HOW TO INNOVATE ON-DEMAND

A practical guide for making innovative choices on every engineering project

AUTODESK.

INTRODUCTION

THE MANDATE TO INNOVATE

Our society is obsessed with innovation. From business to government to academia to media, innovation is a hot topic and a top priority in every sector. The number of books, articles, speeches, and YouTube videos on the subject is absolutely overwhelming.

But for all of the attention paid to innovation, very few of us can answer two very basic questions about it: What is innovation? And how do you do it?

Engineers are familiar with this situation. Company leaders cite innovation as the solution to every challenge. How will we grow? Innovation. How will we compete? Innovation. It seems that If you want to be valuable to your company, you must think up a breakthrough idea that changes everything.

These are admirable impulses. Innovations is essential to success. But if you belong to a typical engineering team, a request for innovation may seem confusing. You are given no tools or methods. The information you've received about innovation isn't helpful, actionable, or even vaguely applicable to the products and processes that make up the bulk of your workload.

This eBook aims to change that. Inside, we will answer those two basic questions above and offer a structured, repeatable process you can follow to make innovation part of your daily experience. In fact, one of the most important insights about this topic is that not every innovation is a paradigm-shifting breakthrough. As we will see, most innovations in engineering are everyday decisions that help make your product lighter, faster, easier to manufacture, or more profitable.

> "Everything that can be invented has been invented"
>
> *Charles H. Duell, Commissioner, U.S. Office of Patents, 1899*

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WHAT IS INNOVATION?

Understanding what innovation is and how it happens is the first step to pursuing it in a reliable, methodical way.

DEFINING THE TERMS

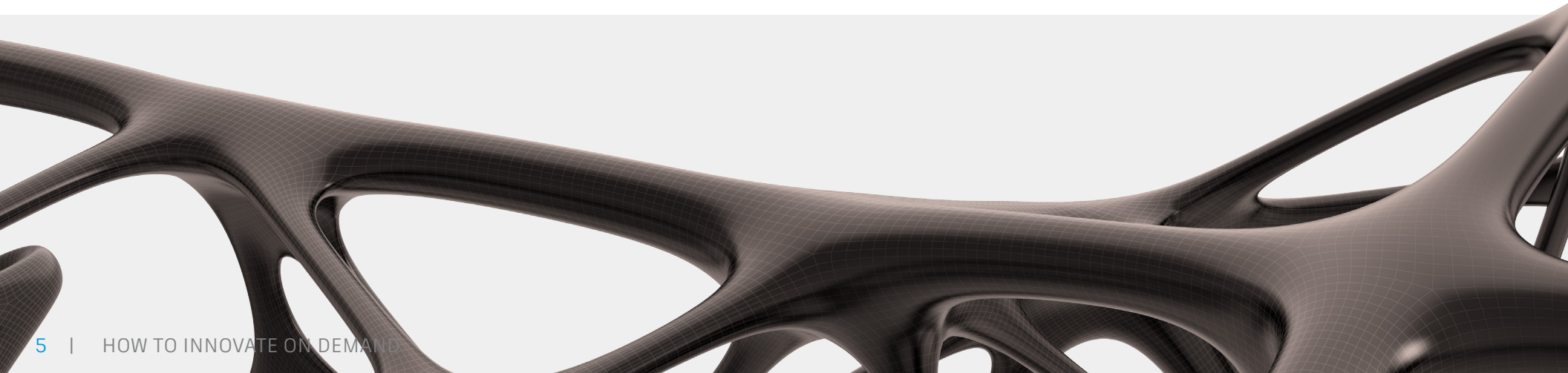
First things first: everything in this eBook is the result of extensive research performed by Autodesk and a large group of our global partners. The goal of this work was to study the most influential innovations in human history, from fire to Facebook, to discover what they have in common. Here is the definition of innovation the research team landed on:

> Innovation is the art of establishing something different or new out in the real world that has a significant impact.

Let's unpack a few nuances within this definition.

1. "DIFFERENT OR NEW"

Most innovations are not wholly new concepts. The vast majority are a different take on an existing idea. The iPhone, for example, was not the first smartphone. This is highly relevant to engineering. If you are tasked with improving a product design, you can still be innovative through incremental changes. If you are focused on a process, coming up with a totally new process is not always the best solution. It may be wiser to make the existing process run more efficiently or produce better outcomes. It's important to get past the assumption that every innovator is Steve Jobs and every innovation shakes the world.



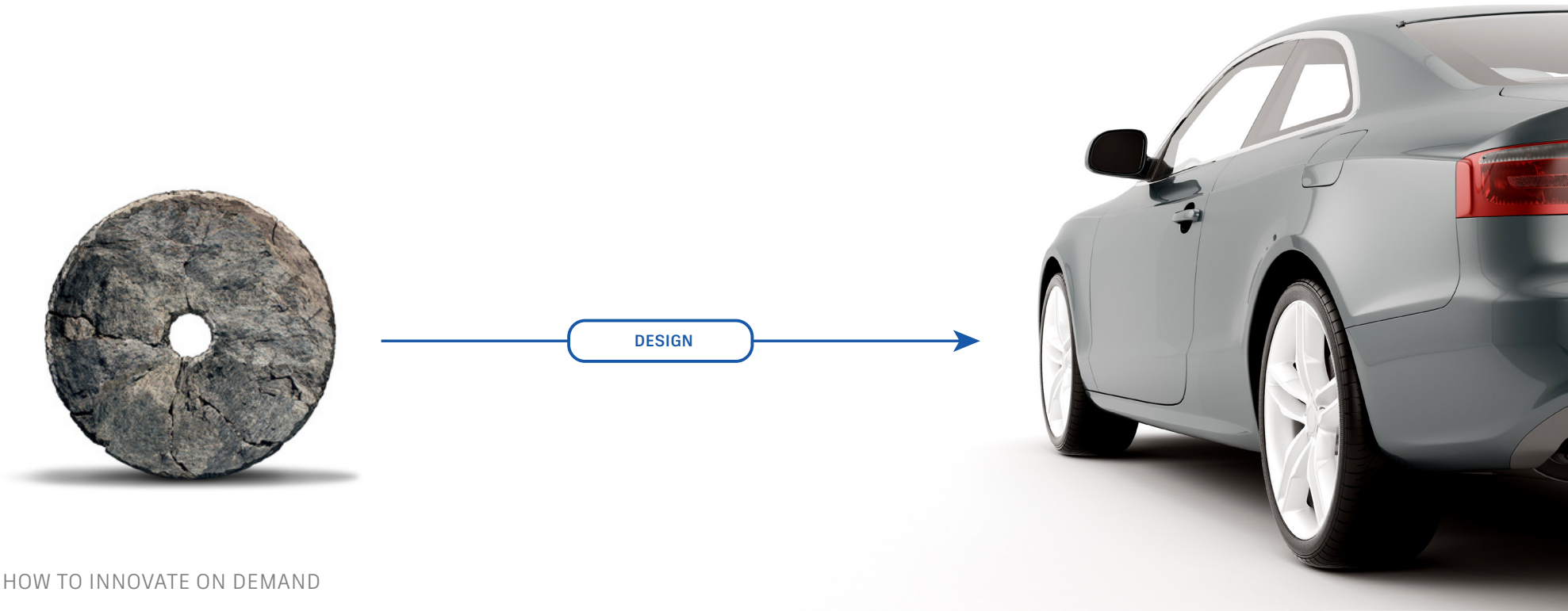
WHAT IS INNOVATION?

2. “OUT IN THE REAL WORLD”

Whether your idea survives and thrives in the real world is the difference between an *invention* and an *innovation*. An innovation is shared with others and put to practical use. It is important for engineers to know that good *design* is the bridge between an invention, which may be interesting but not useful, and an innovation which is interesting but also really useful. A good idea expressed through poor design usually means the project doesn’t launch, so the idea never has a chance to be truly innovative.

3. “SIGNIFICANT IMPACT”

When your idea meets the real world, it needs to produce results. Of course, “significant” is a relative term. For engineers, a significant impact might be a part that is just as strong but uses less material. Or a change to production settings that reduces cycle time. Or an improved surface finish that makes the part more valuable to customers. Any of these results are significant. An innovation produces a noticeable outcome.



THE INNOVATION CONTINUUM

Another assumption we make about innovation is that it "just happens." A genius has a moment of inspiration and the rest is history. Again, this narrative is not very helpful to the rest of us. (Step 1: Be a genius. Step 2: Get inspired.)

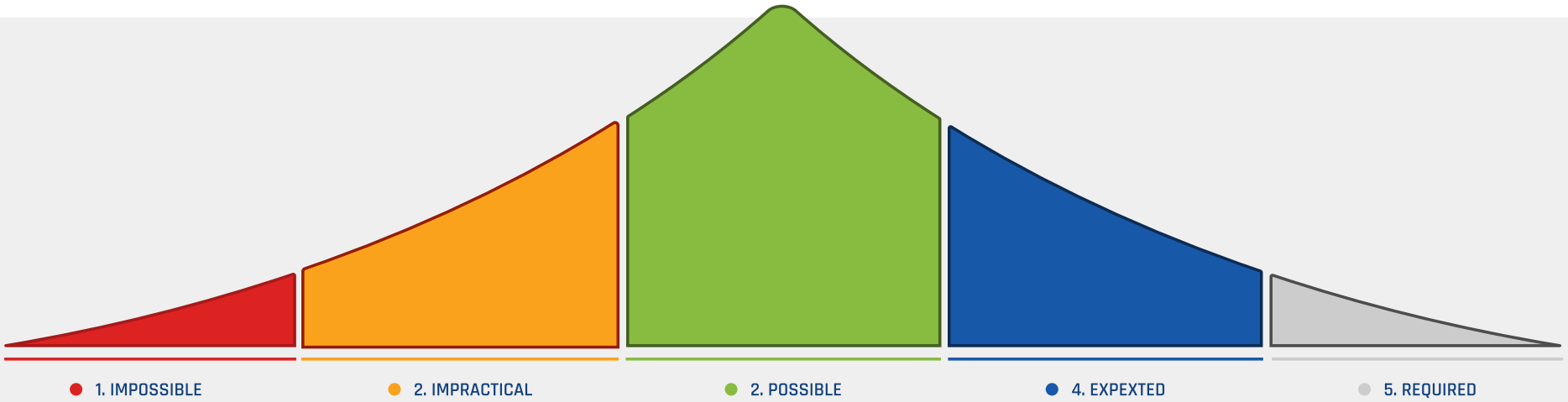
What the research shows is much different. All innovations tend to come to life in a similar way, moving through the phases shown in Figure 3. This continuum represents the amount of value the innovation has at each stage of its lifecycle.

Several hundred years ago, for example, human flight was *impossible*. Nobody was thinking about how to do it, and the idea was not very valuable. Then it became merely *impractical* in the early 20th century when the Wright brothers flew at Kitty Hawk.

At this stage, more people start investing in the idea. They make incremental changes. Collectively, these improvements make the impractical *possible*. Possibility makes the idea much more valuable and an industry begins to coalesce around it, helping it develop.

Consider the history of the internet. When it became widely plausible (no longer impossible) in the 1990s, money and talent started pouring in. Very quickly, websites became *expected*. If you were a company without a website in the early 2000s, your customers might raise an eyebrow. Today, a website is *required*. If you don't have one, your company may as well not exist.

The value of the innovation drops quite a bit in the last two phases. Which is why you must keep coming up with new ideas. Now let's talk about how to do that.



WHAT IS INNOVATION?

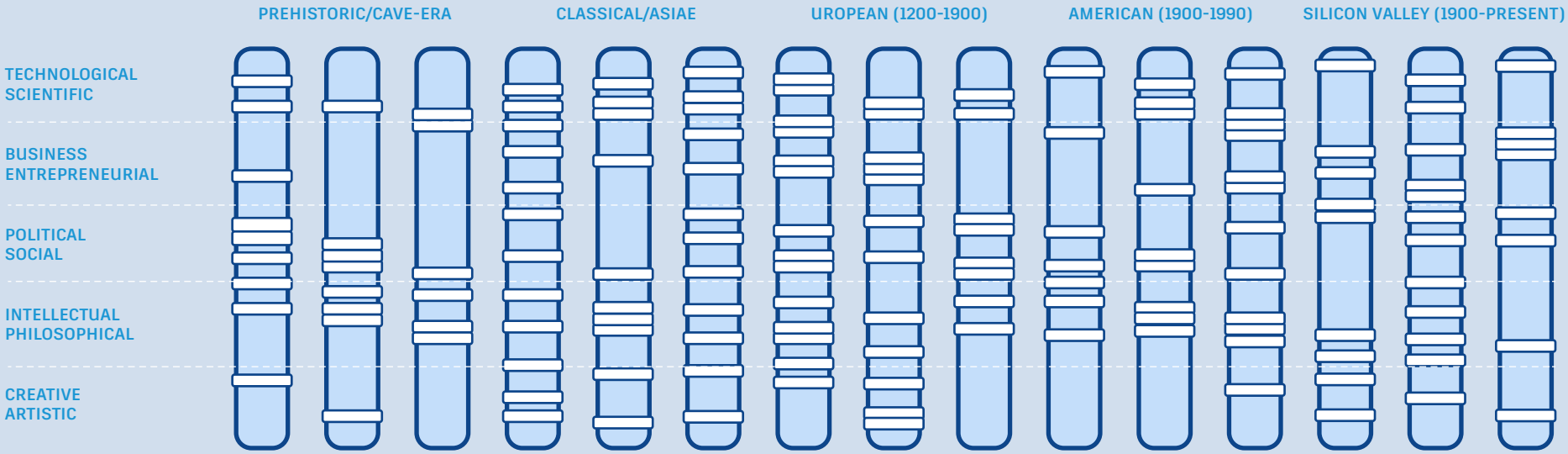
THE INNOVATION GENOME PROJECT

Autodesk has an inherent interest in how engineers innovate. That's why Autodesk CTO Jeff Kowalski established a research project led by Bill O'Connor, Innovation Strategist for Autodesk, to methodically study the phenomenon known as innovation from a more practical angle.

Modeled on the Human Genome Project, the massive research effort that mapped all the genes in human DNA, the Innovation Genome Project brought together dozens of partners in business, technology, and academia to gain insights from 2.6 million years of human innovation, from the stone hand-ax to the Apple iPhone.

The team first identified the top 1,000 most influential innovations, capturing examples from business, technology, politics, philosophy, and the arts. Then the team analyzed each one to understand the foundational principles of its development. How did it happen? What changed? What steps did the innovator follow?

The goal of the Innovation Genome Project was to create transferable insights. Ideally, the group wanted to identify principles that anyone can apply to develop more interesting ideas, challenge assumptions, and make more innovative choices in their chosen field.



CHOOSE THE TARGET

Focusing on a specific goal provides direction and momentum for innovation.

CHOOSE THE TARGET

INNOVATION IS NOT RANDOM

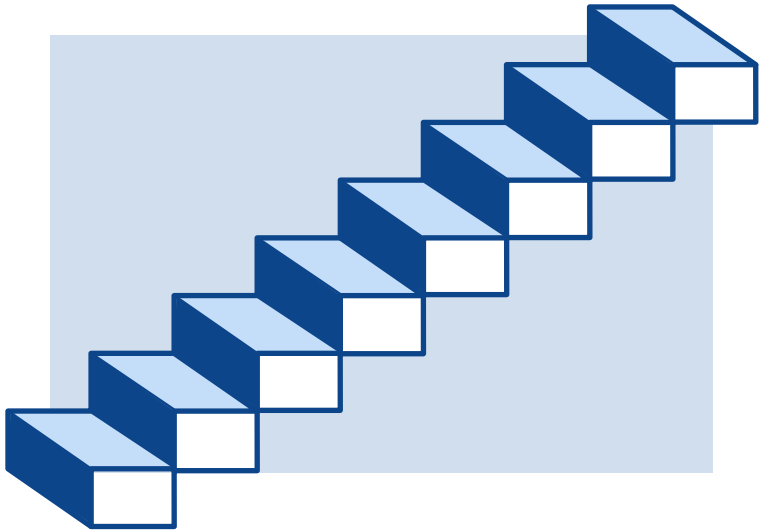
Before we get to the actual step-by-step process, we need to take a brief detour to dispel another myth about innovation – that it is accidental or haphazard. Henry Ford, for example, didn't just come up with the assembly line out of the blue. He was both obsessed with efficiency and inspired by materials handling techniques he witnessed in the meatpacking industry. The pump was primed, so to speak.

To ignite innovation in your own work, identify a target on which to focus your energy. That target should be an issue that naturally gets your brain moving. The momentum may be positive, such as an idea you find exciting or compelling. It may also be negative, such as a problem that is threatening your company or complicating your project work.

As an engineer, you can come up with a good target by asking questions like these:

- How might we use the Internet of Things (IoT) to improve our products?
- How might we incorporate generative design into 25% of projects next year?
- How might we exploit the materials revolution to gain a competitive advantage?

Choosing a target should reflect what is most meaningful to your work. Again, it does not have to be a game-changing, net-new development. Very often your target will be a relatively small, incremental improvement to a product or process.



ASK SEVEN QUESTIONS

Challenging your assumptions with a battery of investigative questions is more effective than aimless brainstorming.

ASK SEVEN QUESTIONS

START WITH THE ESSENTIALS

Studying the origins of highly influential innovations has been extremely enlightening. In our research, we analyzed hundreds of scenarios to learn how innovators conceived of their pioneering ideas. We wanted to know what questions they began with, and hopefully translate them into some transferable insights about the nature of innovation.

Anyone can apply this strategy—changing one critical aspect of an experience—by simply asking "what can I change?" By working through hundreds of these examples, our research team developed a list of seven essential questions any engineer can ask to begin generating more innovative ideas. These questions are not ordered randomly; they escalate gradually from the easiest to the most difficult.

ASK SEVEN QUESTIONS

Louis Braille developed the well-known system of raised writing that enables blind people to read. At first glance, this innovation was not applicable to engineers today, but we probed further.

“How did he develop this system?”

He made written information accessible through touch instead of sight. This is fascinating, but still not practical or repeatable.

“How did he facilitate this change in accessibility?”

He *redesigned* written language from a two-dimensional to a three-dimensional experience.

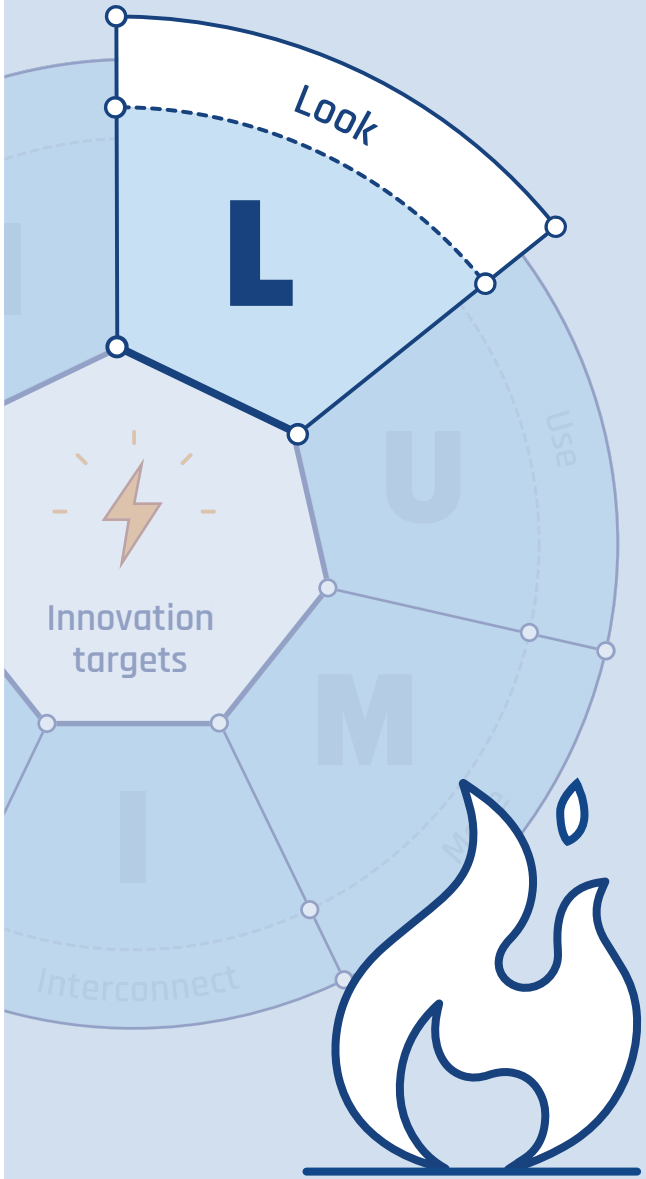
ASK SEVEN QUESTIONS

1. What could we LOOK at in a new way or from a new perspective?

One of the first innovations in human history was fire. Originally, fire was a threatening and terrifying natural phenomenon. Early humans avoided fire at all costs. At some point, however, they saw fire in a new way. They noticed that, if controlled, it could be used to provide light, cook food, keep people warm, and ward off predators. It could even be used as a weapon. Fire didn't change, but the perspective did.

To generate alternative perspectives on any material, process, or product, ask these questions:

- What can we view from a higher vantage point?
- What elements could we reverse or look at inversely?
- What value judgment (bad/good) could we switch?
- How would a child look at this?
- What assumptions could we toss out?
- How could we look at the issue in a more holistic way?



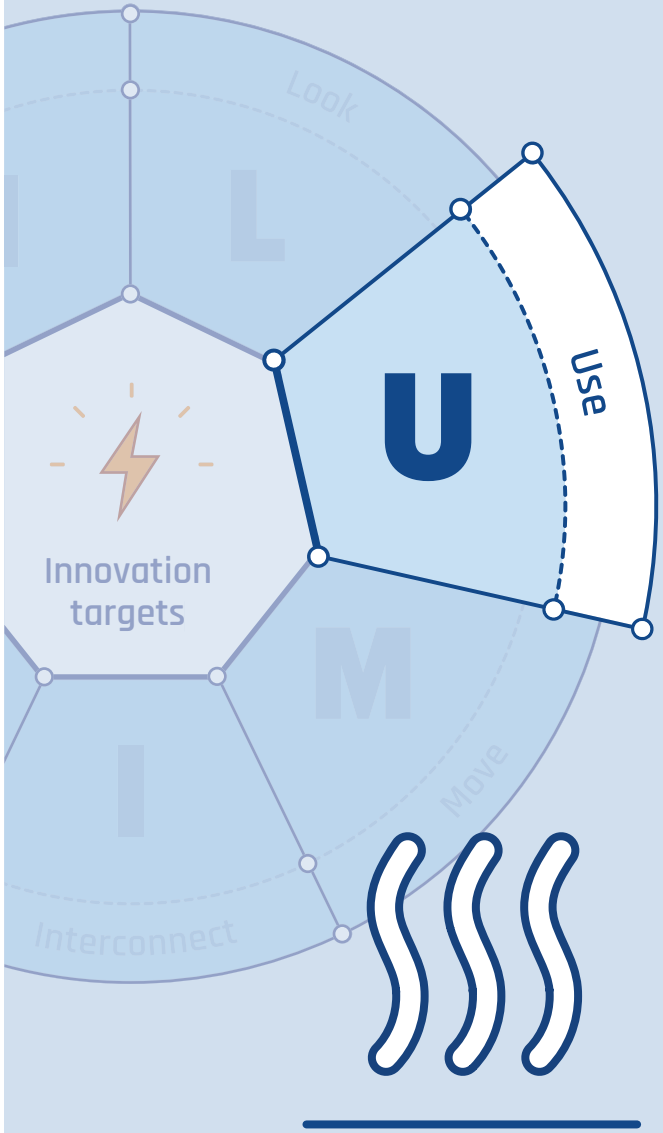
ASK SEVEN QUESTIONS

2. What could we USE in a new way or for the first time?

The steam engine is an excellent example of technology used in a novel way. Steam was familiar to humans for millennia. In fact, producing mechanical motion from boiling water was achieved more than 2,000 years ago. But it took until 1781 for steam to be used to produce continuous rotary motion in James Watt's patented steam engine.

To use a familiar material, concept, or technique in a new way, ask yourself:

- What could we leverage better, or for the first time?
- What could we use as a platform?
- What could we substitute for something else?
- What new aspect of something could we exploit?
- What could we apply in a new way or context?
- What could we change and then use differently?



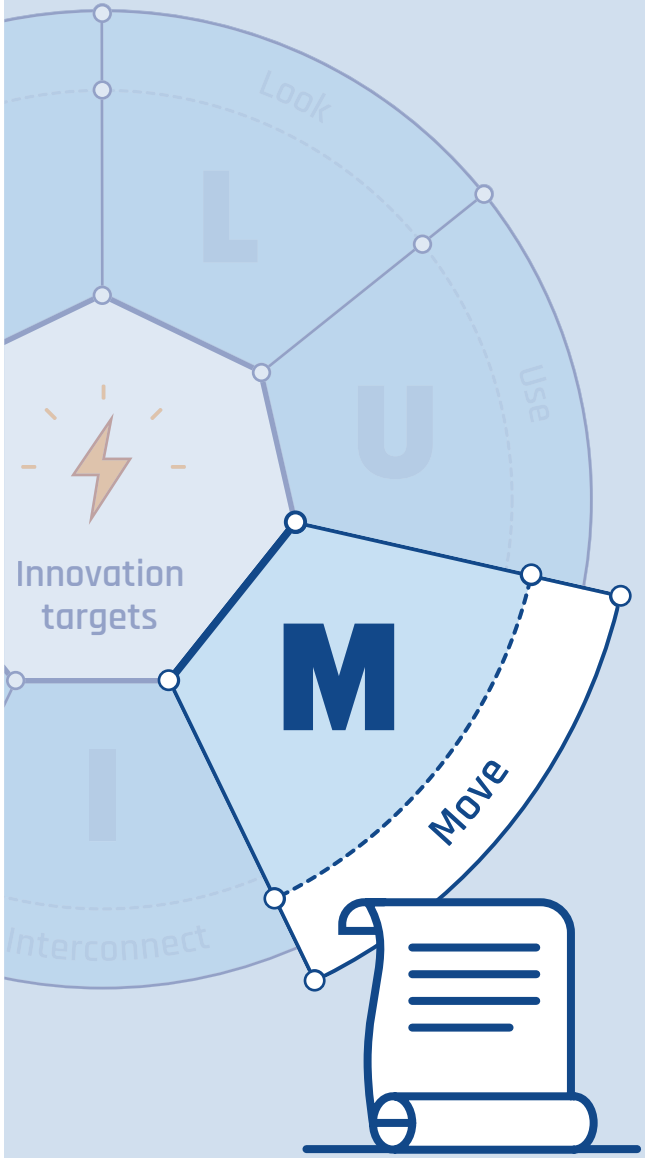
ASK SEVEN QUESTIONS

3. What could we MOVE, changing its position in time or space?

For thousands of years, human language was conveyed primarily through speaking. The earliest attempts to capture language in written form on surfaces such as stone tablets, were (you guessed it) rather impractical. Paper changed everything. Now we could capture knowledge in a transferable, transportable way, beyond the barriers of time and space.

In an engineering context, you can find elements or steps to move by asking:

- What could we import from another field or discipline?
- What could we rearrange or reconfigure?
- What could we replace with something else?
- What could we remove to streamline a process?
- What could we speed up or slow down?
- What could happen more or less frequently?



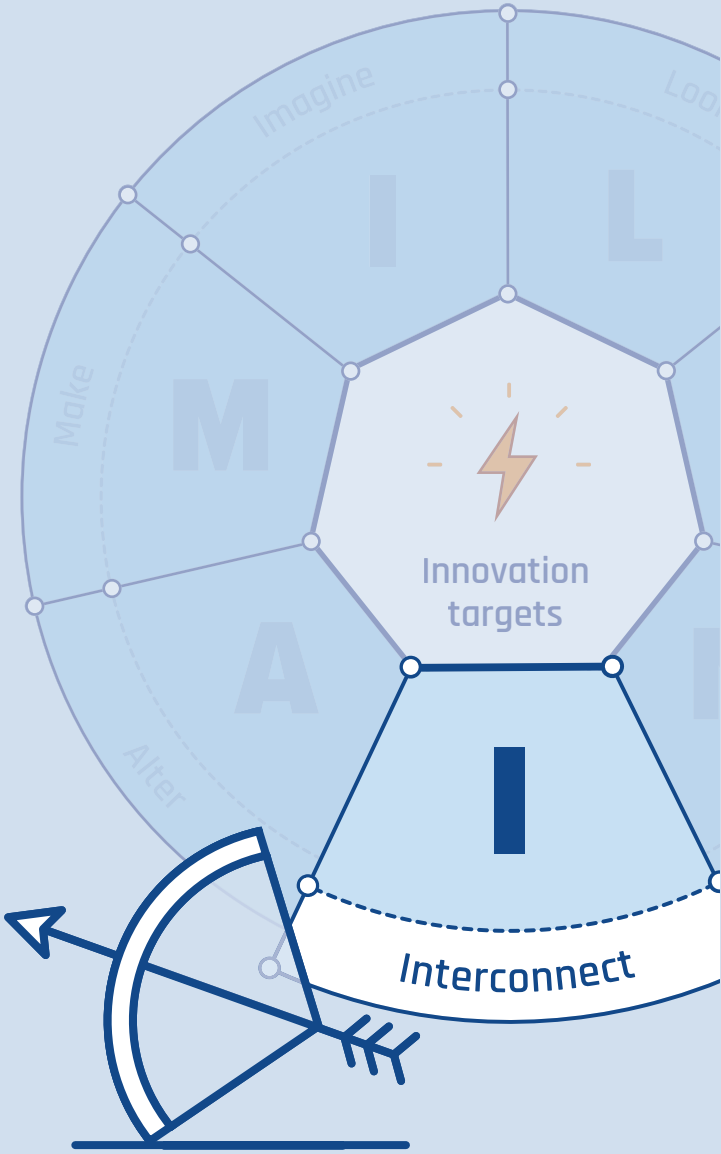
ASK SEVEN QUESTIONS

4. What could we INTERCONNECT in a new way or for the first time?

In 400,000 BCE, the spear was state-of-the-art weaponry. But it took another several hundred thousand years before humans connected the idea of the sharp stick with the idea of flexible launcher to come up with the bow and arrow. Interconnecting spears with projectiles resulted in a much more powerful weapon, but it took millennia to find this particular combination. Some connections are not immediately obvious, so it helps to use a framework.

To interconnect two seemingly unrelated ideas, components, or processes, ask:

- What could we use to power something else?
- What could we combine to make a new thing?
- What could we make more like a network?
- What could we make more transparent?
- What could we make more open?
- What new partnerships might we form?

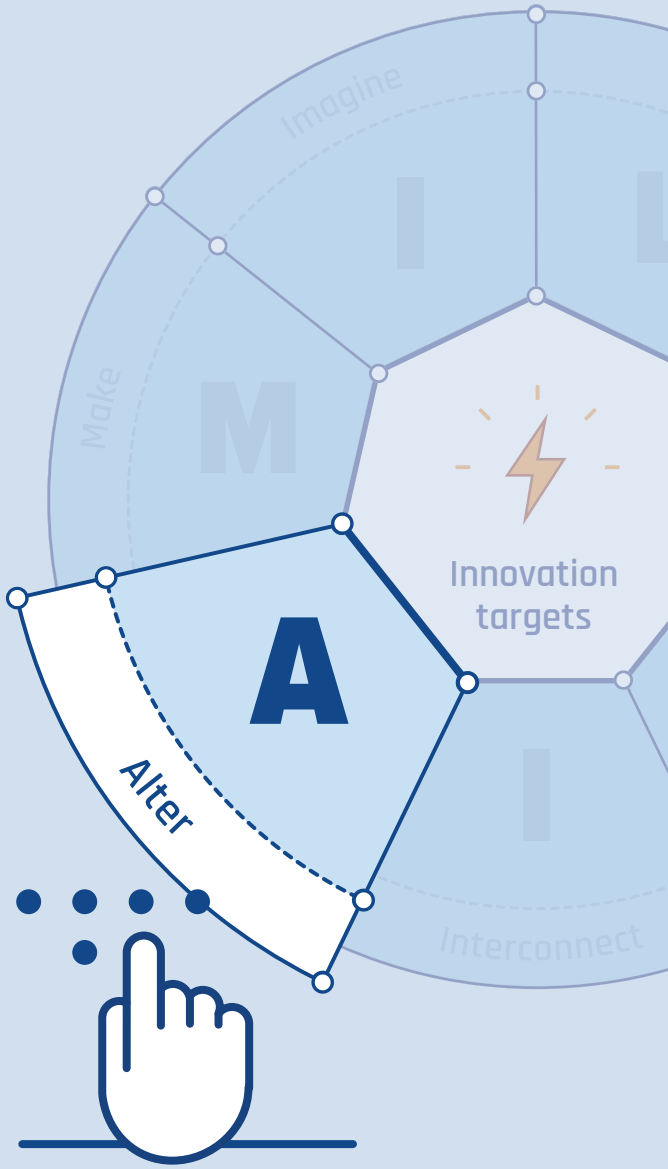


ASK SEVEN QUESTIONS

5. What could we ALTER or change, in terms of design or performance?

As we saw with the example of Braille, rethinking a mechanism or method can be extremely powerful. When musicians decided to improvise melodies instead of playing exactly what was written on the page, an entirely new art form, jazz, was born. Improvisation is a method. To reimage a process or product ask:

- How could we radically improve quality?
- How could we change or improve a design?
- How could we change or improve performance?
- How could we make this more beautiful?
- How could we improve the overall experience?
- What could we standardize?



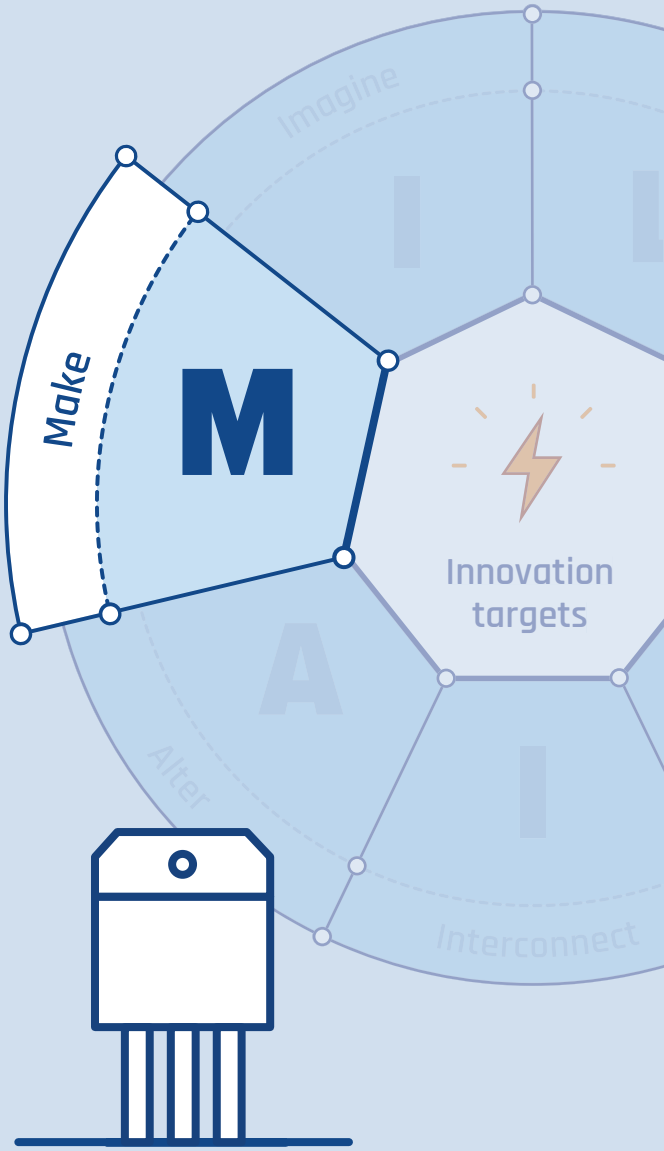
ASK SEVEN QUESTIONS

6. What could we MAKE, that is truly unique?

Creating a genuinely new object or mechanism is extremely powerful but also very rare. Ideas like the transistor, for example, represent the smallest percentage of all innovations. Some innovations are structures that support grand ideas. For example, you may need to make a video that explains your idea to the rest of the company. Or form an advisory board to get input from those outside your company. Or build a lab to solve a specific problem.

To generate ideas for new creations ask:

- What new processes could we create?
- Could we infuse something with new meaning?
- What could we harness to make something new?
- What could we instantiate as something new?
- What new functions could we create?
- What could we make more specialized?



ASK SEVEN QUESTIONS

7. What could we IMAGINE to produce a great experience?

This is the most difficult question to ask because it is the most open-ended. It is also the most likely to generate a truly transformational idea. Steve Jobs saw that computers were stuck in the corporate domain, dominated by huge machines that served business interests. He imagined a way to take that experience and bring it into our homes, effectively democratizing computing power.

Engineers can mine the imagination by asking:

- What could be better if amplified or increased?
- What could we make easier or more fun?
- What negatives could we eliminate?
- What crazy idea could we try that just might work?
- What can we glean from science fiction?
- What could we try just to see what happens?

The point of these seven questions is to provide more structure to your innovation efforts than a traditional, free-for-all brainstorming session. By focusing on your selected target and working through the LUMIAMI wheel of questions, engineers can expect to come up with a wider variety of interesting ideas and more useful results.

PICK YOUR PRIORITY

Not all ideas have the same potential. Rating them identifies the most promising opportunities.

PICK YOUR PRIORITY

CHOOSE A WILD (BUT VIABLE) PATH

After all the questions have been explored and you have developed a stock of ideas, the next step is to rate them based on how wild and worldly they are.

"Wild" ideas are the most unique. Is everyone thinking about how to do this or is it just your team? "Worldly" speaks to the idea's practicality, given your resources. Do you have the money, time, talent, and will to make it happen? Rating each idea on a scale of 1 to 10 for both factors places it within one of the four quadrants shown in Figure 7.

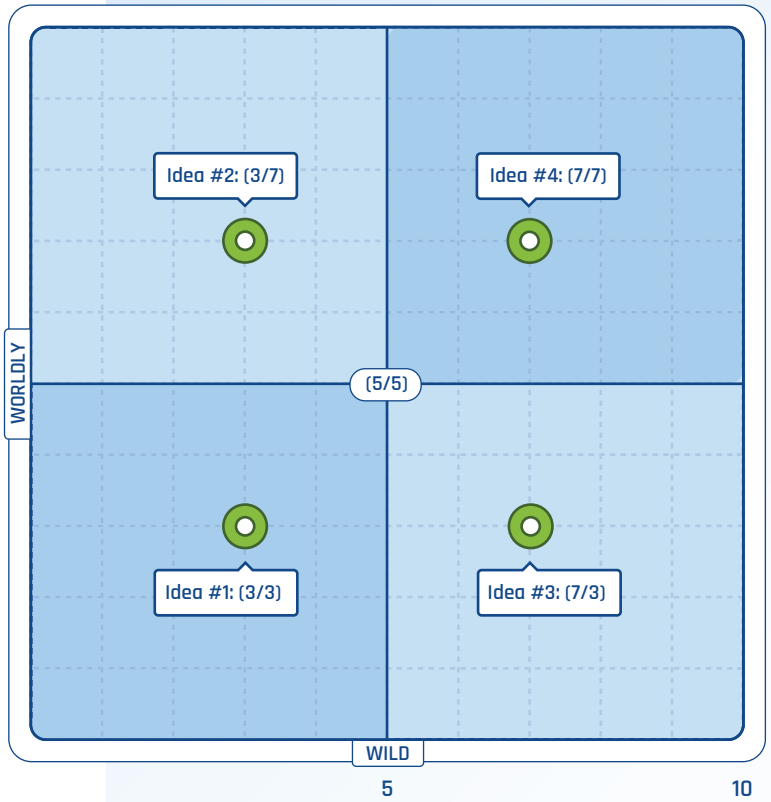
Here's what to do with the ideas in each quadrant.

Quadrant 1: Not very wild... and yet difficult to accomplish. These are ideas you can safely abandon.

Quadrant 2: Not very wild... but do-able. Don't throw these ideas out. Improve them. "Making the idea wilder" becomes a new target for the seven essential questions.

Quadrant 3: Very wild... but not very practical. Keep these ideas. Repeat the process to hopefully make them more viable given your current circumstances.

Quadrant 4: Really wild... and plausible. These ideas tend to draw attention to themselves. They are ready to become projects.



START THE PROJECT

To get your project ready for action, build internal support.

START THE PROJECT

FROM IDEA TO REALITY

You've found your wild and worldly idea. You're ready to begin the project. Before you do, there are four more steps of pre-work to complete.

Engineers are familiar with best practices for iterating, improving, finalizing, and launching ideas. The early steps, however, are just as essential but often neglected. All of them stem from the definition of innovation, particularly the nuance about making it "out in the real world." The real world (starting with your own company) may not be ready for your innovation yet, so you need to lay the proper groundwork.

These four steps are only necessary for your biggest and most audacious ideas. When it comes to most innovations – the daily design decisions that make your product incrementally better – be bold and move forward.

BRILLIANT DESCRIPTION

Your first task is to crystallize your idea into a short, understandable description. Craft one sentence that sums up your goal and makes your audience say "Oh, I get it." A clear description is an indicator of precise thinking. It also helps you gain support from key decision-makers and gatekeepers within your organization. When you pitch your idea, you want nodding heads, not confused expressions. A brilliant description gets you there.

THOUGHT EXPERIMENT

Think about the future of your idea in a positive way. How would it all come together, ideally? How would you bring it to life? What would have to happen first? Visualizing success will help you create a realistic plan and follow through on it.

THREAT ASSESSMENT

Think about the future of your idea in a negative way. Who in your company will reject it outright? Who might hate it at first but eventually come around? Visualizing disaster will help you build a stronger case for your idea.

BOSS APPROVAL

Get the green light for your project. Innovation work should be considered separately from other kinds of work. An internal champion can help you get the support you need to start the project and see it through to completion.

MEASURE THE RESULTS

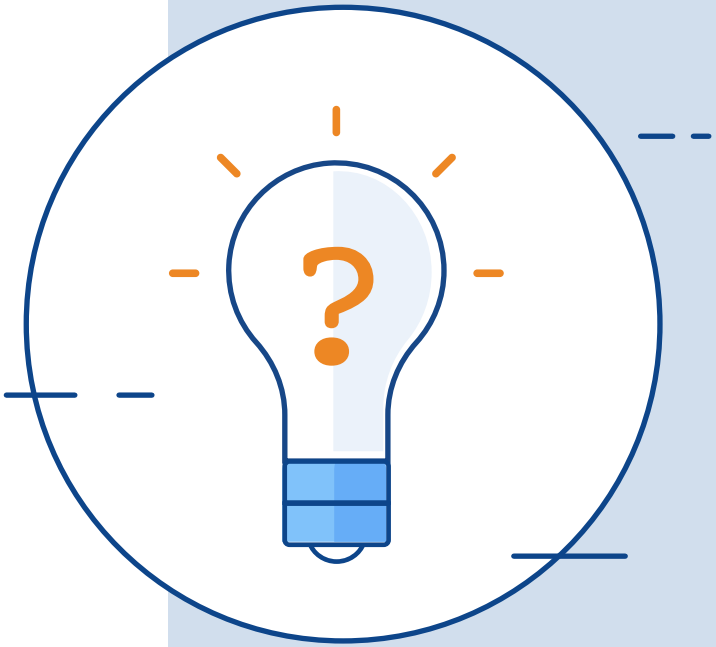
Evaluate your innovations and track them over time to see if you're on the right track.

MEASURE THE RESULTS

HOW INNOVATIVE ARE YOU, REALLY?

If there isn't very much useful information available about how to innovate, there is even less about how to evaluate how innovative your company really is. But as engineers, we know that measurement is a vital part of quality assessment. The final step in this process helps you rate your innovation and track it over time. Think of it as a "GPA" for innovation.

To generate your innovation score, answer each of the following 10 questions with a number from zero to 10. Then add them up to get a total between zero and 100. If you're in the single digits, you need to work on your innovation efforts. If you're scoring 8s, 9s, and 10s across the board, chances are your innovations are creating a significant impact. Calculating your innovation score can be done as often as needed, whether monthly, quarterly, or annually.



MEASURE THE RESULTS

HOW INNOVATIVE ARE YOU, REALLY?

CONSIDER THE PERVASIVENESS OF INNOVATION WITHIN YOUR ORGANIZATION.

1 10

1. Leadership: How seriously has our senior leadership embraced innovation?
2. People: How inspired are employees to really innovate?
3. Process: How effective are our innovation processes?

QUANTIFY THE ACTUAL INNOVATION EFFORTS.

4. Projects: How many innovation projects are we currently working on?
5. Launches: How many innovation attempts have we launched in the past year?
6. Breakthroughs: How many innovations have we produced in the past five years?

OBSERVE WHETHER YOUR IDEAS ARE GAINING TRACTION IN THE REAL WORLD.

7. Trends: How well are we leveraging emerging trends for innovation?
8. Partnerships: How effectively are we partnering for innovation?
9. World Events: How effectively are we using global events for innovation?

INVESTIGATE WHETHER EXTERNAL ACTORS AGREE WITH YOUR ASSESSMENT.

10. Buzz: Do our customers think we're innovative? What about our competitors?

CONCLUSION

CONCLUSION

A NEW WAY TO INNOVATE

Innovation is often what separates thriving companies from those that struggle to compete. But the methodology of innovation has received relatively little attention compared to the innovators themselves and the impact of their ideas. Unfortunately, this has created the impression among many engineers that innovation is not something that can be accomplished on a regular basis.

Like any other area of specialized expertise, innovation takes time, attention and practice. With the framework outlined in this eBook, engineers can follow a practical process for selecting a target, generating more useful and creative ideas, prioritizing these ideas effectively, moving them into projects, and evaluating their success over time.

Ultimately, this framework will help you make more innovative choices in every aspect of your work, whether you are moving into uncharted territory or trying to find the best way to achieve a specific outcome in the projects you work on every day.

Get Started

Spend more time innovating with purpose and extract more value from your efforts with the Modern Engineer's Toolkit from Autodesk.

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