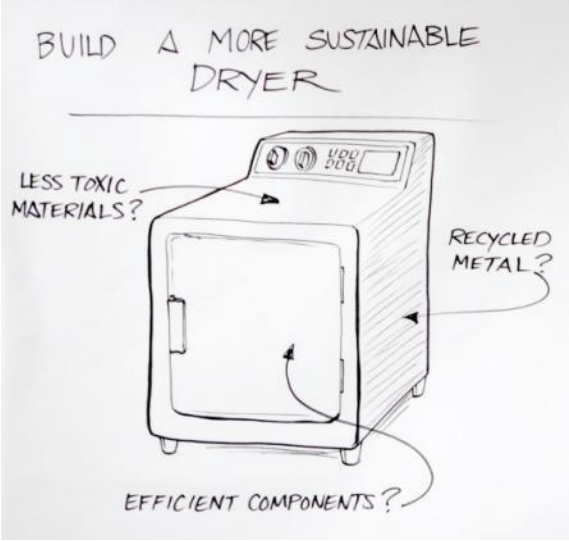
Introduction to Whole Systems Design

Companion to the video: Script and Illustrations

We're going to start by looking at the two most important global principles of sustainable design: Whole Systems and Life-Cycle Thinking.

Here's the challenge: Assume you're designing uh… let's say a clothes dryer, and you want to make one that's more sustainable without driving costs way up or performance way down, how would you do it?



Well, you could let your imagination just run wild and jump in anywhere.

But how would you know when you have a good answer, before you even know what problem you're really trying to solve?

Which approaches should you go with? And how will you make the tough decisions when two strategies conflict?

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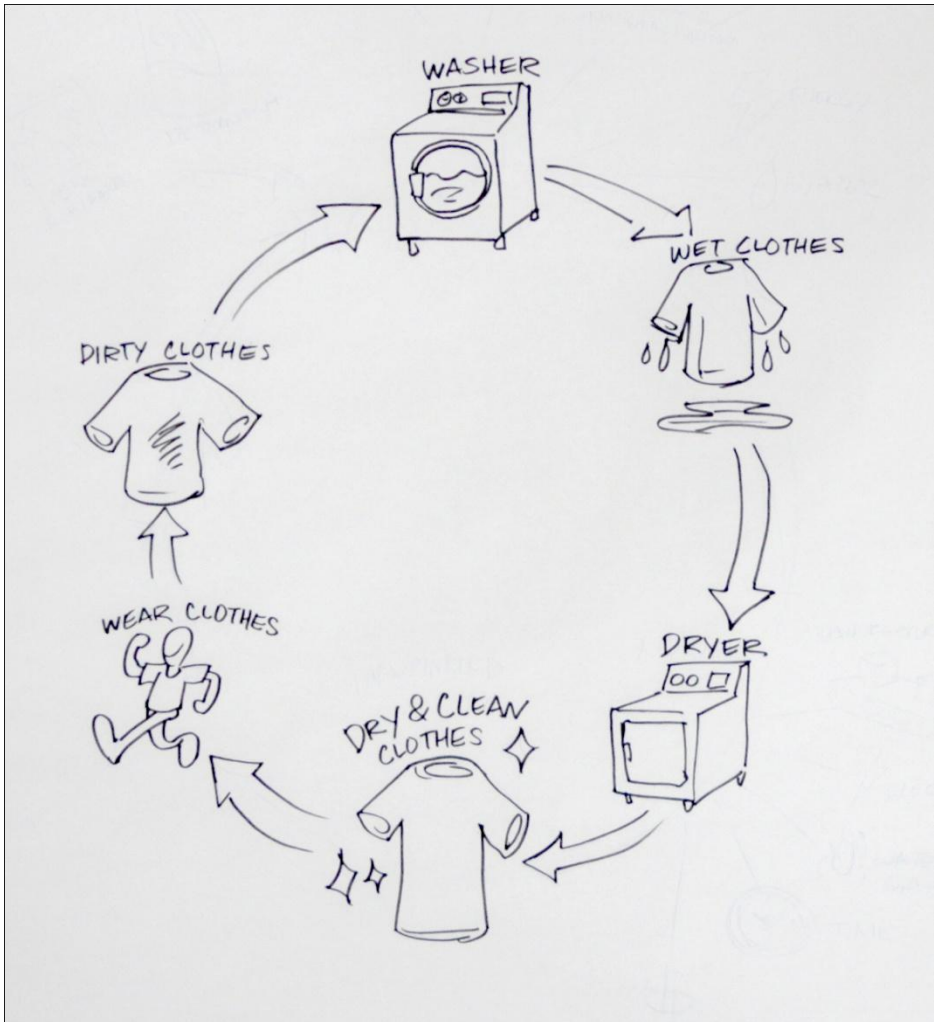
STEP 1: Define the problem by looking at the Whole System

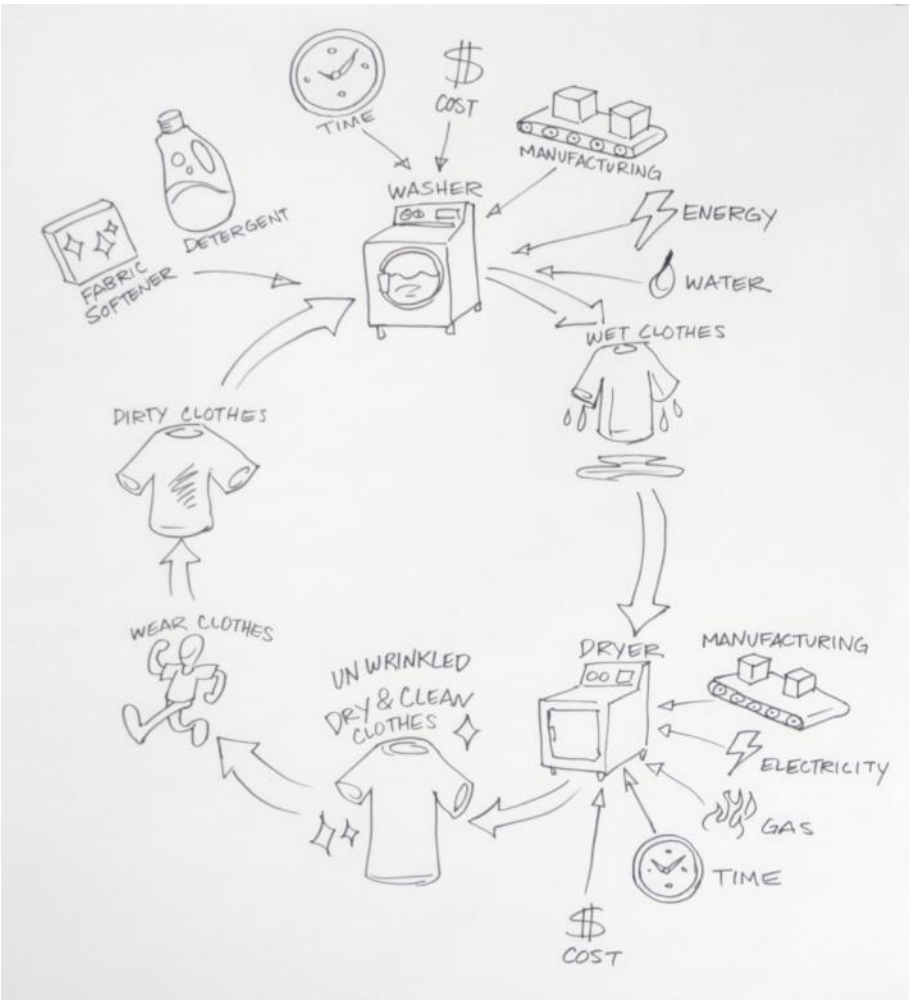
Before you start jumping to conclusions and fixating on any final design solutions, the first step is to more deeply define the problem by looking at the whole system.

So let's expand our thinking from the dryer to the larger process of clothes getting dirty, being washed, and being dried.

It looks something like this.



Now look at the system even more broadly. A marketing person might be able to tell you about how customers actually use their dryers. A manufacturing expert might point out obvious production limitations you'll need to work around. Getting other perspectives early on is always helpful. These kinds of insights help you understand and bound the problem.



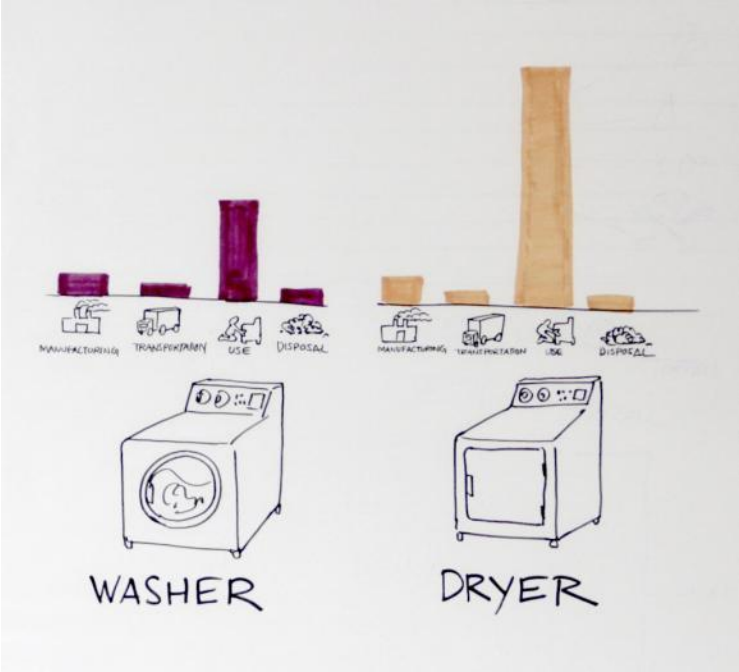
STEP 2: Prioritize objectives by assessing life-cycle impacts.

Now that you see the system, it's time to zero in on how you want to improve it by identifying the biggest impacts and minimizing them.

To optimize for environmental performance, you need to consider impacts through the entire lifecycle of your product or service.

We'll keep our example simple by looking only at the hardware in the system. The washer and dryer impact the environment through their manufacturing, distribution, use, and disposal.

At each one of these stages there may be greenhouse gas emissions, water pollution, air pollution, toxins, or other environmental impacts.

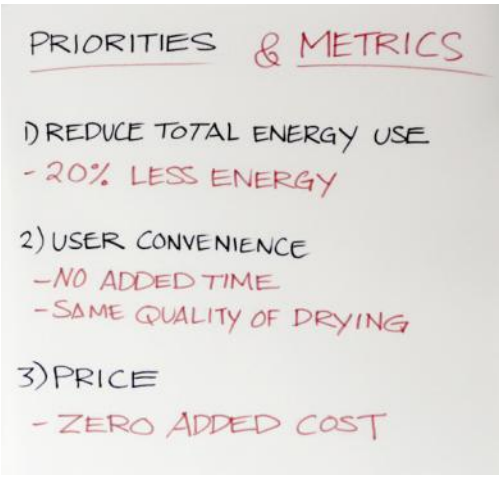


Your analysis should measure these impacts to the best of your ability. The most thorough way to do this is called Lifecycle Assessment.

You may want to compare your results against some benchmark. What's the minimum possible amount of energy or material use for what you're trying to make?

In our case, you'll find that reducing the energy use during the life of the dryer offers the most opportunity for improvement - more than raw material use, waste, or any other factors.

The important thing at this stage is to realize where the environmental impacts are coming from - and quantify them in some way so that you know your priorities and can set metrics around them. That way, you can make the case for your environmental goals and fit them in with other project requirements.



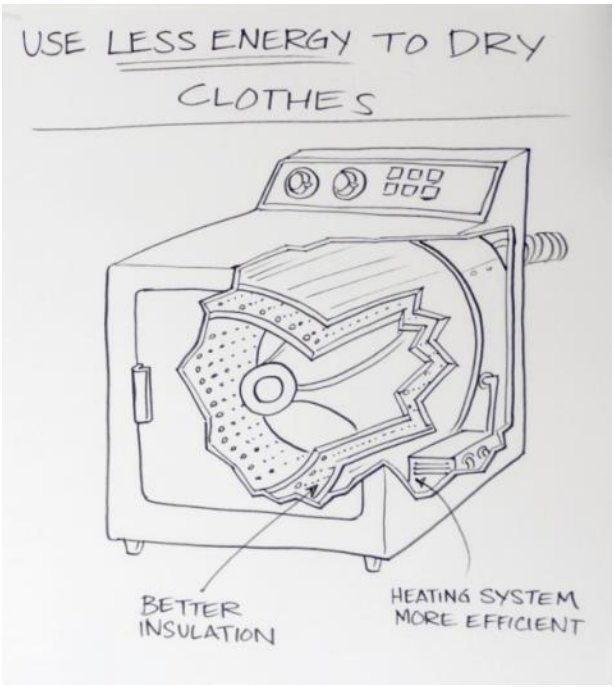
Ok. Using systems and lifecycle thinking, we've narrowed down our challenge from "Build a More Sustainable Clothes Dryer" to "Use less energy to dry clothes."

Now that we've defined the problem, how do we solve it?

STEP 3: Brainstorm solutions by looking at the whole system

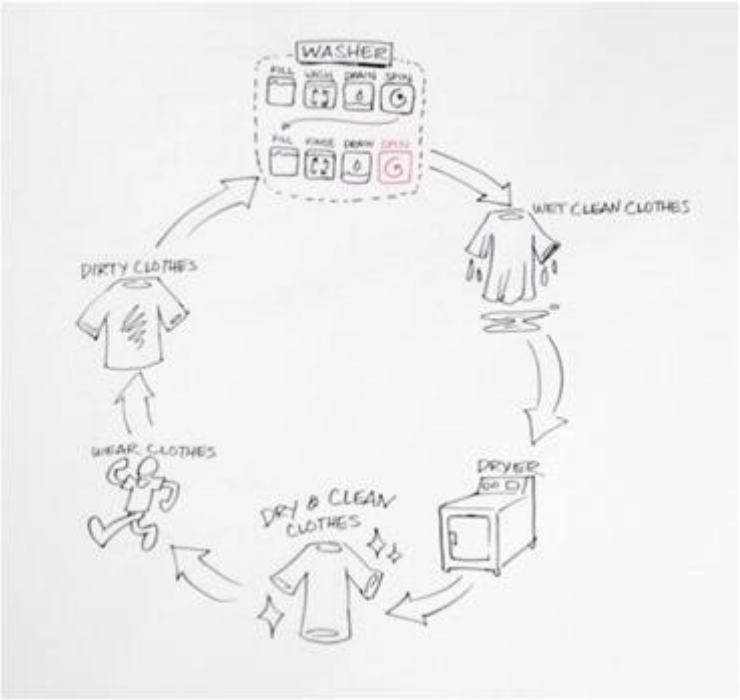
You might jump ahead to the obvious solution of making the dryer's heating system more efficient.

But you're likely to find that heating systems are already quite efficient. And the incremental gains you can make by re-engineering them dry up pretty quickly.



Instead of making small improvements to one part of the clothes drying process, let's look for solutions by looking again at the whole system.

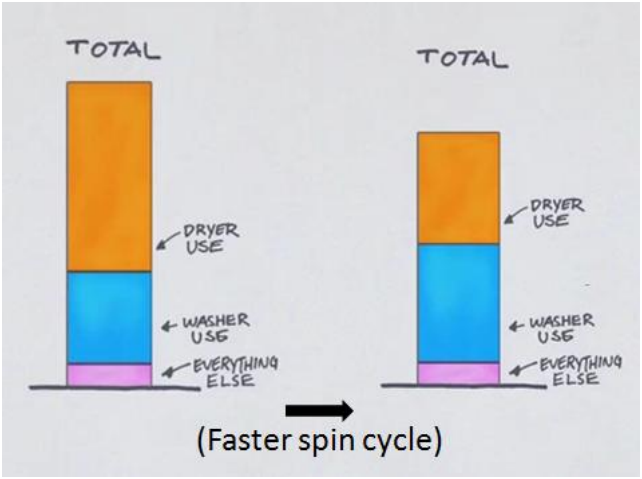
Notice that the washing machine supplies the wet clothes to the dryer. The wetter the clothes are, the more energy they take to dry - right?

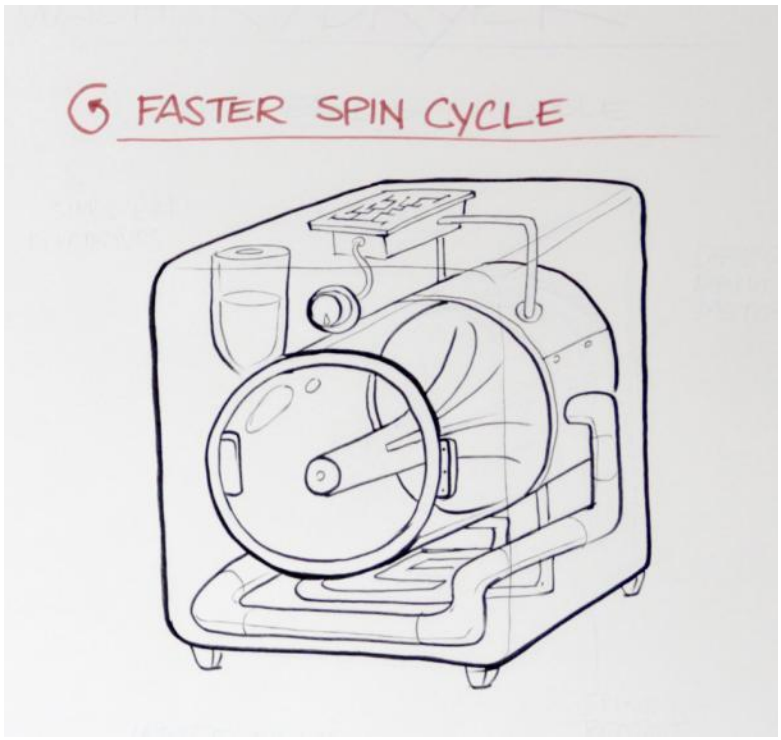


Now we can ask new questions like, might we save energy by delivering the clothes to the dryer in a less-wet condition?

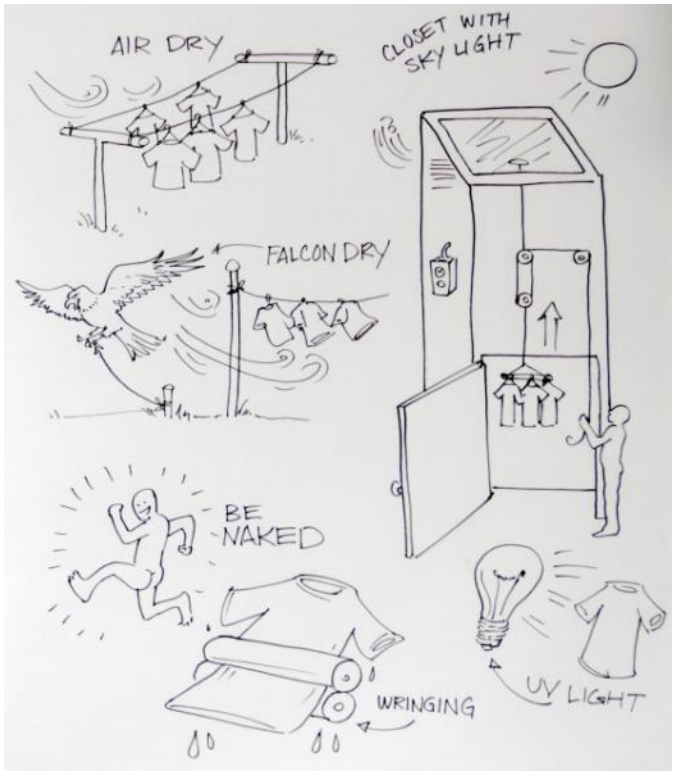
Well, a washing machine already shares in the drying process by spinning the clothes to a damp state with centrifugal force.

And here's a chance to innovate. A washing machine with a more effective spin cycle might use slightly more energy, but lets the dryer save a ton. It turns out one solution for a more sustainable dryer is a slightly more energy intensive washing machine!



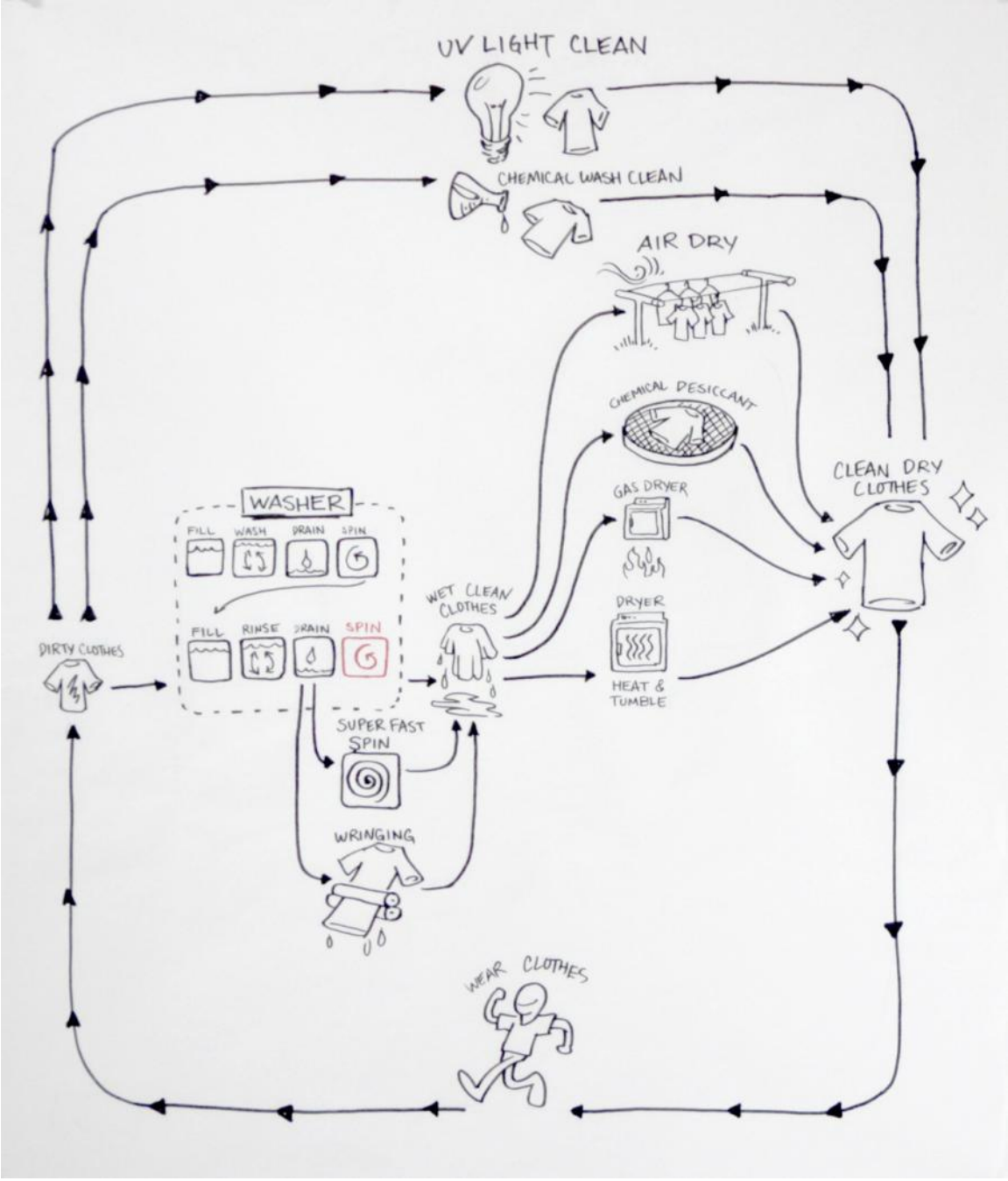


This is just one strategy. By brainstorming, you might come up with a whole slew of other ones. Approaching the problem with a blank slate can help lead you to more drastic innovations like eliminating the dryer altogether from the system in favor of a next-generation clothesline. Or creating fabrics that need to be cleaned less often. Your broad thinking at the beginning makes seeing these solutions possible.

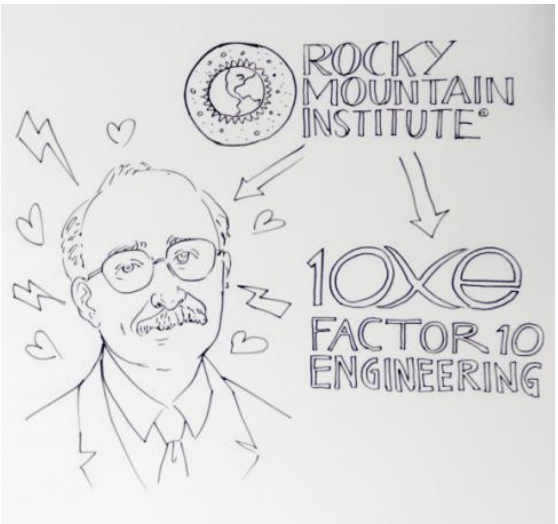


As you start thinking of potential solutions in the context of the whole system, you'll begin to see relationships between them. And one idea is likely to lead to the next.

This is the kind of thinking that's leading to the biggest gains in sustainability everywhere.



For tips to guide your brainstorming and help with this design process, look to folks like Amory Lovins and Rocky Mountain Institute for inspiration. They have developed a whole set of useful approaches for radical resource efficiency, called the Factor 10 Engineering principles.



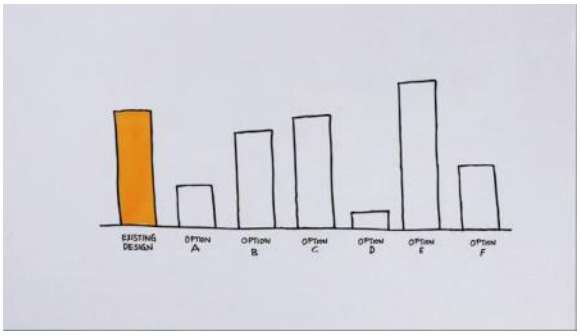
Once you've got a lot of solutions, how do you choose between them?

STEP 4: Use metrics to evaluate & choose solutions

Well, you should go back to the goals you set when thinking about the lifecycle impacts of the design - and assess each option.

Some of these options will obviously be better than others, so you can throw a bunch away quickly. But what about the best few choices that are left?

When you compare all your possible strategies against the same criteria of cost, performance, environmental and social impact you can make an intelligent decision about what the best solutions are.



Once you've chosen a solution to develop, you'll begin solving all kinds of technical engineering problems. Autodesk's tools like Inventor and Algor can help you do simulations and analysis to optimize your design throughout the process.

For example, spinning the washer faster may require a different material or may create the need for vibration suppression, which brings up new costs and impacts.

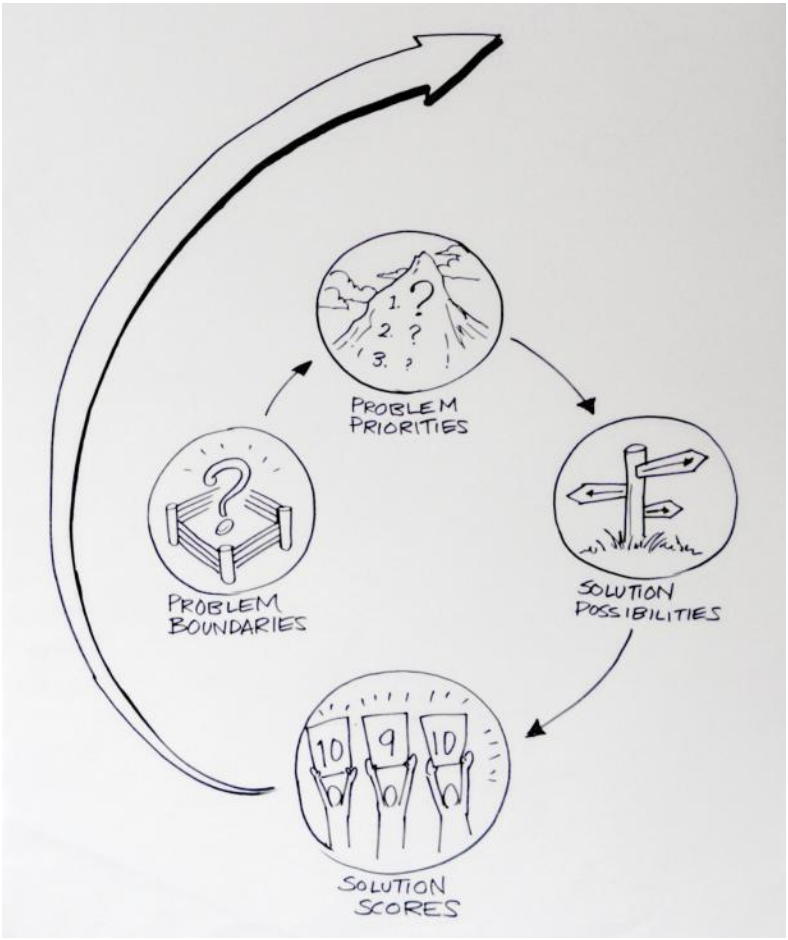
STEP 5: Repeat

This time, we focused on energy use, because that was by far the biggest impact of the dryer. But you may want to repeat this again, and focus on the next highest design priority, which in your case might be raw materials or durability.

We covered that pretty fast - and no design process is ever this linear. But every time you run through this process, you're going to innovate.

It opens your eyes to the bigger picture and helps you attack the most important problem, then it breaks you out of your normal boxes to find super-creative new ideas, and helps make sure you pick the best ones to improve the sustainability of your product.

This is how you get the most far-reaching innovation, helping you design products that are better for their users AND for the world.



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