



Tackling World Hunger: Project Colony

Creating a better solution on transporting food to those
who need it

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Introduction

World hunger is a well-known and documented critical global issue that currently affects hundreds of millions of people every year. To put it simply, it is the condition in which people do not have enough food to meet their dietary need for an active and healthy lifestyle. Addressing world hunger is crucial not only for ethical reasons but also for fostering global stability and development. Firstly, we will delve into the definition of hunger, its causes and grasp the scope of the current situation.

What is Hunger?

It is defined as periods of severe food insecurity, that could result in what could be days without eating which could be attributed to lack of money or other resources that hinder their access to food (Action Against Hunger USA, no date).

This results in undernourishment, where that person fails to reach their suitable daily caloric intake and/or malnutrition that encompasses both undernutrition, which signifies a deficiency in essential vitamins and mineral as well as purely energy, and overnutrition which means to go in excess of those.

What Happens When People Go Hungry?

Lengthy periods of food insecurity can result in a variety of types of malnutrition due to the body's lack of vitamins, minerals, and other nutrients needed to function (Action Against Hunger USA, no date).

Wasting/Acute Malnutrition

Firstly, there is wasting or acute malnutrition where the person becomes too thin for their height (Action Against Hunger USA, no date). This is commonly the case for those found in severe hunger crisis with levels of severity from being treatable to the possibility of death.

Stunting/Chronic Malnutrition

Next there is stunting, or chronic malnutrition which leads drastic issues to the development and growth of a child, becoming too short for their age (Action Against Hunger USA, no date). This can further result in life-long cognitive and physical damage for children with stunted growth.

Micronutrient Deficiencies

Then there are micronutrient deficiencies which is when there is a lack of essential types of vitamins and mineral needed for healthy growth and development (for example this can include zinc, iodine, folate, vitamin A) (Action Against Hunger USA, no date).

Overweight

Finally, there is being overweight, which is in direct contrast to acute malnutrition, meaning they are too heavy for their height (Action Against Hunger USA, no date). This can be due to poor diet, which later in life can result in them being at greater risk of diet-related diseases.

But the consequences do not stop there. This could manifest itself in several issues, where failing to meet their dietary needs will prevent them from living an active and healthy life, that then again results in perpetual hunger as they may not be cable of providing for themselves.

What are the Causes of World Hunger?

Inequality

The Action Against Hunger Organisation states that current food production suggests that “more than enough food is produced to feed everyone on planet,” still enough to keep up rapid population growth (Action Against Hunger USA, no date). So why aren’t the right people getting the food that they need?

Who hunger affects is often influenced by those with power in society, choosing who gets to eat and who goes hungry (Action Against Hunger USA, no date). Which is often the reason places plagued with corruption tend to suffer the most with hunger. With inequality in society, access to food is different for different members of the community, for example women, refugees, and people with disabilities can face more barriers to entry for things that should be are a right for anyone to have such as essential services, jobs, income, and resources. This can again cause a vicious cycle of crippling hunger that creates further challenges for their access to food, deepening the scale of inequality.

To show this here are some recent statistics that show the major disparity between hunger affecting men and women. According to Action Against Hunger Organisation,

"women eat the least and last, despite the fact that 90% of the time, they are responsible for preparing and purchasing food for their families" (Action Against Hunger USA, no date). This is supported by the fact that in 2021 (primarily found in Caribbean, Latin America, Asia), "hunger affected 150 million more women than men".

Climate Change

The exponential increase of significant issues caused by climate change should already be known to most with the rapidly increasing number of cases being reported worldwide with a reported "100% increase in extreme climate-related disasters in the last 30 years", according to Action Against Hunger Organization. With a rise of climate crisis with increasing severity such as droughts, floods, heatwaves and wildfires to name a few, more and more communities are suddenly thrust into deep cases of hunger (Action Against Hunger USA, no date).

On the other hand, subtle yet drastic consequences of climate change can include the reduction in quantity and quality of food production due to extreme and unexpected weather patterns (Action Against Hunger USA, no date). Alongside this, it can also commonly cause limited access to water, whether it be due to being the destruction of the water supply or contamination of the water source itself, which seems to affect many with a reported "700 million people affected by water scarcity", according to Action Against Hunger Organisation.

Conflict

As stated by Action Against Hunger Organisation, "more than 85% of people experiencing hunger crises live in conflict-affected countries", proving the significance of conflict, whether it is from gang violence and local conflicts to full scale wars, hunger follows for those involved and simply to those in proximity. Conflict is unique point when discussing hunger for the fact that it poses itself not only as a cause for hunger, through major disruptions of harvests, displacement of people from their homes, and delivery of humanitarian aid resulting in sudden hunger crises (Action Against Hunger USA, no date). Bringing in some more statistics stated by Action Against Hunger Organisation, "62.5 million people displaced by conflict in 2022". But on the other side hunger can also be the reason for the conflict as disputes can arise over food, water, or the resources required for food production.

To name some specific ways of how conflict causes hunger, previously worn-torn countries often leave remnants of war within said country such as landmines which

make farming and travelling for food extremely dangerous for civilians (Action Against Hunger USA, no date). Another aspect is the destroyed roads and broken infrastructure that again creates more difficulty when buying and selling food.

Disaster & Emergencies

Factors such as climate change, urbanization, and others, have made natural disasters more frequent and severe than ever in history (Action Against Hunger USA, no date). Unfortunately for the vulnerable communities that already live in poverty, disasters when they strike can be exponentially more devastating due to the lack of resources to come back from these desperate times, often resulting in issues like hunger crises. This results in long-term struggles for what might be a short-term emergency initially but begin to multiply as the misfortunes begin to strike one after another.

Poverty

“Around the world, 648 million people live in extreme poverty”, according to Action Against Hunger Organization, surviving on average \$2.15 a day which is unfeasible for anyone to live and maintain a healthy lifestyle, and beyond resembling anything close to comfort (Action Against Hunger USA, no date).

Families may face issues when accessing essentials like nutritious food, clean water, or health care due to struggles with secure and sufficient incomes as well as rising living costs in today's economy (Action Against Hunger USA, no date). A worrying statistic is that “one in three children in low- and middle-income countries suffers from chronic undernutrition” with a report of approximately “356 million children living in extreme poverty around the world”, according to Action Against Hunger Organisation. This entails considerable risks of stunted growth, poor emotional and mental development and possibly death.

What do I Propose to Help Tackle World Hunger?

I am proposing a better solution to the distribution of food to those who really need it. Tackling the issue of food distribution is particularly important for the fact that there is plenty of food to go around yet there is a substantial number of people still suffering from hunger. Therefore, I want to create a solution that can not only do just that but do so in a way that is safest for those involved in a varying range of hazardous environments, from disaster struck suburbs to dangerous war-torn villages located far from another civilisation. In the remainder of this essay, I will be discussing my

concept and how it will resolve this issue, backed with research on how it can be brought to fruition.

The Concept

One of the best ways to find solutions to a variety of diverse kinds of problems we may face is to look towards nature. This is for the simple fact that in nature an organism faced with an issue will adapt over time to eventually overcome said issue. In our instance, the issue communities suffering with hunger may face is limited or no access to food due to being unable to traverse treacherous environments, this can either be due to natural disasters or conflict. As well as going both ways for commuting to buy/sell food or for transporting humanitarian assistance to the place in need. In the animal kingdom, I believe we can find the solution to this very issue with the Ant insect.

The Influence of Ants

Ants perform the fascinating phenomenon of marching in a line when foraging outside of the ant nest. Ants march in lines because they are following the scented chemicals called pheromones, which is the method by which they communicate with each other (Aptive Environmental, 2019). Examples of what they may be communicating with each other include sharing the location of food they may have discovered when foraging, or warning others of predators that are in close proximity and whether the other worker ants should retreat to help defend the colony. So, when either of these concepts must be communicated to other ants in the colony like for example a food source is found, the ant will lay down a trail of pheromones when returning to the colony to lead other ants to said food source to then begin retrieval of it.

An important aspect for ants is their ability to travel around tough terrains. They (and other insects) prove to be very good at traversal due to their 6 legs with many jointed segments. This allows them to have great and constant contact with the ground for greater manoeuvrability and agility despite the rugged and uneven terrain they often travel through when foraging around, to ensure they can complete their tasks as worker ants for their colony.

With the significance of ants as an influence to look up to expressed through these key points above, I want to take these as inspiration for the solution I will be proposing in this essay.

My Solution to the Issue

With my influences established, I want to create an autonomous nimble all-terrain transportation vehicle, capable of providing food security in even the most treacherous of conditions either affected by conflict and/or natural disasters. It will be tasked with delivering equipment and supplies to humanitarian organisation members that are on site as well as delivering food and supplies directly to the people in need of it.

The idea I want to take away from ants to utilize in my concept is the ants' exceptional traversal ability and process of communication in order to optimise other ants' traversal of the surrounding area. So, how will this help achieve my goal of better distribution of food for those in dire need of it despite being located in hard-to-reach environments?

Here I will be briefly listing a few points about what makes this vehicle a unique solution for better distribution of food through humanitarian assistance that I will delve deeper into later in this essay. Firstly, I am choosing to favour having many smaller, more capable vehicles on humanitarian assistance trips, as opposed to the current conventional use of fewer, yet larger (size and capacity), although less manoeuvrable supply vehicles. This is in the hopes of retaining the sentiment of the smaller stature of ants but what they lack in size, they make up for in numbers and impressive traversal ability to improve the chances of a successful expedition and therefore rescue of those in need. Then implementing use of ant-like line formation of vehicles ensures safe traversal of unique environments as the first vehicle in line is tasked with creating a clear and correct path for those behind. Finally, I will be taking inspiration of ants' anatomy that enables great traversal ability to influence the design and functionality, specifically the 6 legs with multiple segments that enable constant contact with the ground and excellent stability no matter how coarse the terrain may be.

Who Would Use this Vehicle?

The intended user for this vehicle is humanitarian organisations. This is to help assist in reaching their aims of providing aid to victims suffering particularly with armed conflict, famines, and natural disasters.

Although this vehicle is autonomous, there is no physical operator of the vehicle, but there are still other users that interact with it. This includes the members of humanitarian organisations on the receiving end of the supplies (needed to enact their humanitarian aid) that are located on site of the place requiring aid. Then there

are also the local people of the South Sudan settlements that are in need of said supplies.

As for commonalities between these various user groups, there wouldn't be many due to the nature of the situation. Humanitarian crises are on a case-by-case basis meaning that aid is offered by organizations that specialise in said types of crises and for the ones receiving the aid, this can depend on the geographical location that is affected by said crises. As for the humanitarian organisation side of users, at a local level those of the age of 16 can volunteer, then work abroad requires volunteers with the minimum age of 18 (UN Volunteers, no date). Depending on the scenario, users with specific skillsets may be required such as engineering, healthcare, child protection, logistics, or search and rescue (GOV.UK, 2018). As for the recipients of the aid, this can vary far more as conflict and natural disaster spares no one from its wrath, resulting in wide spread of users from different backgrounds, ethnicities, age and gender etc.

By far the biggest discrepancies with both user groups is language. Communication is a large portion of how these users may interact with each other and the vehicle and so accommodating for all languages is very important to ensure there is a smooth transaction of giving and receiving supplies. Another key point with both groups is that there are different levels of technological literacy which can depend on factors such as age and exposure to several forms of technology equating to experience. So, it is essential to limit the barrier of entry of technological skill and know-how required to utilise this vehicle for either side of the exchange.

Potential Scenario and Client Profiles

With this in mind, it may prove difficult to cater for such a widespread number and variety of users. Although, I believe that it may not show to be so true as I will attempt to limit and simplify the process of utilising this vehicle to ensure that the needs are met from both perspectives. To help achieve this, I will be specifying a certain group of users in a scenario for this vehicle to which I will aim to meet their needs.

Currently there is a severe hunger crisis in Sudan. The state of hunger in South Sudan is dire with most families facing major issues with food security (South Sudan – Hunger Relief in Africa, 2024). The reason for this is underdevelopment, with basic infrastructure for education, health systems, safe water, functioning markets, or paved roads. According to Action Against Hunger USA, “about 80% of the population live in rural areas and rely on livestock and subsistence farming to survive”. South Sudan has been plagued by conflict and climate related disasters such as flooding, which has

destroyed many home and food sources, forcing locals to flee without much to sustain themselves with.

The scenario is that a humanitarian organisation based in the UK but operates abroad is offering aid to places suffering from severe hunger crises, whether this be of the past or currently ongoing conflict or natural disasters. Their current goal is to transport, from their newly developed overseas home base in the outskirts of Juba (the capital of South Sudan), crates full of food and resources to begin improving agriculture and infrastructure related to agriculture to difficult-to-reach areas of South Sudan. There is a team sent out and now located in a small village in South Sudan to provide just that but have been unable to bring along a majority of their resources to do so due to the challenging terrain made even worse due to heavy submersion from recent flooding and severe damage from previous cases of flooding, mostly enabling travel only by foot. There are also nearby families located a fair commute away awaiting supplies of food for the short term, up until their farms are once again operational with the help of the team making their way around the area.

For the humanitarian organisation side of the users, we will be dealing with a team of five volunteers from the United Kingdom, who are all English speaking, with two being able to speak their own respective native language which is Thai and French. They consist of three men, of the age of 23, 42 and 65, then 2 women, of the age of 18 and 58. Here are their brief user profiles that include information relevant to this essay.

Firstly, we have a Thai male, aged 23, is a mechanical engineer that is very tech-savvy having grown up with technology as an essential to everyday life, whether it be in education or purely recreational purposes. Currently, he has chosen to put a pause on his career working as a mechanical engineer in the water sector (despite only started working there recently) to volunteer himself and his skill set for humanitarian aid. He has joined this group in this expedition to help places abroad suffering with hunger crises, assisting in the setup of a reliable water supply and infrastructure related to agriculture in the small towns and villages of South Sudan.

Next, assisting the user stated previously with the water supply situation, we have a Scottish male, aged 42, who is also a mechanical engineer in the water sector. He has decided to take some time off from his well-established position in a wastewater and water treatment company, as he's felt a sense of calling to help others in need, especially with his honed skill set. This opportunity became more feasible for him as he's well-established in the company and so he has been offered his position back whenever he chooses. Although being quite a bit older than his close working

colleague, he very much has a very high level of technological literacy, meaning that he's very multiskilled and capable of utilizing technology. With this in mind, he is also tasked to be in charge of communications between the group and home base.

Lastly of the men in this group is an English male, aged 65, who is an experienced farmer having been a farmer his whole life. Nearing his time to semi-retire from farming, he's decided to begin delegating his responsibilities within the farm to his son that plans to takeover operations. With this, it has opened the opportunity to offer his expertise elsewhere and so he's decided to help aid others in dire need, with the help of some convincing from his wife (who is also a member of the team, more information on her soon). Owning and operating a farm for decades have allowed him to truly hone his skill and expertise, which now has offered him the position of – co-leading the agriculture team that is heading down to South Sudan. An example of this is his incredible skill at operating farm equipment, but unfortunately this is as far as his technological knowledge and know-how spans.

First of the women in this group is an 18-year-old English female. During her sixth form college education, she decided to try out volunteering part-time at a local level working at the food bank near to where she lives. The year of experience opened her eyes to the vocation of helping those in need and recently reaching the required age to participate in humanitarian aid abroad, she immediately jumped at the opportunity of joining this group to lend a hand in her gap year before university. She now joins the group as extra hands to help where she can in the group, although having no specialized skill that can specifically needed in this scenario. As for her technological literacy, she is very tech-savvy, due to the very same nature of her other younger colleague, as result of growing up with many forms of technology as the norm for everyday life, whether it be in an educational or purely recreational context.

At last, we have the final member of the team and second woman, who is a 58-year-old Dutch female. She is the wife of the 65-year-old experienced farmer of which they both co-lead the agriculture team. This began as they were approached by the humanitarian organisation for their reputable farming business located in the UK, which was just what they needed for their agriculture development goal in South Sudan. Just like her husband, she is highly skilled when it comes to operating a successful farm. This includes hands-on labour work, operating farm equipment and management of the business. She only slightly edges out her husband in technological literacy due to her additional role in their business handling the management side of the business, which entails extensive desk work, as well as also being a hands-on farmer just like her husband.

As for the local Sudanese people situated nearby, we will be dealing with several families with an average of 8.7 members, which is the average family size in South Sudan according to the South Sudan intersectoral needs assessment report by International Organization for Migration.

For the purposes of this essay, I will be summarising the traits of these families. To start, livestock and subsistence farming is commonly relied upon by each family to support themselves food wise. This is primarily managed by the men and boys of the family (Gender in brief South Sudan, 2020). As for the females of the family, they are responsible for chores such as fetching water, cooking, caring for the children and cleaning. With this rural lifestyle, it generally exposes them to very little forms of technology, resulting in very low technological literacy. Although English is the official language of South Sudan according to the Permanent Committee on Geographical Names, in more rural areas of South Sudan different ethnicities located there may speak Dinka (Jieng), which is around 35%-40%, as well as Nuer (Naath) and Shilluk (Chollo) to name a few (South Sudan Toponymic Factfile, 2024). But they may have limited English from general education but not of the standard of fluency.

Bring my Concept to Fruition

Here I will be discussing how this vehicle will come to fruition through current and new/conceptual technologies, in order to achieve the needs of the users stated earlier.

Operations of the Vehicle

This vehicle will operate based on schedules to regularly provide equipment to the on-site agriculture team and food to the South Sudan people when required. The autonomous vehicle will journey to the required locations as a convoy in a line formation utilising LiDAR technology to navigate the terrain (informing vehicles behind of the clear and correct path to take), then once they near their destination they'll disperse to deliver the supplies to their designated users.

Goods and Supplies the Vehicle will Transport

To maximise the food usage, the food that the vehicle must transport to the South Sudan people is canned food for several reasons. Firstly, they have excellent shelf life as canned food can last for several months and even years if the can is kept in good condition, this includes no rust, dents, or swelling signs found on the container (Marianne Gravely, 2013). Another reason being the ease of preparation as these

foods are essentially ready to eat once opened, which is key for these people due to their lack of resources and equipment in order to prepare fresh food. Next reason being the fact that it will ensure that the Sudanese people meet their dietary requirements as it can be very nutritious due to the canning process being able to preserve many nutrients adjacent to fresh or frozen foods (Nazneen Memon, 2022). Then there is a large variety of canned food ranging across all food types and for this reason it can simply satiate the people's inclination for different types of food and not becoming fatigued on the same food. Finally, the compact nature of canned food means an ease of storage for both the humanitarian organisation's local base as well as storage within the vehicle and for the South Sudan people for when it arrives at their settlements.

As for the on-site agriculture team, the equipment required to install water hand pumps include tools such as shovels, post hole digger, level, tape measure, wrenches, pipe cutter, screwdriver, pliers, hammer, drill, concrete mixing tools. As for the materials, this includes direct action hand pump kit, cylinder pipe, foot valve, water source pipe, screws and bolts, concrete mix, waterproof sealant (Learn how to install direct action hand pumps: step by step guide, 2023). Set up and improvement of agriculture require hand tools such as spades, pitchforks, shovels, wheelbarrows, rakes, hoes, pick axe, sledgehammer, post knocker, pruners, trowels. As well as joinery tools such as hammers, hand saws, tape measures, drills, nails, nuts and bolts (Langstaff, C, 2023).

Drivetrain and Battery

This vehicle will utilise 6 100kw hub drive motors that power each wheel, ensuring plentiful amounts of power for each wheel for the several types of terrain found in South Sudan. For rock crawling scenarios, the combined power of 600kw ranges in the average of capable rock crawlers which is 500 to 750 horsepower (Are rock bouncers the ultimate off-roader?, 2020) with the addition of plenty torque electric motors provide. As for higher speed scenarios, such as flat desert roads, it is very sufficient with the combined effort of each 100kw motor offering a plenty capable 600kw (or 804 horsepower) to achieve motorway level speeds. This will also assist in utilisation of independent suspension (which I'll delve into soon).

As for the battery pack that powers this vehicle, it will use solid state batteries that are more capable than the current Lithium-ion batteries, outperforming them in extremes of temperature, smaller form factor, more range and faster charging (Jacob Biba, 2024). According to Forbes solid state batteries will provide "up to 50% longer range" and using the average range of EVs having "about 200 to 350 miles", this will

result in range in about the 300 to 525. This will prove useful for the long distances travelled from the home base to the settlements and back and the on average very hot weather of South Sudan.

Suspension and Wheels

The suspension platform this vehicle will utilise is independent suspension, with anti-like legs/suspension arms that sprout from the sides of the chassis. With the use of hub motors, this creates the opportunity to have greater off-roading ability when used in conjunction with fully independent suspension. This combination results in excellent ground clearance and tracking of the ground despite the unevenness of the terrain.

As for the wheels, the vehicle will feature airless tires. The reason for this being the optimisation of operation productivity with elimination of the dangers of flats and blowouts, meaning lesser downtime and lesser levels of maintenance (Michelin UK, no date). This will also feature modular compatibility with the hub motors with interchangeable airless tires of two different tire treads, one with burly tire knobs for rough and rocky terrain and another with a slicker profile for flatter terrain.

User Interface

With the users of this vehicle coming from various backgrounds with differing languages and various levels of technological literacy, the UI located on a monitor externally of the vehicle will feature a heavy emphasis on infographics to communicate ideas and functionality outside the barriers of language.

Approximate Dimensions

To determine the dimensions of this vehicle I will first need to find out the volume of food and the size of the tools required by the users.

For the sake of ensuring the amount of food is the correct amount, despite the amounts and ages of members varying from family to family, we will treat the average of 8.7 individuals in a household in South Sudan as all adults. This to provide the general recommended caloric intake of around 2,000 – 3,000 calories which still encapsulates individuals of either gender and both younger and older age ranges (2,000 calorie diet: Is it healthful?, no date). This decision must be made as it wouldn't be effective to tailor every food delivery for every single household and so it would better to round up to more amounts of food, which shouldn't be an issue due to the long shelf life of these foods.

For each day, the South Sudan people will be provided 3 calorie-dense canned protein, such as spam and corned beef that equates to around 800 – 1,000 calories per large can (Ken J, no date), 1 can of vegetables, such as corn that's around 132 calories per can (Nutrition facts, no date a) and 1 can of fruits, such as pineapples that's around 117 calories per can (Nutrition facts, no date b). This totals to 5 cans per person per day. We'll round up the household average of 8.7 to 9 people, so 9 (people) multiplied by 5 cans equals 45 cans per day for a household. Ideally, the vehicle will need to carry multiple days or even weeks' worth of food so that it may not need to return so often, so we'll make the vehicle capable of carrying 1 months' (4 weeks) worth of food. To calculate the number of cans it will carry at once is 45 (cans per day) multiplied by 7 equals 315 cans per week then multiplied again by 4 (weeks) is 1,260 cans per month/4 weeks. Utilising the standard size of a baked bean can, which is 11cm in height and 7.5cm in diameter (Empty sealed tin can: Box of 12, no date), we can find the total volume required for this:

$$7.5\text{cm} \times 9 \text{ cans} = 67.5\text{cm width}$$

$$11\text{cm} \times 5 \text{ cans} = 55\text{cm height}$$

$$7.5\text{cm} \times 7 = 52.5\text{cm (length per week)}$$

$$52.5 \times 4 = 210\text{cm (length per month)}$$

$$67.5 \times 55 \times 210 = 779,625 \text{ cubic centimetres (volume per month) or } 779.625 \text{ litres}$$

Above shows the minimum dimensions so we may round up to the volume for the sakes of general tolerances, to comfortably transport this number of canned foods. With this in mind, the finalised dimensions for the cargo bay of this vehicle will be a box length of 212cm, box width of 69.5cm, and a box height of 57cm (a 2cm allowance for each dimension) resulting in a finalised box volume of 839,838 cubic centimetres or 839.838 litres.

As for the general dimensions of the vehicle, I will be determining this vehicle's overall size to be close to dimensions of small SUVs, despite being an all-terrain vehicle, which is in line with the goal of making this a small but capable delivery vehicle that is more comparable to a conventional car but better purpose built and capable to meet demands. After seeking the dimensions of current small SUVs, I have concluded that the length will be 4082mm (rounded up from the average of 4081.8mm), width will be 1848mm (the widest in class, to achieve better turning stability), and finally the height will be 1483mm (the shortest in class, to keep centre of gravity lower for greater stability) (New small SUV comparison with dimensions and boot capacity, no date).

Conclusion

To conclude this essay, hunger is a pressing issue that prevents the fostering of stability and development of many around the world. I believe that one solution to this problem is to help nurture communities one by one through providing food security in their trying times, by the help and services of the Project Colony vehicle. To see them thrive, we must first give them a concrete base to when they can begin their growth.

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