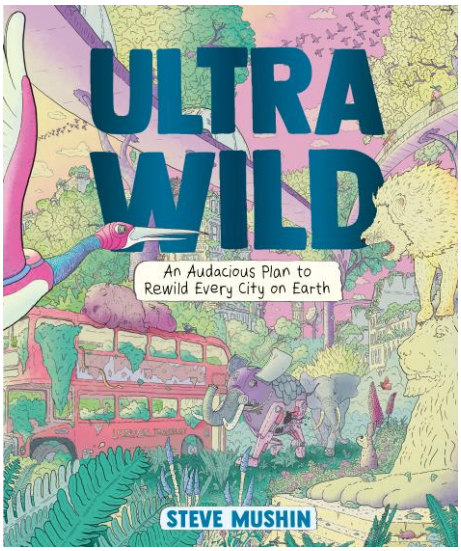


ULTRAWILD

Written and illustrated by STEVE MUSHIN

RECOMMENDED FOR: Ages 9–99 YEARS OLD (UPPER PRIMARY TO SECONDARY SCHOOLS)

GENRE: Graphic Nonfiction / Popular Science

THEMES: design, engineering, science (especially physics and biology), rewilding, climate change, lateral thinking, technology, maths, creativity and imagination

CURRICULUM LEARNING AREAS:

- **Learning areas:** Science, Design and Technology, Maths, Geography, History
- **General capabilities:** Literacy, Critical and Creative Thinking, Personal and Social Capability, Ethical Understanding
- **Cross curriculum priority:** Sustainability

NB: CLASSROOM DISCUSSION AND ACTIVITIES ARE HIGHLIGHTED

NOTES WRITTEN BY: Steve Mushin

ISBN (AUS): 978 1 76029 281 2

WHY STUDY THIS BOOK

- As a hilarious STEM primer to stimulate design thinking and engineering ideas
- To explore the science of climate change, its challenges and solutions
- To develop critical thinking skills around technology, climate change, sustainability and biodiversity
- Most of all: to have fun with science, maths, engineering and imagining the future

THEMES

- **CREATIVE THINKING** TO CHANGE THE WORLD
- **DESIGN AND ENGINEERING** FOR A SUSTAINABLE FUTURE
- **BIOLOGY –** REWILDING ANIMALS, PLANTS AND ECOSYSTEMS
- **PHYSICS** OF ECOLOGICAL MACHINES
- **CHEMISTRY** TO REINVENT THE WORLD
- **MATHS** FOR DESIGN AND ENGINEERING
- **GEOGRAPHY** – HOW WE'RE CHANGING OUR PLANET
- **HISTORY** OF TECHNOLOGICAL INNOVATION
- **ENVIRONMENT** – HUMAN IMPACTS
- **CLIMATE CHANGE** – THE SCIENCE AND SOLUTIONS
- **WATER** – ESSENTIAL FOR ALL SPECIES

INTRODUCTION

Mind-bendingly original and full of intricate illustrations, *Ultrawild* is totally unique, containing over one hundred outrageously funny, scientifically plausible inventions for rewilding cities and saving the planet.

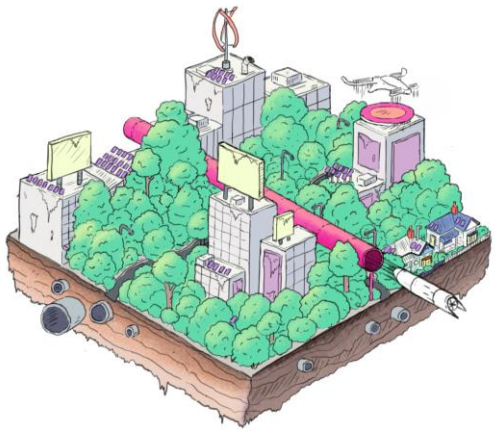
Join maverick inventor Steve Mushin as he tackles climate change with an avalanche of mind-bending, scientifically plausible inventions to rewild cities and save the planet.
Jump into his brain as he designs habitat-printing robot birds and water-filtering sewer submarines, calculates how far compost cannons can blast seed bombs (over a kilometre), brainstorms biomaterials with scientists and engineers, studies ecosystems and develops a deadly serious plan to transform cities into jungles, rewilding them into carbon-sucking mega-habitats for all species, and as fast as possible.

Through marvellously designed and hilarious engineering ideas, Mushin shares his vision for super-high-tech urban rewilding, covering the science of climate change, futuristic materials and foods, bio reactors, soil, forest ecosystems, mechanical flight, solar thermal power, and working out just how fast we could actually turn roads into jungles, absorb carbon and reverse climate change.

Developed over seven years, *Ultrawild* is an optimistic book about creative thinking, science, technology, engineering and maths (STEM) and the potential for massive change. Filled with laugh-out-loud design ridiculousness, it aims to empower and excite a new generation of designers, scientists, engineers and ultra-wild thinkers.

'If this book does not fire your imagination, nothing will. Steve Mushin doesn't hold back when thinking about our green future; humanity needs all the ideas it can get to bring climate change under control, and this book is packed with them!'
Professor James Renwick, climate scientist

PLOT SUMMARY



Ultrawild follows real-life industrial designer and inventor Steve Mushin as he learns about the ecosystem restoration philosophy known as 'rewilding', and develops his own unbelievable-sounding but theoretically possible version for cities, called 'ultrawilding'.

Narrated in a graphic novel style and filled with laugh-out-loud science comedy, readers join Steve on his design process as he brainstorms ultrawilding technologies to transform cities into jungles as fast as possible. Ideas like compost cannons that plant trees on roads and sewer submarines that help transform abandoned sewers into rivers for native fish.

We learn about high-tech materials, the history of toilets, catapults, microbes, flight, climate change, indigenous ecological philosophies and more. As Steve Mushin creates a blueprint for future ultrawilded cities, we discover what cities such as London, Sydney, Wellington and Beijing could look like as ecosystems for all species.

Each chapter in *Ultrawild* ends with a list of dozens of things that need to be designed next, inviting readers to get involved, begin brainstorming, researching, drawing and modelling, and join the ultrawilding project themselves.

Q&A WITH STEVE MUSHIN

What on earth is ultrawilding?

'Ultrawilding is a wild and outrageous version of rewilding. Rewilding means helping wildness return to landscapes. Ultrawilding means bringing wildness to high-tech cities – so we can live among enormous trees and plants, millions of birds, reptiles and mammals, and billions of other species. It is already starting to happen in cities all around the world: wildflower roofs and bug hotels are attracting insects, special hollow bricks help birds nest in walls, and roads are being dug up to restore buried rivers for fish, amphibians and birds. Ultrawilding massively boosts biodiversity, helps cities absorb carbon, and it's ultra-fun too!'

Could you tell me about some of the incredible real-world technologies described in *Ultrawild*?

'Transforming cities into habitats for animals will require lots of extreme 3D printing. In *Ultrawild,* we explore many super-cool 3D printer technologies, like swarms of flying 3D printers printing luxury fake trees for birds. We also look at all kinds of fascinating natural 3D printing materials – like some made of seaweed and pond algae and carbon sucked from the air. And that's just the beginning. *Ultrawild* looks at rockets, aquaponics, inflatable wings, mechanical muscles, autonomous vehicles, drones, electromagnetic catapults and heaps more.'

***Ultrawild* was developed in collaboration with scientists and engineers. Can you tell us about a few of the collaborations?**

'One of my favourite collaborations in *Ultrawild* was with mechanical engineer Neil Faragher. Neil designs solar power stations which use mirrors the size of houses to reflect sunlight onto space-grade solar panels, generating electricity and harnessing heat. Neil and I teamed up to design flying bikes – pedal-powered bicycles that you could theoretically fly across cities.

'Our plan is to use waste heat from thousands of buildings in New York City to create an enormous updraft with which to launch bikes with inflatable hang glider wings. The idea does look feasible, if a little extreme. Our computer simulation suggests that waste heat could accelerate riders faster than an electric hyper car – launching them into the sky at hundreds of kilometres an hour. Which sounds ultra cool to me.'

***Ultrawild* describes how designers use outrageous 'thought experiments' to help solve complex problems. Tell me more!**

'Throughout history, designers, engineers and scientists have boosted their creative thinking by playing around with outlandish hypothetical questions known as 'what-ifs', or 'thought

experiments'. Modern brain science shows us that by 'thinking outside the box', we can overcome conceptual blocks and free our thinking to more easily discover new ideas.

'Ultrawild is written as a series of 'design thought experiments', where one wild design concept to transform cities leads to the next wild idea, then a wilder idea still. The goal is to show readers that when it comes to re-imagining cities (or when brainstorming any innovative project), no idea is too ridiculous. And that right now – with the climate change and biodiversity threats that our planet faces – ultra-wild design thought experiments are not just more important than ever, they're essential.'

What gives you hope that we can reverse climate change?

'It's easy to feel overwhelmed about climate change and the state of the world. But there is absolutely still time to transform cities and reverse climate change.

'The global rewilding movement inspires me every day, and it's something that almost anyone can get involved with and start making a change today. All around the world passionate people are helping to return wildness by planting trees, creating habitats for native animals, and restoring ecosystems. I challenge anyone to get involved in rewilding and not become totally wild about it!'

***Ultrawild* proposes rewilding every city on earth into an ecosystem of jungles and wild animals. But is that *ACTUALLY* possible? Wouldn't we all just get eaten?**

'Returning wolves and lions to the suburbs is probably a lot more possible than it sounds.

'Sure, walking to school would take on a whole new level of excitement. But new technologies such as shared autonomous cars, flying taxis, sky bike paths, hyperloops and pizza delivery drones could free up a vast amount of space for animals to live happily in rewilding cities. Rewilding experiments all around the world have shown that when it is done well, people and animals are happy and safe. And according to brain science, a little more adventure, danger and risk can make us smarter, and even can help give us better ideas. 'But if the odd kid (who probably should have been paying better attention anyway) does, sadly, become a tasty afternoon lion-snack…then maybe that's, just, life?'

'Though there are sixty thousand wolves in North America,
the risk of being killed by one is almost nonexistent.'

GEORGE MONBIOT, writer, activist, and author of *Feral*,
Rewilding the Land, Sea and Human Life

LEARNING AREAS (and TOPICS) COVERED

Science
Rewilding
Life cycles and behaviour of animals and plants
Animal habitats
Interactions between organisms, including the effects of human activities
The carbon cycle
Renewable energy
Future high-tech bio-materials
Solar energy
Understanding how to read scientific literature
Carbon sequestration
Decomposition
Soil science
Photosynthesis
Algae
The development of animal flight
How human powered flight works

Design and Technology
Creative thinking
Future engineering and technology
Design research
Design ideation
Engineering principles
Design drawings

Maths
Exponential growth
Making calculations based on statistics and scientific data
Estimation
Visualising large quantities of materials

Geography
Climate change
Extinction and biodiversity crisis
Human impacts on the environment
The impacts of farming and industry
Water systems in cities
Different types of ecosystems around the world
Indigenous wisdom for ecosystem protection
Sustainability in different cities of the world
Rate of change in cities and society

History
How ancient deforestation has changed the climate
How human hunting of megafauna changed landscapes
Rate of technological change through the ages
The history and significance of the Industrial Revolution
The history of toilets and sewers
The history of catapults

CLASSROOM DISCUSSION AND ACTIVITIES

CREATIVE THINKING TO CHANGE THE WORLD

How do inventors get ideas?

Read about how design thought experiments can help give us ideas (pp 4–5), then start your own!

At the end of each chapter in *Ultrawild* there's a list of 'Design starter ideas'. Examples are the many different types of mechanical megafauna described on page 14, the specialist sewer subs on page 34, or flying skateboards and flying ramps for flying skateboards on page 52.

Choose one starter idea and give yourself just one hour (drawing fast helps with ideas) to complete the tasks below:

- A: Spend 15 minutes filling a page with small drawings, or 'thumbnail sketches', for how various solutions could look and work. Try to generate as many ideas as possible. Add labels and notes. This is your concept page.
- B: Choose one of your new concepts and spend 15 minutes drawing a side view, 15 minutes drawing a front view, and 15 minutes drawing a top or bottom view (and add lots of labels). Then pitch your invention to your class with a short (under 5 minute) 'elevator pitch'.

Extension activity 1:
- Draw a detailed 3D view, or perspective drawing, of your invention.

Extension activity: 2
- Research a historical invention that has surprised everyone and changed the way we live. Write an essay about it or draw a poster about the inventor and how they came up with the idea.

Extension activity: 3

- Inventor Thomas Edison and artist Salvador Dalí famously liked to fall asleep in chairs holding metal objects. They thought that the objects crashing down and waking them up seconds after they fell asleep helped them remember the sorts of great ideas that can come to us as we are nodding off – but which we often forget! Research other creative ways inventors have used to find great ideas.

Imagining the future is tricky

It can be very difficult to imagine the future.
Read pages 60–63. Then consider the thought below that Steve Mushin has in *Ultrawild* after he meets inventor James Watt (in his imagination):

'It's probably AS DIFFICULT for us to imagine how quickly humans could repair the planet, as it would have been for our ancestors to have imagined how quickly humans would trash the planet.'

Write a paragraph about why Steve believes we may be able to rewild cities, and the world, much faster than most people think is possible.

Using science to boost your creative thinking

While reading about chicken-poo-powered algae farms, Steve came up with the idea of making plastic with the help of chickens (p36). And reading about fake meat gave him ideas for edible (and tasty) fake limbs to help us on long flying bike adventures (p49).
One of the fastest ways to come up with ludicrously brilliant new ideas is to use someone else's designs or scientific research – as ludicrous thought experiment starters. And right now, because so few people spend time thinking about ludicrous ideas, you can take almost any new technology or scientific discovery and be one of the first to push it to berserk levels of ingenuity (p75).

Research cool new scientific discoveries by browsing websites like http://www.eurekalert.org which summarise new science. Find a new scientific discovery that fascinates you, then start brainstorming and drawing and come up with some imaginative ways to use the science.

DESIGN AND ENGINEERING FOR A SUSTAINABLE FUTURE

Design a 'nearly tree' house

The 3D-printer birds project (pp19–26) is all about transforming lampposts and power poles and other 'nearly trees' in cities into fake-tree-habitats for native animals. What if we also 3D printed cool little space in these nearly trees for humans to hang out with the birds, like small treehouses? Come up with some designs for these mini treehouses to print on

lampposts. Think about what you'd need inside: windows, periscopes, ladders, secret doors, camouflage, power source, defence systems, etc.

Biomimicry is awesome

Biomimicry means designing inventions with inspiration from how nature solves problems. Like how Velcro was inspired by seeds with hooks, or aircraft wings inspired by bat wings. Read pages 64–67 and research the concept of biomimicry, then summarise what you've learnt, giving a few examples of biomimicry in modern technology.

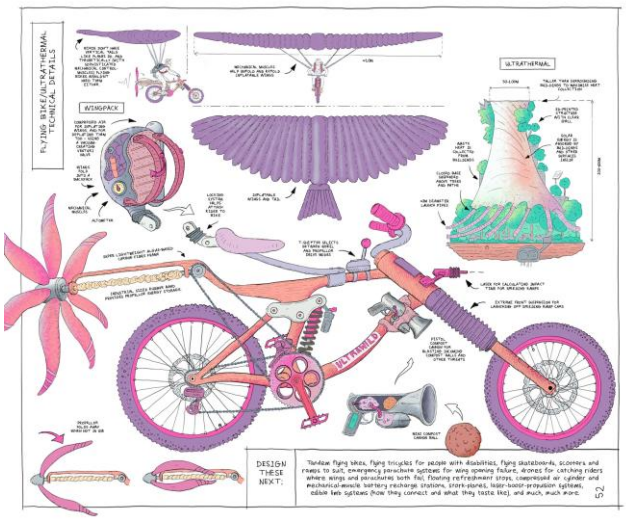
Solar-cooked sky-delivered algae burgers?

In the Chicken Castle project (pp34–44) we learn about the need for sky-delivered omelettes cooked by sun-tracking parabolic mirrors. But solar-thermal (using the power of the sun) cooking systems like this could be designed to cook anything.

Design a cooking system that could be mounted on the side of a skyscraper for making a future type of fast-food. The advantage of doing it up high is of for the ease of delivery by GPS guided parachute – straight into your hungry hands. It's up to you how your system works – drone delivery, food-slides, or small cannons to blast the food for miles, or straight into your mouth as you fly by on a bike, are all open for discussion. Use the design techniques described in the activity 'How do inventors get ideas?' (under the heading CREATIVE THINKING TO CHANGE THE WORLD, below) to develop your designs.

Design a flying skateboard or flying scooter

Read pages 45–52 to learn about Steve Mushin's designs for flying bikes. Use the design techniques described in the activity 'How do inventors get ideas?' (under the heading CREATIVE THINKING TO CHANGE THE WORLD, below) to develop your own designs for a flying skateboard or scooter. You'll need to design the launch system, backpack wings, VR headset, and how to attach yourself to your wheels – among many other things!



BIOLOGY: REWILDING ANIMALS, PLANTS AND ECOSYSTEMS

How trees fight climate change

Trees suck down carbon dioxide from the atmosphere and use photosynthesis to split the carbon from the oxygen to help create wood (p28). Create a poster or mind map, or write an essay explaining how photosynthesis works, and why trees are so important for reversing climate change.

Animal habitats

Some birds build nests out of sticks, some mud. Some nest in the ground and others modify the perfect tree hollow. Then there's bees, beavers, termites and bower birds (p20).
Lots of animals are designers, and humans are constantly learning from our animal friends' engineering. Research biomimicry (the science of copying nature's engineering (pp65–66) and write an essay on it, or create a poster about a super cool example of biomimicry that inspires you. A great book to start with is *Invented by animals: meet the creatures who inspired our everyday technology*, by Christiane Dorion.

Soil: a universe under your feet

Check out the soil diagram on page 7. Have you ever seen a soil mite or a nematode? Now's the time! Dig up some soil in your school playground or backyard. Use a magnifying glass or microscope to explore what's in the soil. Create an illustrated soil diagram of what you find.

There are many resource guides on the internet which show how to examine soil. A good one to start with is this: https://kidsgardening.org/resources/lesson-plan-soil-is-alive/ - exploration:

Life in an ultrawilded city

Ultrawilding means rewilding cities as fast as possible – filling the streets (or what once were the streets) with millions of mammals and birds and reptiles and insects and more (p15).

Research the native animals in your local ecosystem (or what would have once lived where you live) and draw your house, school or local shop in an ultrawilded future – where you're surrounded by thousands of other species. Or write a story about going to school, or eating breakfast on the roof of your house, or some other ultra-wild scenario in your imagined ultrawilded city.

Extension activity:

- Scientists estimate that there were six times more wild mammals on earth (measured by total weight, or biomass) before humans spread across the continents

(p7), and ultrawilding aims to bring them back. Research not only the type of animals, but how many animals, there could once have been in your garden or school playground. Use a drawing to explain your findings.

Rewilding projects around the world:

Research a famous rewilding project – such as wolves returning to the USA, or beavers returning to the UK (p15) – and write an essay or create a poster about it.

How many species are there in the world? We don't really know!

Ultrawilding cities is about making cities into nice places for all species (p15). But how many species ARE there to return to cities? Hundreds? Thousands? Some experts estimate there are millions of species of animals and plants and microbes in the world. Others say trillions! Research and write an essay, or create a poster, exploring how many species there are in the world.

Extension activity 1:

- Research 'food web' diagrams that show how different species are connected in an ecosystem. Draw a simple food web for the native animals and plants that will return to live in your future ultrawilded city or town.

Extension activity 2:

- Research 'tree of life' diagrams that show how all species – plants, animals, fungi, bacteria and all the rest – are related to each other. Make your own simplified tree of life diagram, or make a short film or animation explaining how all life is connected.

Symbiotic relationships

Like ants and squirrels that bury seeds, and bees and mice that pollinate flowers, almost every plant relies on animals to help spread and germinate seeds. And almost every flowering plant has a symbiotic, or cooperative, relationship with a particular pollinating animal (p18). Research a pollinator or seed spreader in your local ecosystem. Then write a story from the perspective of that creature going about its life.

Keystone species

When some animals return to ecosystems, they can create massive positive changes called TROPHIC CASCADES (p23). These animals are known as 'keystone species'. Examples are wolves returning to Yellowstone Park in the US which helped re-establish dozens of other species. Research and create a poster explaining one example of trophic cascades.

PHYSICS OF ECOLOGICAL MACHINES

The power of the sun

The 3D-printer birds in *Ultrawild* focus the sun's energy by using their wings as 'heliostats' (p21). Heliostats are sun-tracking mirrors which can be as big as houses. In some huge 'solar thermal' projects around the world, there are thousands of massive heliostats focusing light to create enormous amounts of heat.

Research cool solar thermal projects like Noor Solar Power Plant in the United Arab Emirates. Think about how they work, and propose a design for a smaller version that could work on the roof of your house – to generate electricity, heat, or cook food (like the solar-powered sky omelettes on p38)!

Flying bikes exist!

Flying bikes have been around for decades. One even flew across the English Channel (p45). Explain in an essay, diagram or poster how real flying bikes work, and why their wings need to be so large.

Paper plane competition –-how gliding works

In *Ultrawild* we learn about how some objects glide better than others (p49). Run a class paper plane competition, and calculate the 'glide ratio' (see p49) for each plane*. Have a class discussion about what makes some planes glide further than others.

*Note that to calculate paper plane glide ratios, the planes must all be dropped from the same fixed height – not thrown.

CHEMISTRY TO REINVENT THE WORLD

Algae plastic

Plastic made from oil is old news. The cool new stuff is called BIOPLASTIC! (pp21, 36, 40–41). Made from corn or algae like seaweed or even fungi, you can easily make bioplastic at home. Research bioplastic recipes and make some yourself. Then test how strong it is.

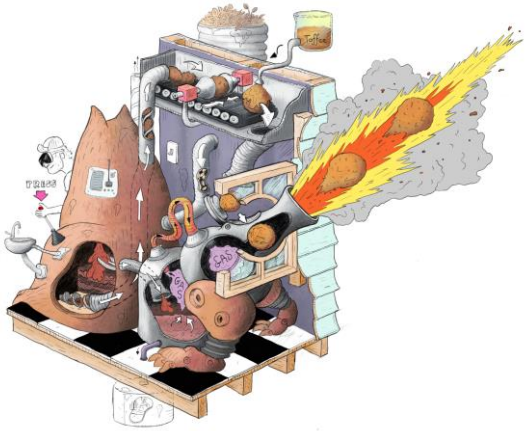
Here are some links for making your own plastic:

- https://www.youtube.com/watch?v=fDStwxetx7Q&ab_channel=MaryLempres
- https://www.youtube.com/watch?v=7BMtchgejK0&ab_channel=RobertMurray-Smith

Explosive human gas! (high school age students)

According to Steve Mushin's calculations, the poo from an average human could produce the equivalent of 133 dynamite sticks of explosive methane gas each year*. That's about 133 MEGAJOULES OF ENERGY (p10). Can this possibly be true?

Research the volume of gas that an average person farts, the explosive energy (or 'energy density') of methane gas, and the energy density of dynamite. Do some simple 'back of envelope' calculations to work out if our farts could possibly equal 113 dynamite sticks of power. Then check your calculations against Steve's calculations on the Ultrawild calculations spreadsheet, which you can download at http://www.ultrawild.org/calculations (look for the spreadsheet tab on Compost Cannons).



Finally, research three other animals and use Steve's spreadsheet to help you calculate their 'fart power' – the number of dynamite sticks of explosive energy that they produce each year in farts. Hint: cattle, whales and termites are massively flatulent!

Extension activity 1:

- Assume that the waste and gas from of one of the animals that you have researched above is collected and used to power the compost cannon invention. Look at the calculations for firing compost cannons (http://www.ultrawild.org/calculations) and work out how large the balls would be and how far they would need to go, if such a toilet were powered by your chosen animal.

Extension activity 2:

- Research high-tech ways to recycle human waste – like using microbes (p8) or worms or plants (p31) – and push your imagination to the limits by designing your own ultra-wild toilet to transform waste into something valuable – like compost, or drinking water. Or cakes and soft drinks (actually not impossible – google 'Scientists Working on Converting Human Waste into Food for Astronauts').

MATHS FOR DESIGN AND ENGINEERING

Self-replicating machines and the GREY GOOP Problem

If 3D-printer birds could make copies of themselves, and those copies could make more copies, the birds would multiply exponentially (p22).

Exponential growth is where the growth of something accelerates over time. It can be terrifying – like the sci-fi-popularised 'grey goop problem', which could theoretically destroy

the world. It could also make you rich, like the cunning way the inventor of the game of chess in the link below asked for his reward.

Watch the videos below on the Grey Goop problem, the wheat and chessboard problem, and the Khan Academy video, and create a poster to explain exponential growth.

The grey goop problem explained
https://www.youtube.com/watch?v=w7w4W6Bz95o&ab_channel=ScienceUnbound

Wheat and chessboard problem
https://www.youtube.com/watch?v=eJmWu18pWtI&ab_channel=ScienceWorld

Exponential growth explained

https://www.youtube.com/watch?v=6WMZ7J0wwMI&ab_channel=KhanAcademy

GEOGRAPHY – HOW WE'RE CHANGING OUR PLANET

Ecosystems in crisis

'While calculating how much ultrawilding cities could add to the world's total wilderness... I discovered how fast we're destroying the wilderness we already have.' (P56)

Read pages 56–59 and do your own research into some of the biggest environmental challenges the world faces today. Write an essay on one of these challenges.

The sixth mass extinction

Scientists say that climate change has now helped push the planet into its sixth mass extinction event (p57). Write an essay, create a mind map, or create a poster about the sixth mass extinction, or one of the previous five mass extinction events (the fifth was when the dinosaurs disappeared). Describe what has caused these events, and what the outcome has been.

HISTORY OF TECHNOLOGICAL INNOVATION

Technological change

Throughout history, people have failed to predict how quickly new technologies like cars and aeroplanes and phones will completely change how we live. Such technologies are known as DISRUPTIVE TECHNOLOGIES. We fail to predict change because we're living on autopilotand because we struggle to imagine innovations changing FASTER AND FASTER EACH YEAR. This is known as exponential change (p16).

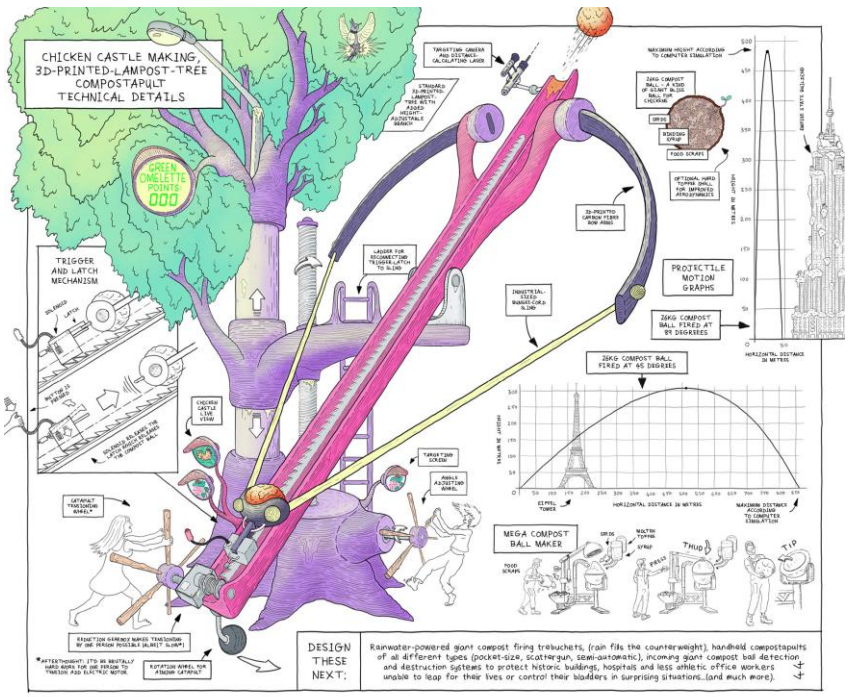
Research major inventions made in the last few centuries. Make a poster of exponential change by plotting all the inventions you can on a timeline, to illustrate how change has sped up in the last few hundred years.

Extension activity

- Write an essay, or create a poster or a short film explaining how one DISRUPTIVE TECHNOLOGY (such as the car, the internet, or the printing press) has changed the way we live.

How ancient catapults work. And why they could be handy in the future.

Catapults are cool,especially now that we don't use them for killing each other. They're handy, too. Steve Mushin proposes using catapults for delivering food scraps to chickens who live on roofs (p37), but you may have better ideas.
Research one style of ancient catapult, such as the ballista or trebuchet (p38–39). Describe how it works as an essay or poster. In the same presentation propose how a modern version could do something useful in cities (like deliver mail or algae burgers, or help return lost pets).



Buried alive by horse poo!

'Compost cannons on every building WOULD COMPLETELY SOLVE the problem of getting buried by your own compost.' (p10) But hang on – would they really? If we kept blasting the roads with compost, wouldn't it eventually build up and up? Or would animals and plants break it down and move it around?

In the late 1800s people had similar concerns about being buried. They worried that streets would be buried in horse manure because of all the tens of thousands of horse-drawn carts. The London *Times* predicted in 1894 that every street in London would be buried under nine feet of manure within 50 years!
Research compost making, and 'The Great Horse Manure Crisis of 1894' and write an essay or create a poster exploring exactly what you think would happen if we turned all of our waste into soil and used it in cities.

Why did most megafauna disappear?

There is much debate about why many incredible giant animals, or megafauna, died out in the last few tens of thousands of years. Epic scale beasts like wombats the size of vans in Australia (diprotodon), lions, hippos and elephants in the UK, giant rhinos with 2m long horns in Europe (elasmotherium) and giant sloths in the Americas (megatherium) (pp6–7) once lived where every modern city is now built. Research one type of extinct megafauna and write an essay or create a poster exploring when, where and how it lived, and the theories as to why the poor creature vanished.

ENVIRONMENT – HUMAN IMPACTS

Blame the steam engine!

Read about Steve Mushin's imaginary conversation with James Watt (p63). Write about the Industrial Revolution and how the invention of steam power eventually led to climate change.

Indigenous ecosystem management

To guide ecological restoration in Aotearoa, New Zealand, large projects follow the indigenous Māori ecological concept of guardianship known as kaitiakitanga. This philosophy reminds us that humans are part of the natural world – that we have kinship to all species – and so we have a responsibility to protect and nurture all species (p18). Research

kaitiakitanga, or other philosophies or management practices that indigenous people use to help protect our environment.

A treaty with chickens

Steve Mushin thinks that humans should sign a treaty with the world's 33 billion chickens. We give them their freedom, and every roof in the world. They help us transform every building into a vertical farm (p36).
Hold a class debate to discuss whether we should, or should not free the world's chickens, cattle, pigs, sheep, hamsters, or any other animal, or ALL animals!

Going vegan

Meat and dairy farming require massive amount of land and resources, meaning less for animals and other species. If everyone on earth ate the same meat-packed diet as Australians or New Zealanders, we'd need roughly one extra planet to fit all the farm animals, and more planets to absorb the emissions (p57)! Write a persuasive argument for why you think the world should or should not go vegan.

Giving animals and places legal personality rights

Ecuador, Bolivia, New Zealand, Mexico, Uganda, Bangladesh, India and others have given legal rights (like human rights) to wild animals, rivers, lakes, mountains, forests and animals (p61). Research some of these incredible situations and write about this ecological movement to protect nature.

CLIMATE CHANGE – THE SCIENCE AND SOLUTIONS

Climate change = innovation

Climate change is threatening almost all life on earth, but it's also a massive driver of new ideas and incredible technological innovations (pp27–28). Research how climate change works, then create an exciting-looking poster that explains the facts, and some of the incredible opportunities that we have to change how cities work.

What on earth is a GIGATONNE?

Find some fun ways of visually explaining what a gigatonne of carbon dioxide is (p27). Then research projects around the world that suck down carbon dioxide, known as 'sequestering carbon'. Create a poster which explains the challenge of sucking down carbon dioxide, and showcases some cool new (or old!) technologies (p28) that are doing it.

WATER – ESSENTIAL FOR ALL SPECIES

Water under cities

Underground rivers, sewers, stormwater pipes, animal burrows, electricity cables, gas, drinking water pipes, old graves, caves, abandoned mines, bunkers…(p29). Research what might be under your local main street and create a cross-section drawing explaining the situation.

Design a water-filtering sewer submarine

Study the Sewersub Project on pages 27–34, then design your own sewer submarine. You could work on one of the unfinished concepts in the 'design this next' section on page 34, or come up with a completely new idea. Think about who would use your design, how it would be powered, and how you'd make it a super fun ride.

Re-creating lost city rivers for native fish

The Sewer Submarine chapter in *Ultrawild* discusses the modern concept of daylighting – digging up and restoring rivers that have been buried inside pipes and deep under roads and buildings (p29). A famous example is Cheong Gye in South Korea (p30). In many modern cities almost every river and stream has been put inside a pipe, a situation that's terrible for fish and other aquatic creatures.

Every valley once had a river running through it. A river that's probably now running through a pipe under a road. Think about the landscape of a city near you. Do a drawing imagining one of these rivers 'daylighted' back into a beautiful river ecosystem, full of fish and insects and birds, with shops and houses and bike paths tucked among it.

ABOUT THE AUTHOR

STEVE MUSHIN is an industrial designer, artist and inventor who collaborates with scientists and engineers to solve perplexing problems that no one else seems to know what to do about - like what can be done with explosive cow gas or how to make bikes fly or cities transform into jungles as fast as possible. Steve has exhibited large-scale design drawings and models around Australia and in Japan. He works between Australia and Aotearoa New Zealand, and in 2015 received an Australian Design Honours award for his work in sustainable futures thinking. *Ultrawild* is Steve's first book.

CORRESPONDING LITERATURE

SUITABLE FOR PRIMARY STUDENTS

What If by Randall Munroe

How To: Absurd Scientific Advice for Common Real-World Problems by Randall Munroe

Invented by animals: meet the creatures who inspired our everyday technology by Christiane Dorion

The Observologist by Giselle Clarkson

In the Sky: Designs Inspired by Nature by Harriet Evans, illustrated by Gonçalo Viana

Wild Australian Life by Leonard Cronin, illustrated by Chris Nixon

Rewilding: Bringing wildlife back where it belongs by David A Steen, illustrated by Chiara Fedele

Superpowered Animals: Meet the World's Strongest, Smartest, and Swiftest Creatures by Soledad Romero Mariño, illustrated by Sonia Pulido

Rewild the World at Bedtime: Hopeful Stories from Mother Nature by Emily Hawkins, illustrated by Ella Beech

SUITABLE FOR SECONDARY STUDENTS

What If by Randall Munroe

How To: Absurd Scientific Advice for Common Real-World Problems by Randall Munroe

Sunlight and Seaweed by Tim Flannery

Feral by George Monbiot

Regenesis, by George Monbiot

Wilding by Isabella Tree

Braiding Sweetgrass, Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants by Robin Wall Kimmerer

Bringing Back the Beaver: The Story of One Man's Quest to Rewild Britain's Waterways by Derek Gow

Rewilding the World: Dispatches from the Conservation Revolution by Caroline Fraser

WEB RESOURCES

The official *Ultrawild* website – for Steve's full calculations, science references, notes and inventions

http://www.ultrawild.org

Our World in Data – *Research and data to make progress against the world's largest problems*

A brilliant free resource of easy-to-read information and statistics on world land use, environmental challenges, climate change science, biodiversity, population (and a lot more).

http://www.ourworldindata.org

Zealandia – A pioneering urban rewilding project in Wellington, Aotearoa, New Zealand

http://www.visitzealandia.com/

WWF Rewilding Australia

https://wwf.org.au/what-we-do/rewilding-australia/

Rewilding Europe – A non-profit organisation based in Netherlands, working to create rewilded landscapes throughout Europe.

http://www.rewildingeurope.com

Rewilding Earth – The website of the US-based Rewilding Institute. Lots of information about North American rewilding projects.

https://rewilding.org/

Australian Youth Climate Coalition – Australia's youth-run climate organisation with a mission to empower young people to change the world.

https://www.aycc.org.au/

Climate Council – An Australian-based, independent, evidence-based organisation providing information on climate science, impacts and solutions.

https://www.climatecouncil.org.au/about/

NIWA – Aotearoa's National Institute of Water and Atmospheric Research

Resources for teachers page

Educational resources and scientific data for young people to learn about science.

https://niwa.co.nz/education-and-training/educational-resources/resources-for-teachers