

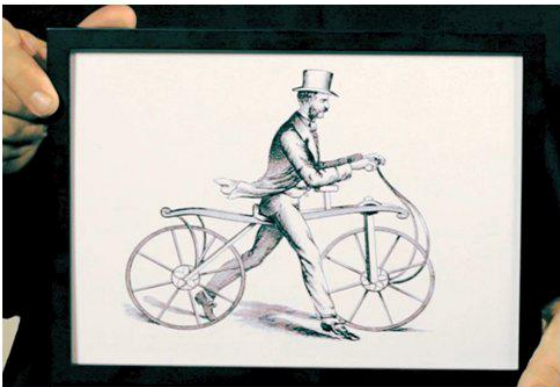
# Introduction to Lightweighting and Material Reduction

Companion to the video: [Script and Illustrations](#)

When it comes to designing sustainably, it pays to think light. Products made with less material have less negative impact all the way from production to disposal. And they're often cheaper to produce.

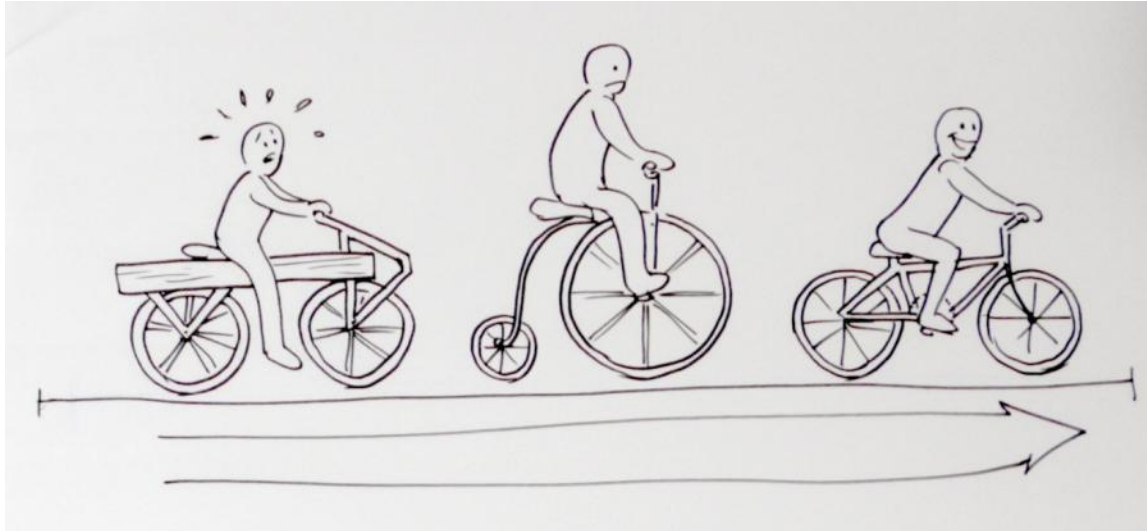
It's obvious why a light-weight car saves energy, it takes less gas to operate. But even a bicycle, which doesn't need fossil fuel, can be made more sustainable when you Lightweight it. In fact, that's exactly what's happened to bicycles over the last century.

They used to look like this. Now they look like this.

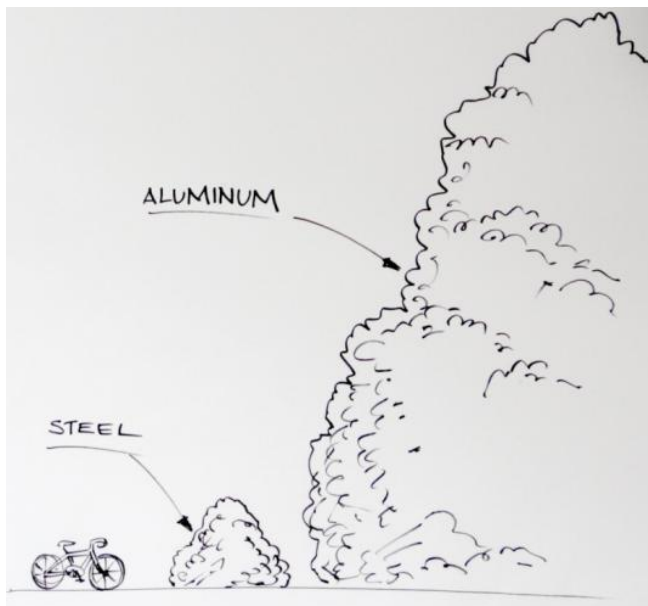


# Why to Lightweight

Innovations in design have helped to reduce the weight of bikes by 50% while also making them stronger. This is good business because it makes for happy riders. It's also great for sustainability, because it means using less material.



Every pound of material you save in your product saves much more upstream - and the amount varies. For example, you've got to dig up and dispose of about seven lbs of material to make one pound of virgin steel. And it's 85 to one for aluminum.



Or look at the energy it takes to make the material. Making one pound of virgin aluminum uses about 130 megajoules of energy. That's like seven-thousand five-hundred people pedaling bicycles for an hour!

So it's easy to see why sustainability performance goes up when materials use goes down.

# Lightweighting Strategies

Designers have radically lessened their demand for materials by optimizing a bike's geometry and structure.

We'll look at a bunch of great strategies for creating lighter geometry, like hollowing parts and decreasing wall thickness, using reinforcements like ribs and posts, and using trusses.

We'll learn how to maintain integrity in these lighter weight designs by avoiding stress concentrations, following lines of force, or using tensegrity.



## When to Lightweight:

But before we really dive into how to lightweight, let's look at when it's the right strategy. It's the right strategy if materials or waste are a big part of your product's ecological or social impact.

If you're designing something that moves and is powered by a motor or other energy source.

If your function is well defined, your form is at least roughly known, and you fully understand the forces at work.

If you don't, lightweighting could compromise your product's robustness.

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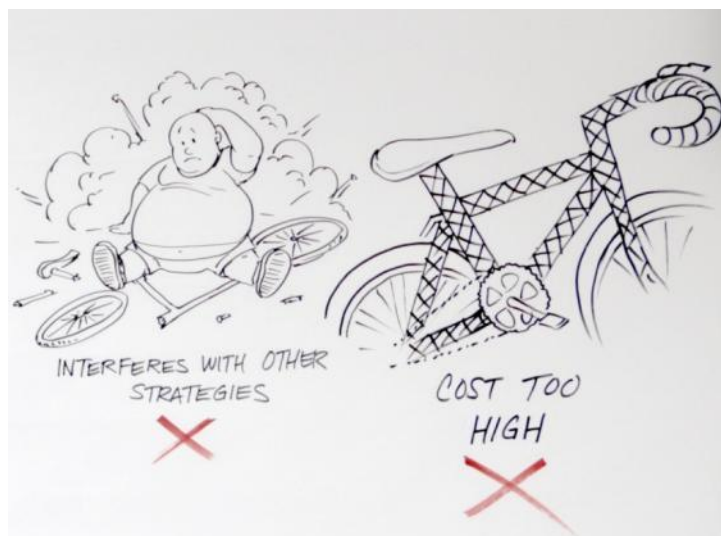


There are other times when lightweighting can be a liability, like:

If it interferes with other strategies you consider important like design for durability, repair, or long life.

Or if the design or manufacturing costs are too high compared to other sustainability strategies like using recycled materials.

Or, finally, if the manufacturing processes end up causing more impacts in energy or toxins than they save in material.



How would you know?

Lifecycle thinking and Whole Systems Thinking can help you start identifying when it's important to lightweight.

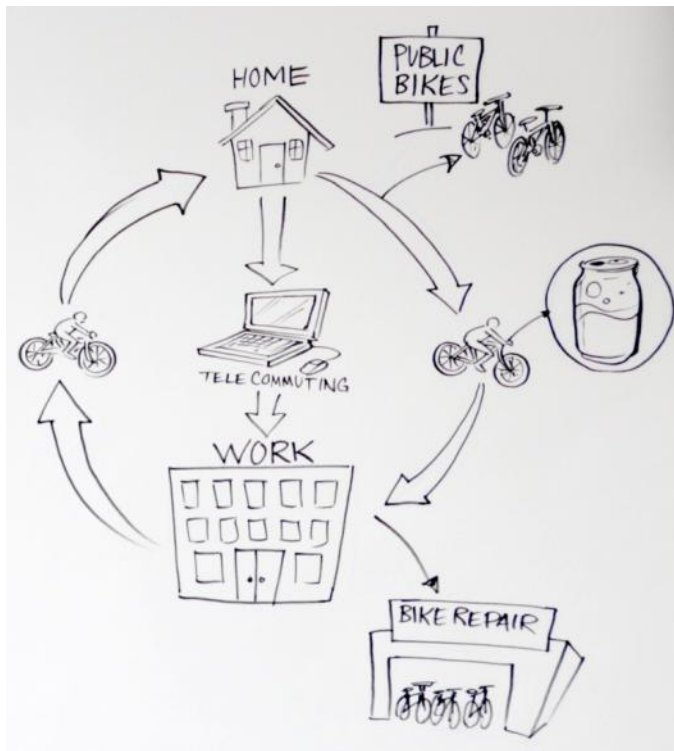
And digital prototyping tools like Autodesk Inventor and Algor can evaluate your design options and validate the robustness of your designs as you work to make them lighter.

## Other Material Reducing Strategies

If you find you can't lightweight or want to go further than just lightweighting, there are other material-reducing strategies out there, too.

I'm talking about:

sharing the product among many people,  
making the lifetime of the product much longer,  
using re-used components or recycled materials,  
and replacing physical objects with digital information.



So, you see lightweighting is not the only option and it's not always the best one. But when it is right, the improvements in performance and sustainability can boggle the imagination. So let's jump in and see how it's done.

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