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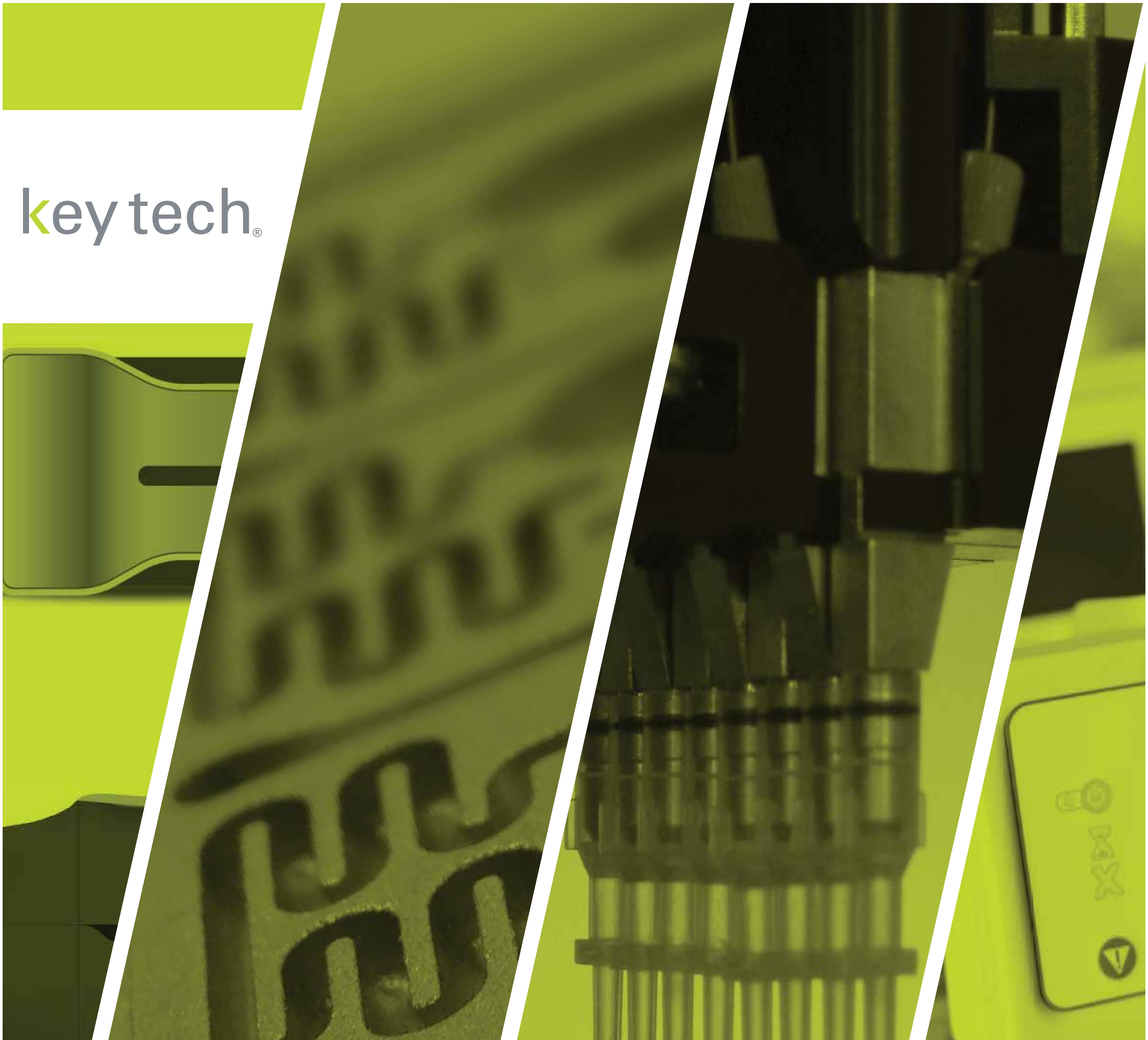

PROVING NEW TECHNOLOGY WORKS IN PRODUCTS:

THE 8-POINT ASSESSMENT CHECKLIST

We're often visited at Key Tech by an enthusiastic and clever inventor demonstrating a brand new technology, hopeful it could make it into a product. We've never seen a perfect technology; even the best has its limitations and flaws. And it's hard to see those imperfections when you're in the honeymoon period, having just convinced yourself and your backers that you've created an innovation really worth pursuing.

At this first meeting, the new technology is usually embodied in a contraption we like to call the "Frankenstein Prototype," an enormous accomplishment that is also unfinished and imperfect. Our first task is to tease out the flaws in these new technologies in order to understand what it will take to get rid of them. Our clients love to love their technology, but they have also grown to appreciate focusing the team on the real risks and charting a path forward – or not.

So we thought it would be helpful to offer a quick checklist and some examples to illustrate the types of flaws inventors can look for before planning development:

PERFORMANCE	Does it work?
PERFORMANCE AT THE LIMITS	Does it work outside the best case scenario?
SENSITIVITY	How sensitive is it to changing conditions?
REPEATABILITY	Does it work the same way every time?
RELIABILITY	Will it last?
SCALABILITY	Will it work in a product?
PRACTICALITY	Can it work with fewer features?
INTERFERING CLAPTRAP	Can it work with added features?

PERFORMANCE

Does it work in the most basic sense, or are you extrapolating and assuming it will work if you just make this or that change?

To answer that question, start by establishing a set of performance requirements that the technology is expected to meet. Then, if you detect a gap between performance and requirements, make sure that gap can be closed and understand what it takes to close it. If it's not probable that a gap can be closed, stop now and save yourself a lot of heartache.

By the way, are you certain you can even tell if your technology is working? What if you can't observe it working, or you can't be sure about what's happening in intervening steps between input and desired output? It often helps to develop test fixtures so you can see whether it's working or not, now and also during further development.

What "gold standard" instrument or system are you using as a performance benchmark for your new technology? Is it accurate enough to set the bar for your new technology's performance? More often these days, it isn't. For example, using an optical technique for cell counting as a standard for a new ultrasound technology, we found that the new technology performed better than the gold standard and it was difficult to demonstrate its superior results with the less accurate, though well-understood, optical technique.

If your product relies on your technology integrating well with another technology, how confident are you about the compatibility of the two? Are there interactions between the technologies that will reduce the performance of either one?

PERFORMANCE AT THE LIMITS

Your technology works great in your Frankenstein prototype in your own lab, but under what other circumstances will you need your technology to perform well?

Do you know whether those circumstances will be within the good performance limits for your technology? Think, for instance, of environmental annoyances like temperature, humidity, elevation, vibration, and orientation. Does it work well on a horizontal surface, but perhaps not in the many orientations necessary for a mobile application? Does it work well in an air-conditioned building but not in a similar unconditioned lab? Operating well in a warm environment might require a fan for active cooling in the electronics enclosure, which can add to cost, reduce reliability, and introduce new issues to overcome.

In order to perform in some circumstances near the limits of operation, will your technology require more features to be active simultaneously than in your prototype? In one project at Key Tech, the product required simultaneous functionality that had not been planned for, and this resulted in a power draw that forced a late change in the power supply, with accompanying delay and expense.

In some circumstances, will your sensors needed for control or protection while in use need to go beyond their proven range in your prototype? For instance, if you need to read light signals, you'd better learn whether it's realistic to be able to do so in bright places. In another example, too much of a good thing can oversaturate your sensors and they will become unresponsive. **In many of these cases you don't need to solve the issue in the prototype**, but having answers to these questions early will inform the design direction, give you a better idea of how much work it'll take to get your technology successfully into a product, and sometimes determine whether you'll even be able to do so.

SENSITIVITY

Is your technology too sensitive to changes in environment?

Do you know which parameters in your technology are more skittish than others, and how to reduce that sensitivity or prevent the related environmental changes? **How steady is that bias you observe in your prototype** that you are planning to "calibrate out" in the product? Is it really constant or will it change with time and degrade performance?

Most performance parameters are sensitive to more than one changing input. For example, flow calibration factors in a pumping system are notoriously sensitive to multiple factors such as tubing smoothness, ambient temperature, and downstream resistance. A change over time in any one of these factors may adversely affect your flow measurement or flow delivery accuracy.

Conversely, many technologies succeed precisely because they *benefit* from being extremely sensitive to a targeted environmental change. **Is your technology sensitive enough to do so over the range of conditions you expect?** Will its sensitivity provide a useful result? For example, when the ability to detect a pollutant in a water sample relies on a change in detected voltage, that change must be detectable over the range that's meaningful – where the danger is real and the pollutant concentration is realistic.

REPEATABILITY

Recognizing that prototypes are not perfect, can you develop confidence that your technology will work the same way every time?

If performance is not sufficiently repeatable in your prototype, it's OK as long as you understand why and how to prevent the variability as development continues. If you built another prototype **would it work the same way as the first one?** What if someone other than your core team built an identical prototype? Sometimes a core invention team is unaware of the special care taken to assemble one or two demonstration prototypes and is surprised at the poor performance resulting from a third party responsibly building to the same specifications.

If your team has more than one prototype, the prototypes are often not exactly the same as each other because you are in a development process and are testing variations along the way. Did you change one thing at a time or a lot of things all at once? If your results are not reproducible from one prototype to the next, have you fully analyzed why? Some causes of non-repeatability are lot-to-lot difference in components, varying outcomes of 3D printing processes, and insufficient tolerances on rapid-prototype parts.

RELIABILITY

Reliability engineering is often thought of as an exercise undertaken when a product is far along the development cycle and readying for manufacturing.

It is always helpful to ask early on: Is the promise of your technology based on an assumption that it will be sufficiently reliable in its product form? **What is behind this assumption, and can you test against it with early prototypes?** In addition to prognostics about later reliability, it's important that your early prototype is reliable enough to be able to understand and test your technology as you move through the development cycle. As with other technology flaws, knowing this as early as possible is crucial.

SCALABILITY

The ability to scale from several prototypes to hundreds of thousands in mass production is another concept often understood too late in the development process.

There are constructive questions that can be asked at the outset even though the new technology's only been proven in an early prototype.

One hopeful misconception is that the shortcomings of manual steps undertaken in an early prototype will be improved once that step is automated. In fact, **automation does make performance more consistent, but it doesn't always improve performance.** Automated optical checks are a good example of this. If a camera is making sure a sample is present instead of the human eye, the presence of the sample can be missed due to lighting or resolution issues. Similarly, if a robotic element is moving a component from A to B, it may need the element to be within a certain tolerance of A in order to move the component every time, while the human was more forgiving of this.

Speaking of tolerances, migrating from 3D printed parts to production molded plastic parts will cure some ills associated with rough surfaces and low tolerances. However, there is a tradeoff here as well. **Production parts do not automatically equate to better performance reliability, and can influence performance in other ways.**

PRACTICALITY

Inventors are sometimes unfortunately persuaded by “the cool factor.”

As infatuated as you might become with a clever design, it’s important to rein yourself in with the reality that the **end user of your product only cares about how well it works and how easy it is to use.** Users won’t pay extra for nifty design that doesn’t enhance performance. So do you really **need a facial recognition feature when a barcode scan will do?** And can you do without that extra microprocessor by adapting one to do the job of both? Will reducing processor load reduce heat in the enclosure, allowing you to simplify it further by getting rid of a cooling fan?

INTERFERING CLAPTRAP

Yes, that’s the technical term.

Product features can be added because they are required for safety reasons, or just because they are desirable. Regardless, new features can degrade performance, and unacceptably increase cost or the launch schedule. Take, for instance, a wireless monitor relying on an RFID antenna that works like a dream in the prototype. When packaged to survive drop impact, the antenna reception suffers. In another case, including bubble detection on an infusion pump to make sure that dangerous air bubbles are avoided will in turn limit pumping accuracy at low flows. Also, **the more features added, the less likely they will all work.** That’s just statistics.

Building a new product that works as intended and truly helps people is truly exhilarating – but when it’s done right, it is also **complex and daunting.** Proving new technology works in products, and building products to work in the real world under varying conditions, requires to designers to think carefully through a long list of questions. And the earlier in the process those questions are asked, the better your chance of success.

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