The Future of Innovation



Design vs. Discovery

By Paul Leonard

MOVING FROM DISCOVERY TO DESIGN: THE GAME-CHANGING IMPLICATIONS FOR TECHNOLOGY AND YOU

Imagine if the technology you use every day was not just *discovered* but rather meticulously *designed* to be better than ever before. This shift from accidental breakthroughs to deliberate innovation could transform everything from how we power our gadgets to how we manage global energy.

A given discovery may be known to work only at high pressure and high heat, so technologists must accommodate accordingly— and all energy used to generate heat and pressure is wasted on creating process conditions rather than directly making the product. Still, it is impressive that we can, for example, take the discovery in 1909 that nitrogen can be 'fixed' with the help of iron (albeit at high pressure and high heat) to create fertilizers. Yes, this 115-year old discovery is our planet's primary nitrogen-fixing technology even today. Nature can also fix nitrogen, although without high pressure and temperature, so we know it can be done without wasting energy on heat and pressure, we just haven't learned how to do it quite so efficiently.

Energy is often the bottleneck in technology. If we had limitless energy, we could use any process without worrying about efficiency. Back in the day, gas was cheap and cars were big so no real need to be efficient. But because energy is limited and costly, improving processes to use less energy is vital. The paradox here is that we know that GDP is inexorably linked to energy use— the more energy we use per capita, the better off we are. This is the same for every person in every country in the world. So what to

do? Should we hoard energy and regulate its use, use energy as a cudgel internationally, intentionally jack up prices with a sin tax—no more soup for you, energy over-user! One man's induced scarcity is some bureaucrat's treasure. Who knows where we are headed, but... what if we could design processes within materials that generate and use *their own* energy as part of the process, well, that would be a game-changer, or at least half of one. The other half, and arguably the more important half, appears initially a bit underwhelming— having a goal. If you don't have a purpose for your internally generated process energy, then all you've got is discovery. That's not design.

If we don't fully understand why a process works, it's like trying to tune a car engine without knowing what makes it run smoothly. It's just another black box technology-- we know it works, at least to some degree, but we don't know why. Can we make it better?

Fundamental discoveries in materials science over the years and decades currently account for more than two-thirds of the global technologies that feed us, clothe us, keep us warm, keep us relatively healthy, transport us and power our many devices, our communications and our technological world. These discoveries are massively important to our lives. For the most part, though, we haven't learned *why* these catalyst-assisted technologies fundamentally work, much less how to accomplish tasks and goals with better efficiency.

Not to get all science-y, but recent understandings in subatomic processes have led us to the development of a successful and repeatable design template for building these fundamental processes from scratch. This is a new methodology that can be used to make far more energy available to do, well, a whole bunch of things— remember that energy is the limiting factor for almost everything in technology. If you have the energy you can accomplish a lot.

We've recently discovered a way to manipulate energy more effectively in elemental materials. This means we can use everyday elements in new ways to perform tasks more efficiently. The implications of this new understanding mean that we can factor out certain exotic elements within a given process in lieu of more readily-available elements (cheaper), and we can take intelligent steps to further improve processes, make them even more efficient, and reduce the energy to power the process (far more efficient).

Essentially, we are learning to model quantum-effect materials and systems that operate more effectively and efficiently in our world's baseline conditions, atmospheric pressure and ambient temperature.

For us, it turns out that the primary difference between discovery and design is having a goal. With discovery, technologists set about finding out interesting ways to employ technology in various uses with lots of trial and error. With design, a given process must

have an identified goal beforehand because *how* you direct that internally generated energy is an integral part of the model and the design. Just being able to design a quantum-effect source without the understanding on directing that energy to perform tasks would be, well, discovery. Good but not great.

“So why haven’t I read anything about this?” As I’ve written before, fundamental discovery, and in this case fundamental *design*, most often occur on the periphery, far away from the flagpole. It’s sometimes hard to hear us but we’re there.

Allow me to provide a real-world example of something apropos on which we are currently engaged.

Recently, a prospective client connected with the buildout of multiple data centers in the US inquired about potential technologies that could improve the thermal management capability (dealing with the heat represents more than a third of the operational costs) and possibly reduce the massive energy demand to power the many thousands of high-heat generating servers (with oodles of low-energy, high-efficiency components like CPUs) housed there. As we touched on above, thermal emissions in a electronic system are a waste of energy. Additionally, the International Energy Agency states that world supplies of copper— the primary material we use for electronic conductivity and for thermal management, will be largely insufficient in the very near future. "I’ll believe it when I see it,” right? Luckily, our design model allows us to choose from a combination of readily-available elements capable of fulfilling specific roles necessary for electronic and thermal conductivity, and to combine both of these primary characteristics into a quantum-sandwich, composite material. We don’t have to wait for calamity and brinkmanship problem-solving, we can take direct action now.

Our team set about modelling what we call a phase I assessment that serves as a goal-specific design template. It appears that this dog should hunt, and at atmospheric pressure and ambient temperature, and could be manufactured by existing vapour deposition techniques. No metals, no exotic elements, no super expensive engineered surfaces (like with single atom catalysts—SACs-- that are all the rage in the East). Our design model is telling us that we should be able to greatly improve the thermal capacity, transmission and dissipation of heat in our composite material— by a factor of 10.

As any solid-state researcher knows, accumulated heat is not just a waste of energy, but as circuits become more an more miniaturized, the inability to dissipate the heat prevents their further miniaturization in electronics design. Reduce the heat, miniaturize, reduce the footprint.

Without getting even further ahead of our skis than we already are, if we get these quantum-sandwich designs right— and our model has a proven record of success— the benefits beyond data centers could be very far-reaching and including a leap forward in

the design of room temperature (and above) superconductors. Here's a look at where these improvements could make a real difference:

- Energy Transmission and Storage:
- greatly reducing or eliminating resistive losses in power lines
- more efficient electrical grids
- reduced energy waste and cost
- new and improved materials for batteries

- Electronics and Computing:
- simplifying the design and operation of quantum computers
- expanded applications

- Magnetic Levitation and Transportation:
- advanced materials at ambient conditions are crucial for economic viability of this technology

- Medical and Scientific Instrumentation:
- improved imaging
- improved wealth, detail and depth of analytics
- non-invasive imaging enhancements

- Material Science and Manufacturing:
- innovative utilization of 80 or more additional elements (the excited states of the existing stable elements exhibit different characteristics)

- Economic and Environmental Impact Technologies:
- design parameters to reduce or eliminate emissions and waste

- Fundamental Science:
- new physics in the utilization of excitons and Bose-Einstein condensate

While we're still in the early stages, the move from discovery to design holds the key to unlocking transformative technologies now. Stay tuned as we continue to explore these exciting possibilities.

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Note: for those of you interested in the more technical details, I will publish a non-confidential summary of our phase I assessment for the quantum-sandwich material under the "Projects" section on my LinkedIn profile.

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Update:

- Q: *what happened to the client mentioned above?* A: Status is pending— they went off to find money.