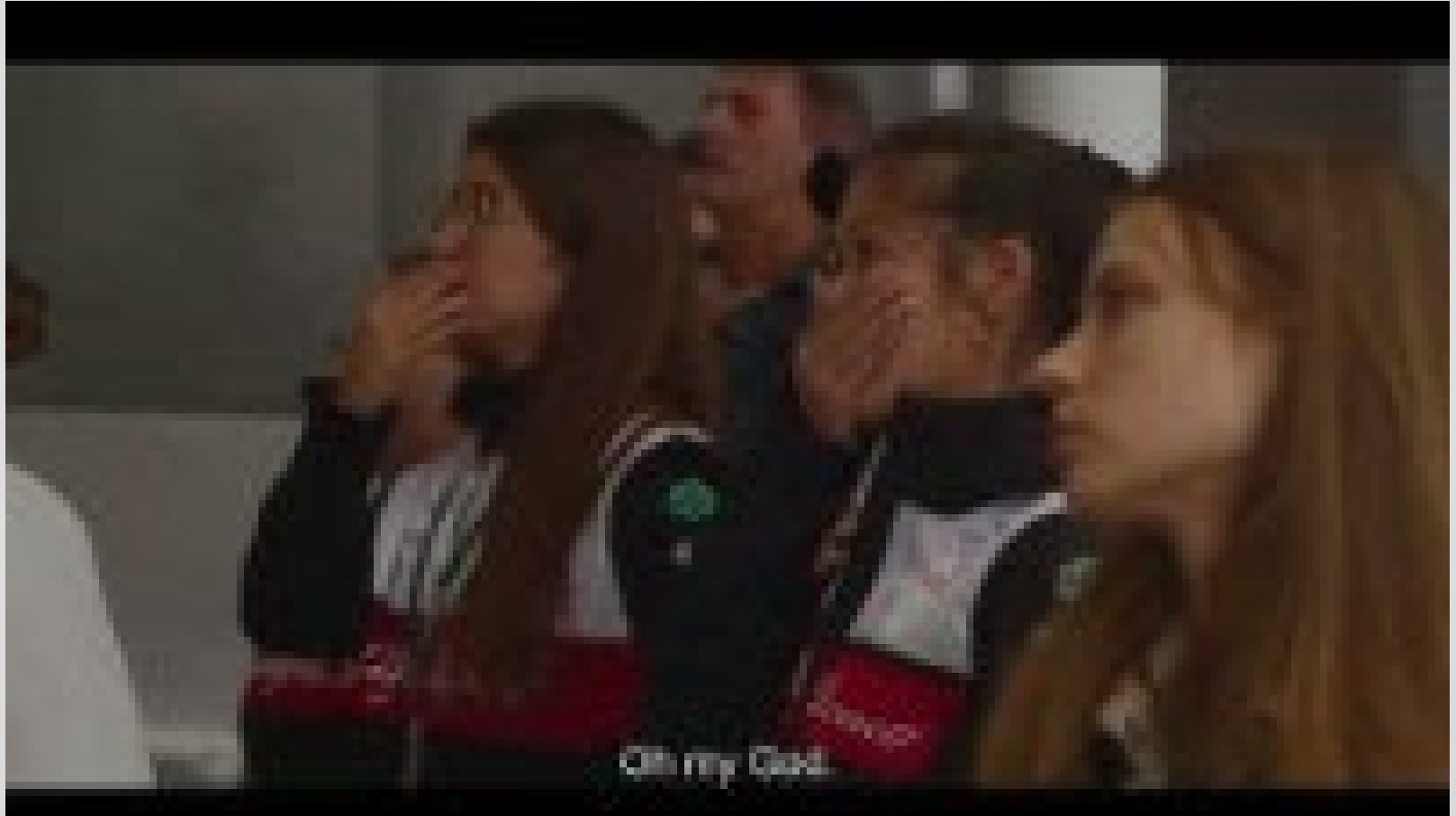


Please Note

In all crashes the drivers all are still alive and racing to this day. Romain Grosjean is no longer racing for F1 however still is a motorsport racer, all injuries cannot be seen in videos and were all mostly unharmed



Zhou Guan Yu Barrel Crash



Zhou Guan Yu Barrel Crash

- Zhou Gyanyu's crash only left him with minor bruising but was fine the next day. This is due to all the safety features f1 has (Noble 2022)
- The tyre wall and barriers Zhou got stuck in, stopped him from rolling and even if he was trapped kept the audience safe as well The Halo was said to save his life as it took all the weight and allowed his head to remain safely in the car.
- The roll structure impact was **double** the f1 crash test requirement (Noble 2022)



Romain Grosjean Fire Crash



GROSJEAN'S
FIREBALL CRASH

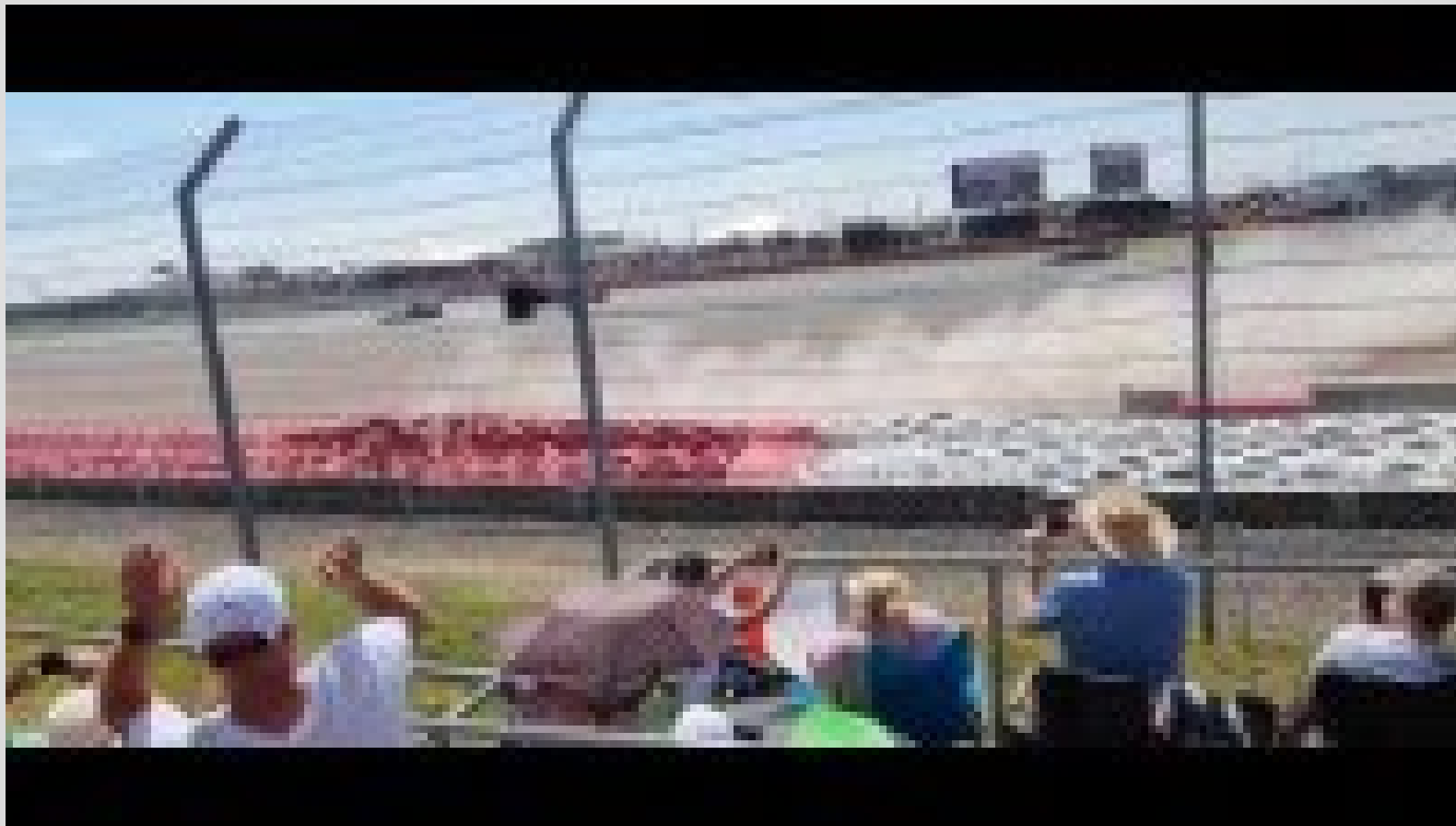
Romain Grosjean Fire Crash

- He hit the wall at 192km/h with a g-force of 67g's
- According to the report written about the accident the HANS device and halo protected and performed to accordance as the expected
- He got out of the car within 27 seconds and the medical car was on sight in 11 seconds (FiA 2021)
- The crash was lucky to happen of the first lap as the safety car was still behind the group of drivers and was able to access the scene as quickly as they could.
- The roll structure apart of the car performed in accordance as expected



Max Verstappen 51

g crash



Max Verstappen 51

g crash

- Left the track at 290km/h
- He came out of the crash very winded and had a mild concussion. (F1 2021)
- The safety features of the HANS reduced the amount of injury that could have happened to his spine and head.
- The gravel slowed him down along with the tyre wall so that absorbed the impact along with the car so that the driver had less harm done to him. (Foster 2021)



04

My Opinion

My Approach to the Issue.



My Approach to the Issue

- G-Force is going to constantly be a problem, but it also contributes to the speed of the car and the downforce it experiences so there are always positives. In my opinion, the FIA have done enough at this point for the safety of F1 cars in regard to g-force as the last death in F1 was in 2015 (almost 10 years ago!), in motorsport there will always be injuries and deaths to learn from for future safety devices, however, at this point with crashes being as severe as they are and the driver coming out with little to no injury shows a huge advancement and something that can constantly be built on.



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