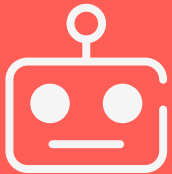
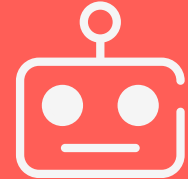
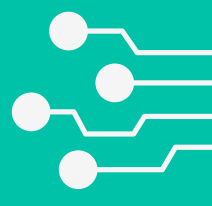
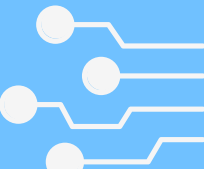
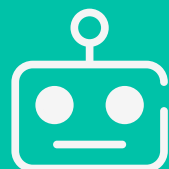
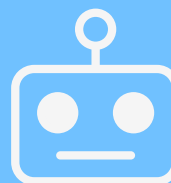


SPARC
Sustainable Project And
Research Challenge **3.0**



PROJECT GUIDEBOOK



**“Ideas to SPARC
your imagination!”**



SPARC 3.0

Sustainable Project And Research Challenge

The main idea of SPARC is sustainability. It means using the Earth's resources carefully so that there is enough for everyone, today and in the future. It is also about caring for people, protecting nature, and making fair and responsible choices.

The themes in SPARC 3.0 will help you explore real-world challenges in fun and creative ways. You will discover how science and technology can help people and protect our planet. Get ready to ask questions, explore ideas, and create solutions that make a difference.

Explore the **four themes** of SPARC 3.0 and choose the **one** that interests you most for your project.

Saving Energy, Fighting Climate Change

How we power our world and use resources — cleanly, wisely, and without harming the planet



Protecting Nature, Reducing Pollution

Protecting forests, oceans, rivers, and wildlife so they remain clean and healthy for future generations.



Safer & Inclusive Cities, Easier Transport

Building cities where everyone can move freely, stay safe, and feel they truly belong



Better Health for Everyone

Making sure every person has clean water, safe food, and the care they need to live well.



STEP 1: Observe and Understand the Problem around you

Saving Energy, Fighting Climate Change

Problem Areas:

- Using too much electricity
- Not enough use of clean energy sources
- Wasting energy
- Frequent power cuts
- Depending too much on coal, oil, and other fossil fuels
- Using technology to save and manage energy better
- Air pollution and harmful gases
- Hotter temperatures around the world
- More floods, droughts, and storms
- Not recycling enough and wasting resources
- Finding ways to reduce our carbon footprint
- Systems that warn about disasters

Protecting Nature, Reducing Pollution

Problem Areas:

- Deforestation & forest fires
- Loss of plants, animals, and their homes
- Soil erosion & degradation
- Human-wildlife conflict
- Land turning into desert
- Regrowing forests
- Improving soil health
- Creating green spaces in cities
- Protecting bees, butterflies & other pollinators
- Using land wisely and responsibly
- Plastic & microplastic pollution
- Industrial wastewater discharge
- Declining fish populations & aquatic biodiversity
- Sustainable fishing
- Cleaning oceans & rivers
- Sustainable Materials & Climate Solutions





Safer & Inclusive Cities, Easier Transport

Problem Areas:

- Traffic congestion & parking
- Urban flooding
- Waste management
- Accessible & Climate-Resilient Infrastructure
- Public services
- Bridge & infrastructure monitoring
- Logistics & delivery optimisation
- Road safety
- Smart transportation & traffic management
- Women's safety & unsafe public spaces
- Inclusive sanitation & safe public space design
- Inclusive mobility for all

Better Health for Everyone

Problem Areas:

- Disease prevention & diagnosis
- Mosquito-borne diseases & snake bites
- Healthcare accessibility & emergency care
- Food spoilage
- Post-harvest losses
- Food quality
- safety & distribution
- Unsafe drinking water
- Water leakage & wastewater treatment
- Reusing household water
- Visual, hearing, and mobility impairments

STEP 2: Brainstorm Ideas

What is the main problem have you chosen to solve?

Who is affected by this problem and how?

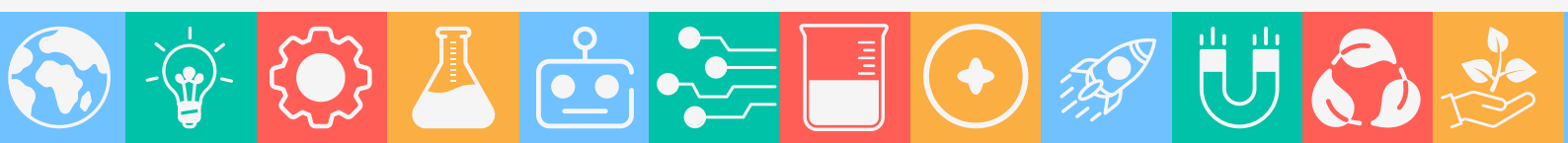
Why is this problem important to solve?

Let's think of as many practical models or prototype ideas as we can to help solve the problem.

1. _____
2. _____
3. _____

4. _____
5. _____
6. _____

Note: Think of ideas that can become a real model or product to solve the chosen problem using science and technology.





STEP 3: Design Your Project

Which solution will you develop into a working model and why?

What makes your idea unique or different from existing solutions?

Explain how your solution will work.

What are the most important materials will you need to build your model?

1.

2.

3.

4.

5.

6.





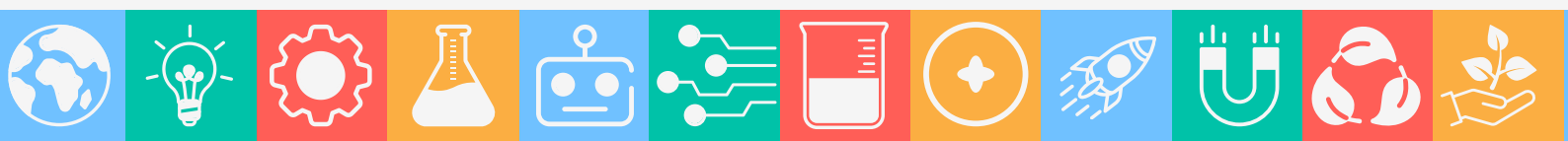
STEP 4: Sketch your Idea



A large rectangular area with a dashed black border, intended for sketching an idea.



Think Ahead: What is the one improvement you would make in the future?





SAVING ENERGY, FIGHTING CLIMATE CHANGE



Project: Water from Air: Sustainable Atmospheric Water Generation



Problem Statement:

Many places in India and around the world do not have enough water because of droughts, growing populations, and overuse of water. Not having clean water can affect people's health, education, and daily lives.



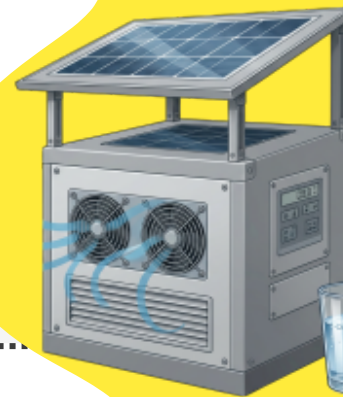
Challenge:

Water shortages can affect people's health and make life harder for communities that already have limited access to water.



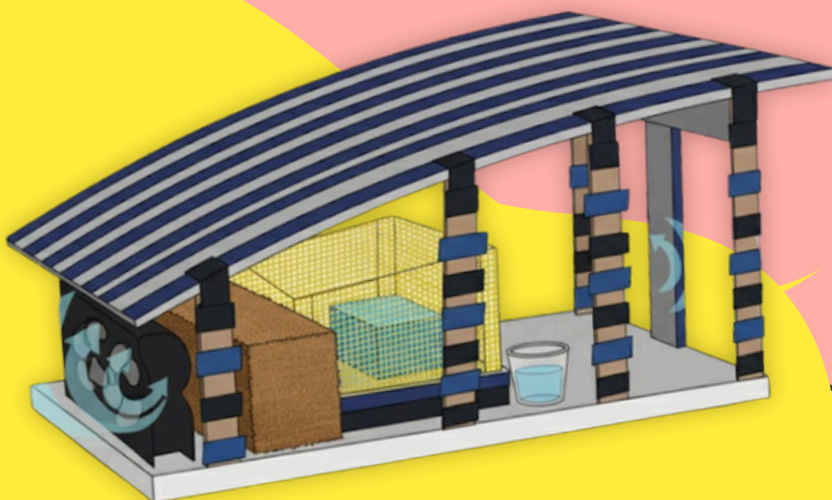
Opportunity:

New technologies can turn moisture in the air into water. If these systems are low-cost and run on clean energy, they can provide safe drinking water in many places, even where water is scarce.



Solution:

Atmospheric Water Generation (AWG) systems collect moisture from the air and turn it into drinking water. When powered by renewable energy such as solar or wind power, these systems can provide a sustainable source of clean water, even in remote areas.





SAVING ENERGY, FIGHTING CLIMATE CHANGE

Project: Liquid Power Bank for the Planet



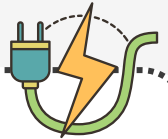
Problem Statement:

Solar and wind energy are clean sources of electricity, but they do not generate power continuously. Solar panels produce energy only during the day, and wind power depends on weather conditions. Without effective storage systems, much of this clean energy cannot be used when people need it the most.



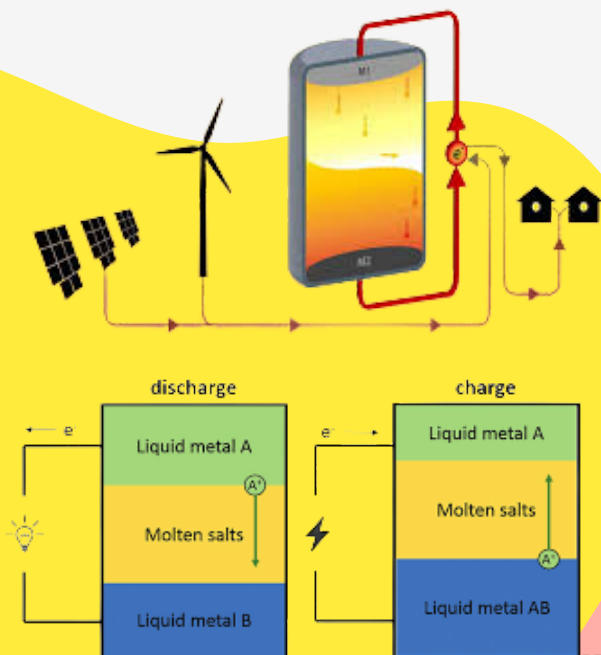
Challenge:

Traditional batteries used for storing renewable energy, such as lithium-ion batteries, can lose performance after many charging cycles and may become expensive when used for large-scale energy storage. A safer, long-lasting, and affordable energy storage solution is needed to support a clean energy future.



Opportunity

Innovative battery technologies that use easily available materials can store extra energy from the sun and wind for later use. Efficient energy storage systems can reduce our dependence on fossil fuels and make renewable energy available whenever it is needed.



Solution:

Develop a liquid metal battery system that stores renewable energy using layers of melted metals and molten salts. Unlike conventional batteries, liquid metal batteries use self-healing liquid materials that can maintain performance for thousands of charging cycles. These batteries can store large amounts of solar and wind energy and release it during peak demand, helping create a cleaner and more reliable electricity grid.





SAVING ENERGY, FIGHTING CLIMATE CHANGE



Project: WindSpin – Small Wind Turbines for Clean Energy Anywhere



Problem Statement:

Many communities still depend on electricity generated from fossil fuels, which releases greenhouse gases and increases climate change. Traditional large wind turbines require large open spaces and strong, steady winds, making them difficult to install in cities, homes, and crowded areas.



Challenge:

How can we generate clean electricity from wind energy in places where traditional wind turbines cannot be installed? A small, low-cost, and efficient wind energy solution is needed for urban areas and small spaces.



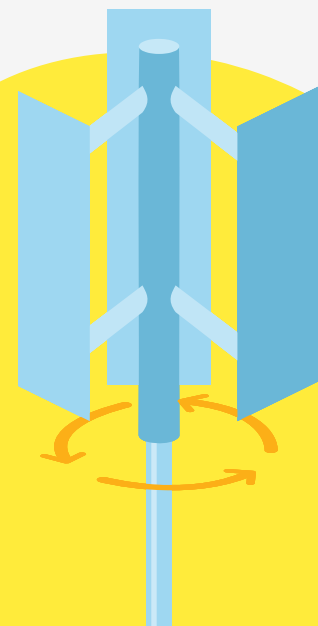
Opportunity

Small-scale wind energy systems can capture wind from different directions and provide renewable electricity for homes, streetlights, schools, and public spaces. Innovative turbine designs can make clean energy accessible even in areas with changing wind conditions.



Solution:

Design a Vertical Axis Wind Turbine (VAWT) that rotates around a vertical shaft and captures wind from any direction. Unlike traditional turbines, VAWTs can work in changing wind conditions and require less space. The rotating blades power a generator that converts wind energy into electricity, which can be stored in batteries and used for applications such as street lighting, charging stations, and small electrical devices.





SAVING ENERGY, FIGHTING CLIMATE CHANGE



Project: CarbonLock Concrete – Building Materials That Capture Carbon



Problem Statement:

Concrete is one of the most widely used construction materials in the world, but its production releases a large amount of carbon dioxide (CO₂), contributing significantly to climate change. As cities continue to grow, the demand for concrete is increasing, making its environmental impact a major concern.

Challenge:

How can we continue building roads, houses, and infrastructure while reducing the carbon emissions created by traditional concrete? A sustainable construction material is needed that is strong, affordable, and better for the environment.



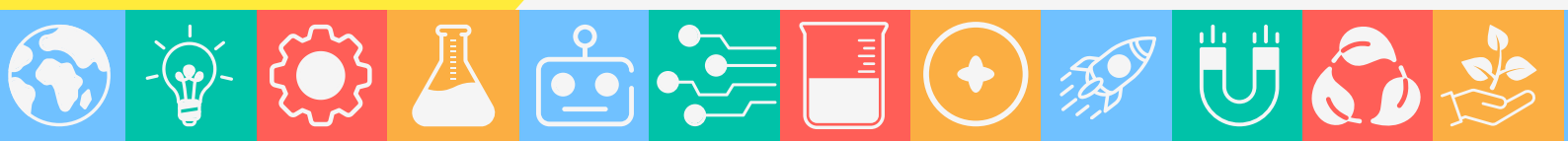
Opportunity:

Concrete naturally absorbs a small amount of CO₂ from the atmosphere through a process called carbonation. By improving this natural process and using recycled materials, we can transform concrete from a carbon-emitting material into a carbon-storing solution.



Solution:

Develop CarbonLock Concrete, an eco-friendly concrete that captures and stores carbon dioxide during its production process. The solution uses techniques such as carbonation curing, where CO₂ is injected into fresh concrete to form stable carbonates, and replaces some traditional materials with recycled alternatives like fly ash, steel slag, and biochar. This creates stronger, greener concrete that helps reduce pollution and fight climate change.





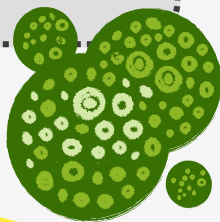
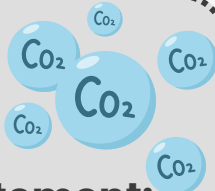
SAVING ENERGY, FIGHTING CLIMATE CHANGE

Project: Algae Power – Turning Carbon into Clean Fuel



Problem Statement:

The burning of fossil fuels for electricity, transport, and industries releases large amounts of carbon dioxide (CO_2), increasing global warming and climate change. At the same time, the world needs renewable sources of energy that can reduce dependence on fossil fuels.



Challenge:

How can we capture harmful carbon dioxide from the atmosphere while producing clean energy? A sustainable solution is needed that reduces emissions without competing with food production or requiring large amounts of land.



Opportunity:

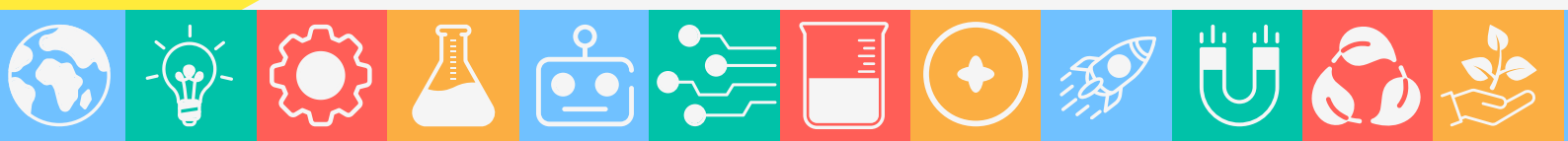
Algae are tiny organisms that naturally absorb CO_2 through photosynthesis and convert it into biomass. They grow rapidly, require less land than traditional biofuel crops, and can grow in environments such as wastewater, saltwater, and non-fertile areas.



Solution:

Develop Algae Power, a carbon-capturing renewable energy system that uses algae to absorb CO_2 and convert it into useful biomass. In this system, algae can be grown in specially designed tanks called algae bioreactors or open ponds, where they capture carbon dioxide and transform it into biomass. This biomass can then be processed into renewable fuels such as biodiesel, biogas, bioethanol, and even hydrogen.

The system can also be connected with industrial emissions or wastewater treatment plants, allowing algae to capture carbon while improving water quality and producing valuable resources.





PROTECTING NATURE, REDUCING POLLUTION

Project: Leafware Revolution: Zero-Carbon Disposable Plates



Problem Statement:

Disposable plates made of plastic or Styrofoam create long-lasting waste and release carbon emissions during production. This pollutes land, water, and air, making climate problems worse.



Challenge:

Single-use tableware is convenient but causes massive environmental harm and is difficult to recycle.



Opportunity:

We can switch to natural, biodegradable alternatives that do not harm the environment.



Solution:

Make disposable plates from naturally shed leaves (like Tad Patra). These plates are fully compostable, require no fossil fuels, and do not contribute to carbon emissions.





PROTECTING NATURE, REDUCING POLLUTION

Project: LeafCycle Paper: Turning Fallen Leaves
into Sustainable Paper



Problem Statement:

Paper production depends heavily on wood from trees, leading to deforestation and loss of natural ecosystems. At the same time, millions of tonnes of fallen leaves from parks, streets, and public spaces are treated as waste and are often burned, releasing harmful gases and increasing carbon emissions.



Challenge:

How can we reduce tree cutting and manage fallen leaf waste in a sustainable way? A solution is needed to create useful products from natural waste materials while reducing pollution.

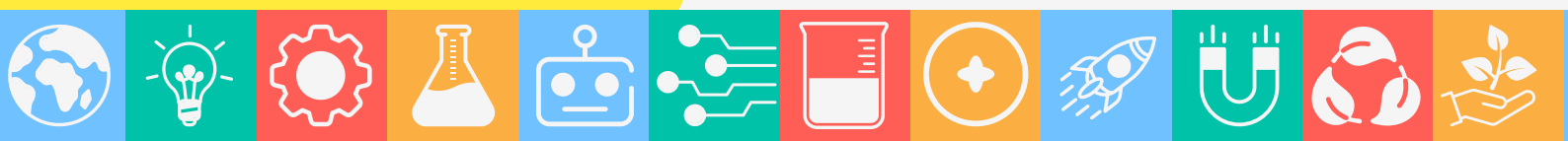
Opportunity:

Fallen leaves contain cellulose, the same natural fibre used in traditional paper production. By extracting cellulose from leaves, we can create an alternative raw material for making paper products while protecting forests and reducing waste.



Solution:

Develop LeafCycle Paper, an eco-friendly paper made from fallen leaves collected from urban areas. The leaves are cleaned, processed, and converted into cellulose fibres that can be used to create paper, packaging materials, and bags. This innovation reduces dependence on wood pulp, prevents leaf burning, lowers carbon emissions, and transforms waste into a valuable resource.





PROTECTING NATURE, REDUCING POLLUTION

Project: MetalClean Plants – Using Nature to Restore Polluted Soil



Problem Statement:

Industrial activities, mining, improper waste disposal, and excessive use of chemicals can contaminate soil with toxic heavy metals such as lead, mercury, cadmium, and arsenic. Polluted soil affects plant growth, enters the food chain, and threatens human health and ecosystems.



Challenge:

How can we clean polluted soil without using expensive or harmful chemicals? We need safe, low cost, and environmentally friendly ways to restore damaged land.



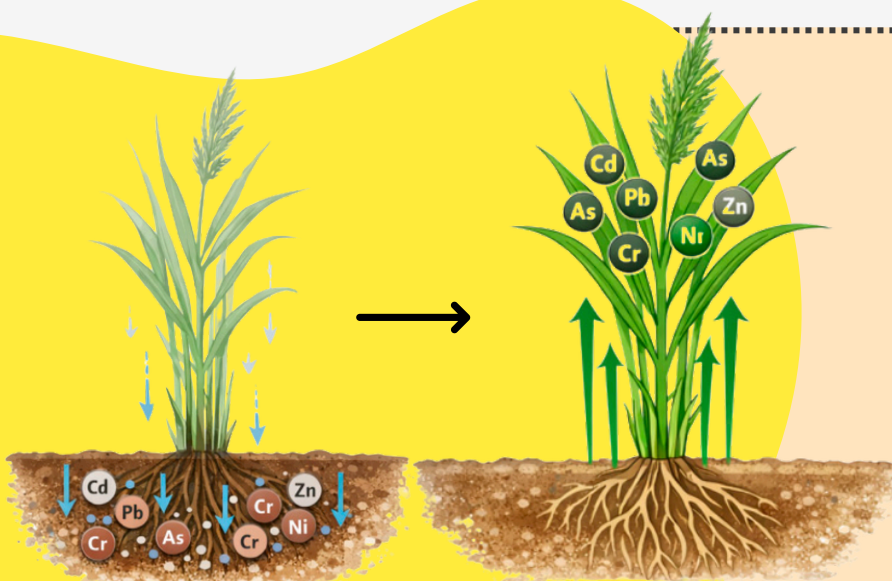
Opportunity:

Some plants have developed the ability to absorb and store high amounts of heavy metals from the soil without getting damaged. By studying these special "metal-eating" plants, we can use nature's own cleaning system to restore polluted environments.



Solution:

Develop MetalClean Plants, a phytoremediation system that uses special plants called hyperaccumulators to remove toxic metals from contaminated soil. These plants absorb pollutants through their roots and store them in their tissues. After the plants are harvested, the contaminated biomass can be safely processed, leaving cleaner and healthier soil behind.





PROTECTING NATURE, REDUCING POLLUTION

Project: Green Bricks from Farm Waste – Sustainable Building Materials for the Future



Problem Statement:

Every year, millions of tonnes of agricultural waste such as rice husk and sugarcane bagasse are discarded or burned after harvest. This practice contributes to air pollution, greenhouse gas emissions, and waste management challenges. At the same time, the construction industry relies heavily on conventional bricks, whose production consumes natural resources and energy.

Challenge:

How can we turn agricultural waste into useful building materials? The challenge is to develop low cost, environmentally friendly alternatives to traditional materials that can be produced and used on a large scale.



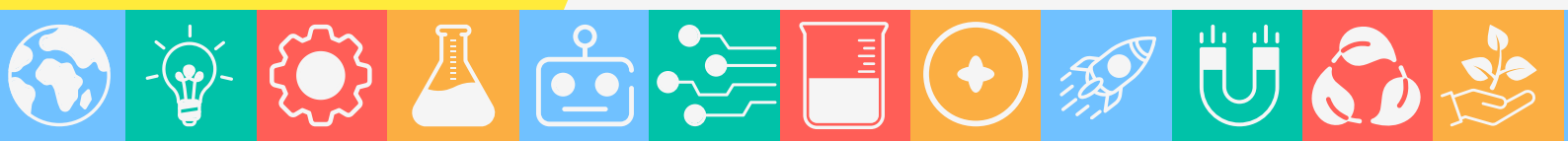
Opportunity:

Rice husk and sugarcane bagasse are rich in natural fibers and possess properties that can improve insulation, reduce weight, and increase sustainability in building materials. By transforming these agricultural residues into biodegradable bricks, waste can be converted into a valuable resource.



Solution:

Design and develop eco-friendly biodegradable bricks using rice husk, sugarcane bagasse, and natural binding materials. These bricks can help keep buildings cooler in hot weather and warmer in cold weather, reduce agricultural waste burning, lower the environmental impact of construction, and promote circular economy practices. Such sustainable building materials can contribute to greener infrastructure and communities that are better equipped to adapt to climate change.





PROTECTING NATURE, REDUCING POLLUTION

Project: Green Polymers – A Cheaper and Greener Process
for Producing Bioplastics



Problem Statement:

Conventional plastics are made from fossil fuels and can take hundreds of years to decompose. The increasing use of single-use plastics has led to severe environmental pollution, harming ecosystems, wildlife, and human health. While bioplastics offer a sustainable alternative, their production is often expensive and requires significant resources.



Challenge:

Developing bioplastics that are affordable, environmentally friendly, and suitable for large-scale production remains a major challenge. The production process must reduce costs while maintaining the strength, durability, and usability of conventional plastics.



Opportunity:

Many natural and renewable resources, such as agricultural waste, starch-rich crops, algae, and food-processing by-products, can be used as raw materials for bioplastics. Advances in biotechnology and green chemistry are creating opportunities to produce bioplastics more efficiently and sustainably.



Solution:

Design a cost-effective and eco-friendly process for producing bioplastics using renewable materials and agricultural waste. The process should minimize energy consumption, reduce dependence on fossil fuels, and create biodegradable products that safely decompose after use. By transforming waste into valuable materials, bioplastics can support a circular economy and reduce environmental pollution.





SAFER & INCLUSIVE CITIES, EASIER TRANSPORT



Project: Cool by Nature – Biomimicry for Energy – Efficient Buildings



Problem Statement:

Today, most buildings use air-conditioners and other cooling systems that consume a lot of electricity. This not only increases electricity bills but also adds greenhouse gases to the environment, making climate change worse. We need ways to keep buildings cool without using too much energy.



Challenge:

Conventional cooling systems consume massive energy, increasing greenhouse gas emissions and hindering climate targets.



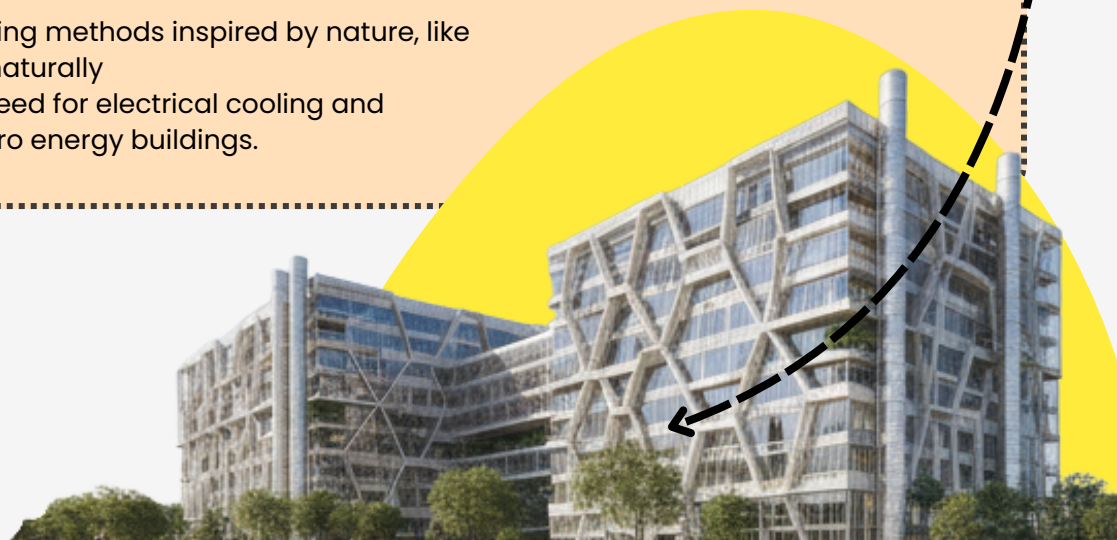
Opportunity:

Nature provides amazing examples of cooling. For instance, termite mounds stay cool inside, even in hot weather. By learning from these natural designs, we can create buildings that remain comfortable without consuming much energy.



Solution:

We can use passive cooling methods inspired by nature, like building structures that naturally stay cool, reducing the need for electrical cooling and moving towards near-zero energy buildings.





SAFER & INCLUSIVE CITIES, EASIER TRANSPORT



Project: Tactile Navigation for All



Problem Statement:

Visually impaired people face serious challenges while moving around cities. Without tactile paths or warning systems, they risk accidents and cannot access public transport or other services independently.



Challenge:

Lack of safe and simple navigation tools limits the mobility, independence, and opportunities for visually impaired citizens.



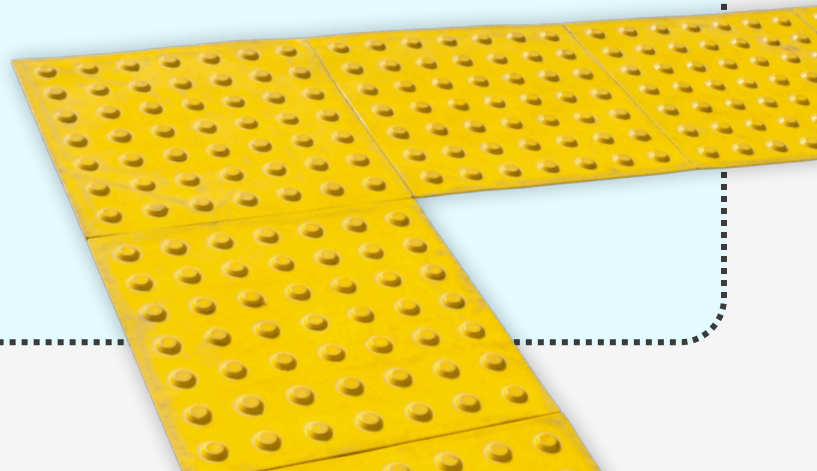
Opportunity:

Simple, low-cost tactile guidance systems can make public spaces safe and accessible for everyone.



Solution:

Install tactile warning blocks (like Tenji Blocks) and guidance paths across sidewalks, bus stops, train stations, and public buildings, so all citizens can move safely and independently.





SAFER & INCLUSIVE CITIES, EASIER TRANSPORT

Project: Bird-Safe Glass – Biomimicry for Wildlife Conservation



Problem Statement:

Birds do not perceive clear or highly-reflective glass as a barrier. They see reflections of the sky and trees, or they see a clear path right through the building, leading to an estimated 300 million to 1 billion fatal collisions in North America every year.

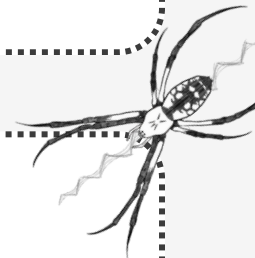
Challenge:

Lack of bird-safe building designs and materials leads to millions of preventable bird deaths each year due to glass collisions.



Opportunity:

Biomimicry: The Spider's Trick. Orb-weaver spiders weave a special, UV-reflective silk pattern, called stabilimenta, into their webs. Birds, unlike humans, can see light in the Ultraviolet (UV) spectrum. The glowing UV threads serve as an unmissable warning sign to flying birds, preventing them from destroying the spider's hard-won trap.



Solution:

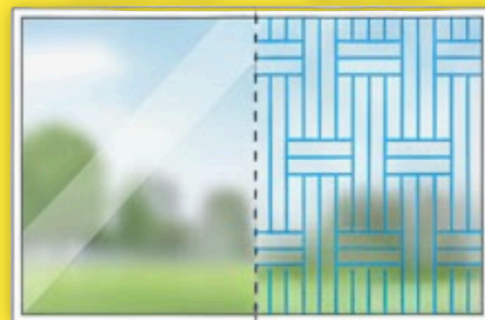
A Window Birds Can See.

Inspired by the spider, architects now use UV-Reflective Patterned Glass. A special coating is applied to the glass in a subtle grid or criss-cross pattern. This pattern follows the 2x4 Rule (visual markers spaced no more than 2 inches apart horizontally or 4 inches vertically) to be effective for



HUMAN VIEW

BIRD VIEW





SAFER & INCLUSIVE CITIES, EASIER TRANSPORT

Project: Nature's Speed – Biomimicry Behind the Shinkansen Bullet Train



?

Problem Statement:

High-speed trains are an efficient way to transport people, but early bullet trains in Japan faced several challenges. When trains exited tunnels at high speed, they created a loud "tunnel boom" sound. They also consumed large amounts of energy and generated significant noise while travelling.



Challenge:

Design a train that could travel faster, use less energy, and reduce noise pollution without compromising passenger comfort and safety.



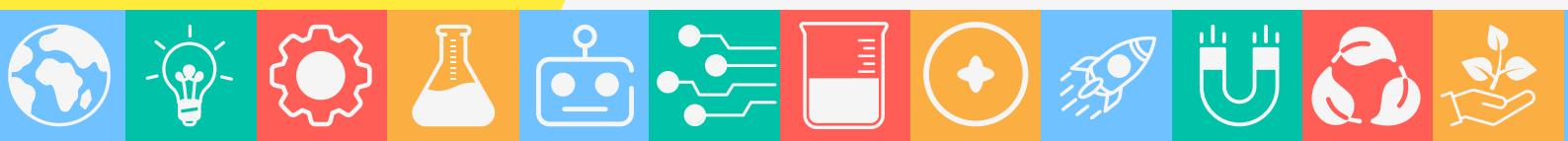
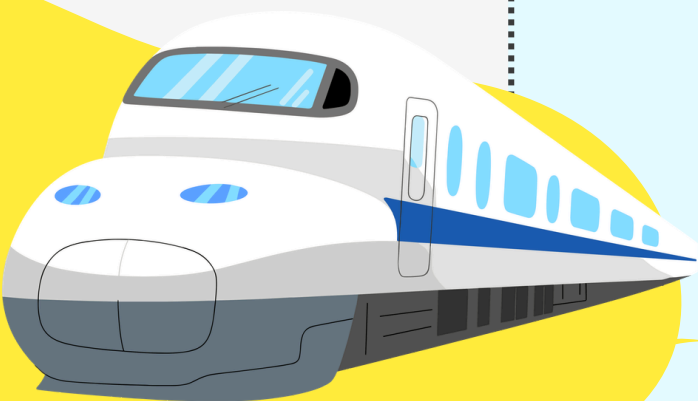
Opportunity:

Nature has already solved many problems related to speed, movement, and efficiency. By studying animals that move quickly and quietly through different environments, engineers can discover innovative solutions for transportation.



Solution:

Inspired by nature, engineers combined the unique abilities of the kingfisher, owl, and penguin to redesign the Shinkansen Bullet Train. The kingfisher's beak inspired a streamlined nose that reduces air pressure and tunnel noise. The owl's silent flight inspired a quieter pantograph design that minimizes vibration and sound. The penguin's streamlined body influenced the train's overall aerodynamics, reducing drag and improving efficiency. Together, these biomimicry-based innovations created a faster, quieter, and more energy-efficient high-speed transportation system.





SAFER & INCLUSIVE CITIES, EASIER TRANSPORT

Project: Nature's Repair System – Self-Healing Concrete
Using Beneficial Bacteria



Problem Statement:

Cracks in concrete structures such as buildings, bridges, roads, and dams are a common problem. Over time, these cracks allow water and harmful chemicals to enter, weakening the structure and increasing maintenance costs. Repairing damaged concrete requires significant resources, energy, and money.

Challenge:

Traditional concrete cannot repair itself once cracks form. Engineers need durable and sustainable construction materials that can automatically repair damage before it becomes a serious safety risk.



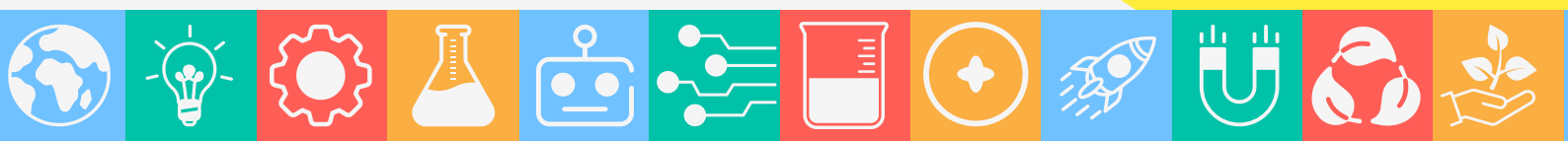
Opportunity:

Certain species of *Bacillus* bacteria can survive in harsh conditions for many years. When exposed to water and oxygen, these bacteria become active and produce limestone (calcium carbonate), which can naturally fill and seal cracks in concrete.



Solution:

Develop self-healing bio-concrete containing dormant *Bacillus* bacteria and nutrients. When cracks form and water enters the concrete, the bacteria activate and produce limestone, automatically sealing the cracks. This biomimetic approach can extend the lifespan of structures, reduce maintenance costs, and improve infrastructure sustainability.





SAFER & INCLUSIVE CITIES, EASIER TRANSPORT

Project: Nature's Clean Touch: Sustainable Self-Cleaning Urban Infrastructure



Problem Statement:

Public spaces such as bus stops, parks, sidewalks, public toilets, and building surfaces often accumulate dust, dirt, water stains, and pollutants. Frequent cleaning requires large amounts of water, cleaning chemicals, labor, and maintenance costs.



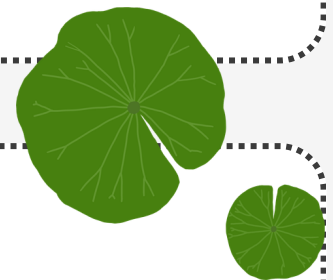
Challenge:

Keeping public spaces clean and hygienic in a sustainable and cost-effective manner is difficult, especially in busy urban areas. Traditional cleaning methods consume resources and may have environmental impacts.



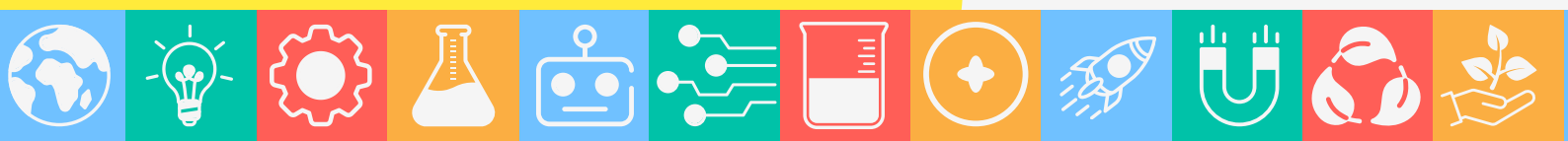
Opportunity:

Nature offers a clever and natural solution through the lotus leaf. Lotus leaves remain clean even in muddy environments because their microscopic surface structure causes water droplets to roll off, carrying away dust and dirt. This phenomenon is known as the "Lotus Effect."



Solution:

Develop self-cleaning coatings, tiles, paints, or public infrastructure surfaces inspired by the lotus leaf. These surfaces can repel water, dust, and impurities, allowing rainwater to naturally wash away dirt.





BETTER HEALTH FOR EVERYONE

Project: Plastic-Free Planet: Microplastic Detection Device



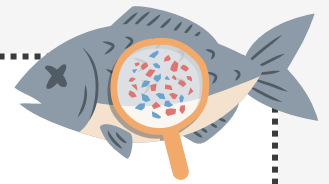
Problem Statement:

Microplastics—tiny plastic particles—have become a hidden danger in our environment. They enter rivers, lakes, and even drinking water, harming fish, plants, and human health. Since they are too small to see, it is difficult to know how much water is polluted. Detecting microplastics quickly and accurately is the first step towards cleaning our water sources.



Challenge:

Microplastics are invisible to the naked eye and often pass through regular water filters. This makes it hard to measure the pollution level and take action to clean it.



Opportunity:

By developing a device that can detect and measure microplastics in water, scientists and communities can monitor pollution levels and find solutions faster. Such a device can help industries, households, and governments track contamination and prevent further harm.



Solution:

Create a portable, affordable detection device that uses sensors, light, or image analysis to identify and measure microplastics in water. This technology will support early detection, improve water safety, and help design better pollution control methods.





BETTER HEALTH FOR EVERYONE

Project: Gentle Touch – Biomimicry for Painless Needles



Problem Statement:

Millions of people require injections, vaccinations, and blood tests every year. However, many people, especially children, fear needles because they can cause pain and discomfort. This fear sometimes leads people to avoid important medical treatments and vaccinations.



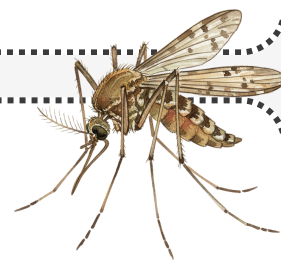
Challenge:

Traditional needles pierce the skin directly, which can stimulate pain receptors and cause discomfort. Developing a needle that delivers medicine effectively while reducing pain remains a major challenge in healthcare.



Opportunity:

Nature provides an interesting solution through the mosquito. A mosquito's proboscis can pierce human skin and draw blood with very little pain. By studying its structure and movement, scientists can design medical needles that are thinner, more flexible, and less painful.



Solution:

Develop a biomimetic needle inspired by the mosquito proboscis. The design could use micro-serrated edges, flexible structures, or vibration-assisted insertion to reduce pain while maintaining effective drug delivery.





BETTER HEALTH FOR EVERYONE

Project: Clean Sip Anywhere – Portable Water Filter Straw



Problem Statement:

Millions of people around the world lack access to clean drinking water. During floods, natural disasters, travel, or in remote regions, people may be forced to drink contaminated water, increasing the risk of waterborne diseases.



Challenge:

Large water treatment systems are not always available in emergencies or remote locations. People need a simple, portable, and affordable way to access safe drinking water wherever they are.



Opportunity:

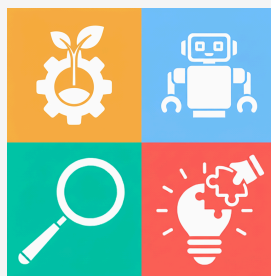
Modern filtration technologies can remove bacteria, parasites, sediments, and other contaminants from water using compact filtration systems. Portable filter straws allow individuals to drink directly from natural water sources while reducing health risks.



Solution:

Design a lightweight and reusable portable water filter straw that uses multiple filtration layers to remove contaminants and improve water quality. The device should be affordable, easy to carry, and suitable for emergency situations, outdoor activities, and communities with limited access to clean water.





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