A long view of disruption

The more dire the climate change predictions, the louder the calls for new and disruptive technologies. While it's a great aspiration, as a theory disruptive innovation provides dangerous guidance on how disruption really happens.

I've talked before about how not all that disrupts is good, and not all that is good disrupts. But on the heels of yesterday's DOE headline shouting ARPA-E ANNOUNCES $60M IN FUNDING OPPORTUNITIES FOR DISRUPTIVE ENERGY TECHNOLOGIES (a call for disruptive improvements in coal burning)?it's worth thinking about how disruption happens.

Jill Lepore's recent takedown of the theory of disruptive innovation pointed out not only some of its weaker points but also, from the reactions it provoked, the strength of its followers.[1] The term has now become the rallying cry of every entrepreneur, venture capitalist, middle manager, consultant, and now government agency promising to change things.

Disrupt or be disrupted.

When it comes to selling innovation, it's the ?new and improved? logo on your laundry detergent. This is not your father's innovation?this innovation goes to eleven.

In fact, disruptive innovation has become so embedded in the national psyche?both in business and now in politics?as to be counter-productive. This should not be a contentious claim since, as Will Oremus of Slate points out, it is something both LePore and Christensen agree upon.

It didn't start out this way. The original definition, offered by Joseph Bower and Clayton Christensen in their original 1995 HBR article, was more narrow in scope:
Disruptive technologies introduce a very different package of attributes from the one mainstream customers historically value, and they often perform far worse along one or two dimensions that are particularly important to those customers. As a rule, mainstream customers are unwilling to use a disruptive product in applications they know and understand. At first, then, disruptive technologies tend to be used and valued only in new markets or new applications; in fact, they generally make possible the emergence of new markets.
Now, the label gets slapped on pretty much anything?a new technology, new venture, new business model?that has revolutionary aspirations. Or even evolutionary aspirations, like improving the efficiency of coal burning plants.[2]

But the real problem is more insidious. That's because disruptiveness is not an inherent quality of a technology (or business model or idea). It's an outcome?the observable changes to an industry's technological, organizational, and economic structure after something happens.

If we believe a particular technology or business model or idea holds all the potential for disruption inside it, like some technological homunculus, then we lose sight of the process that leads to disruptive outcomes. Basically, everything else that's required to make a technology disruptive.

It can be hard to see in the moment, so consider something that gives us a little less hyperbole and a little more perspective?the disruption of shipping by the steam engine.

Steam and Sail

Few would argue that the steam engine powered the Industrial Revolution: first by pumping water from progressively deeper coal mines, then by powering textile mills, factories, railroads, and ships.

The steam engine's role in shipping neatly fits the original definition of a disruptive technology. It was first introduced in the early 1800s (in England in 1802 with Patrick Miller's Charlotte Dundas and in the U.S. in 1807 with Robert Fulton's Clermont) for a niche market as small, river-going vessels built for short routes on calm waters. And by the end of the century, sailing ships were all but gone, and steamships revolutionized the global transport of goods and passengers.

So did the steam engine disrupt shipping? Sure, but does that, ipso facto, make it a disruptive technology? Almost a half century of other social, regulatory, and technical innovations had to happen before the steam engine could economically enter, let alone transform, shipping. Here are a few of the more influential innovations:[3]

- Before the steam engine entered shipping, up through most of the 1700's, global trade played a minor role in ship building and design relative to the demands of colonial imperialism.
- In the late 1700s, increasing production of textiles, metalworks and other exports, as well as increasing demand for raw materials drove tremendous growth in England's global trade?a trend that continued through the 19th century.

This growth in trade in turn drove demand for more, faster, and bigger ships, for more favorable regulatory policies, and for more shipping companies serving more ports.

- Beginning in 1813, a series of policies deregulated trade?particularly by ending the East India Company's monopoly on trade with India and ending discriminatory duties on trade with the U.S.?that reduced both costs and barriers to entry by new companies.
- In 1836, England revised how port authorities calculated and taxed the amount of freight on board (tonnage). Previous formulas rewarded deep, wide, flat-bottomed and relatively slow-moving ships (think of the bulbous ships of old naval lore), while the new calculations enabled longer, narrower, and faster vessels hulls.

- Increased trade and new regulatory regimes led to a demand for larger ships focused on moving more goods further and faster, as well as to larger ports that could handle more and larger ships. Steam ships began to gain value, but only as tugs able to help these larger and longer ships maneuver in harbor.

These market and regulatory changes led also to a set of technological changes in the design of sailing ships:

the Blackwall hull, introduced a greater length and narrower beam,
the Aberdeen (concave) bow increased the efficiency of these new hulls, and
composite construction replaced wood with iron in the internal frame, increasing speed and cargo capacity.

- The American Baltimore Clippers were a great example of these innovations in use in sailing ships.

- These changes in vessel design made it easier for steam, first powering side-paddle wheels and then screw propellors, to integrate into ship designs as auxiliary power alongside sails (this hybrid design would dominate steamships through the end of the 19th century).
- Increasing trade in the mid?1800s reached a scale that made building and maintaining coal refueling facilities economical, reducing one of the bigger range anxiety challenges of the 19th century and also the need for hybrids.

- Finally, during all these changes in shipping, steam engine technology was undergoing dramatic changes driven by its widespread adoption and evolution in factories and railroads. By the end of the 19th century, steam engines were 30 times more powerful and 10 times more efficient than when they were first installed in ships. Moreover, the best ones were, for the same power output, one-fifth the weight.

What drove the disruption of shipping? Economic and regulatory shifts created the demand for innovations in shipping. Advances of ship designs, proven first in sailing ships, unwittingly suited the oceangoing steamships and even more so the screw-propeller designs that would emerge after the 1850s. Sure the steam engine was at the center of it all, but it was hardly the guiding force.

The disruption to shipping associated with steam power peaked roughly in 1875 and continued only through the first decades of the 20th century. By then, the steam engine had created the conditions for the next disruption, the internal combustion engine and diesel fuel.

Calling for, let alone funding, ?disruptive technologies? brings both false hopes and foolish actions if it isn't tempered by the recognition that the impact of any emerging technology depends as much on changes in complementary technologies, market demands, regulatory policies as its own inherent properties.

See for example, responses by colleagues and co-authors Michael Raynor, ?Of Waves and Ripples, and Clark Gilbert, ?What Jill Lepore Gets Wrong?"as well as Christensen's own surprisingly vehement response Clayton Christensen Responds? ?

That's likely why even one of disruptive technology's strongest advocates, Michael Raynor, suggests that progress may lie in ?defining more precisely, and very likely more narrowly, the circumstances in which disruption theory applies.? ?

A particular thanks to Sandro Mendonça's excellent research, ?The ?sailing Ship Effect': Reassessing History as a Source of Insight on Technical Change.? Research Policy 42, no. 10 (2013): 1724?38. ?