Technological Innovation in Education: What the Past Teaches, What the Present Promises

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“Revolutions” and “Game Changers”
Talk about technology in higher education often claims that this will cause a revolution or that will be a game changer. (See, for instance, Thomas L. Friedman’s piece on MOOCs [massive open online courses] titled “Revolution Hits the Universities,” or the collection titled Game Changers: Education and Information Technologies.) The terms should give us pause. At least in the realm of human events, revolutions usually take the form of uprisings from within. When they hit (or maybe just impend on) higher education, however, they are usually disruptions from without (as Clayton Christensen has taken pains to point out). Similarly, games are circumscribed affairs, whether they happen on a board, on a screen, or in a stadium. If they are based on rules and mutual understandings—and most are—changing them is usually a long, iterative process. So “revolutions” and “game changers” actually deserve the scare quotes. They’re misfit terms. The kind of change resulting from impactful innovation in education is neither sudden and internal nor gradual and regulated. But it is, presumably, significant. With significant change (not semantic hairsplitting) to consider, we need better ways of gauging it. One way may be to look to the past.

The Last Great Disruption
We are at a turning point roughly analogous to what happened in the 15th century. There were 30,000 texts in Europe at its beginning, and 9 million at the end, because of a tech “revolution” in the middle: the advent of mass, mechanized printing. The impact on the clergy is well known: These keepers of sacred texts and traditions were anxious about an unmediated transmission of these to the laity. And rightly: The Reformation as
it played out is unimaginable without the printing press, though that innovation was still fairly new and unassimilated.

Those who taught in the universities of the time also felt threatened—potentially automated out of existence by the printing press, as it were. (Let’s say you were an expert on Aristotle back then; what would it mean if Aristotle himself could “speak” to your students? What need then for you to tell them what he said?) The perceived threat was not baseless, but it was rooted in an understandable inability to see how teaching practice would change—how, arguably, access to texts would force it to change. Transmission of what was said was not the be-all and end-all of teaching, as it turned out. It was not enough to know what Aristotle said; one should also understand and interpret and apply that, something teachers could help with (and books allowed them to focus more on). Practice changed over time, and changed so thoroughly that we have moved from a professoriate that could not imagine surviving the mass-produced text to one that can’t imagine surviving without it. The apparent threat was a boon, like the VCR, then the DVD, and now streaming or downloadable video to the movie industry.

There are important differences between then and now, of course. What good were mass-produced texts without mass literacy? How important was college or university learning anyway, and just what was it good for? Even in this country, in the “New World,” the first colleges and universities came into being primarily to turn out preachers and teachers, the same literate elite that had bristled at the advent of mass printing. The rise of the reading public and a restructured economy had to help define the ultimate impact. That took centuries and another revolution (the industrial, with the rise of the bourgeoisie and a managerial class). In fact, of all the differences, the most important is the time this took. The key difference between then and now is the rate of change.

Still, let’s assume that this accelerated rate is also fundamentally a matter of degree. What are the important principles then and now? One is that technological change is not the same as behavioral change, nor is it a clear determinant of that, particularly in terms of what the potential of an innovation seems to be at the time. Another is that we are not talking about simple causes and effects but interactions of whole systems: economic systems, educational systems, cultural systems. These have their own differential rates
of change, their own affordances and resistances. The outcomes of their interactions with technological change and one another are unpredictable, even if it seems, with hindsight, that those outcomes might have been foreseen by those in the throes of early change and adoption.

Differential rates of change are key here. To put it too simply, technology, if it is a game changer, changes the possibilities of the game, but not the players, or the arena, or the feelings of longtime aficionados about how it should be played. Those may change slowly, even resisting the technological intrusion. Such resistance to change has long been with us. When Socrates inveighed against writing in Plato’s Phaedrus (because it would weaken our ability to remember), he noted he was rehearsing objections raised by the ancient Egyptians, ancient even to him. Even then, and especially now, change shouldn’t be confused with progress, at least in some purely linear and wholly positive sense. We are speaking instead of accommodations and trade-offs, a calculus of gain and loss.

What’s more, if technology moves us forward, it still leaves us us. If technology were to make us better, we would have to become better, and technology may not have the virtue to make that happen. We can communicate faster, for instance, and more broadly, but does that improve what gets communicated? (Does that feel like a rhetorical question?) To return to our flawed metaphors, for technology to spark a revolution would be one thing; to have that revolution make our world freer and fairer would be quite another. For it to be that kind of game changer, it would have to allow and even call forth better performances from us. That, at least, is the hope. How often is it realized? Returning to our historical example, the printing press certainly gave the world more books. Did it make the world more wise? And if it didn’t, is that another limit on what technology can do? That’s a question we’ll return to.

Unintended Consequences
For now, we need to acknowledge that the situation is more complicated than we’ve heretofore acknowledged. It’s not just that technological innovations, being subject to
some slowness in adoption, take time to reach their potential. They are often not used as they were expected (even intended) to be used. Their potential turns out to be less a matter of design than discovery, even serendipity. The history of inventions is filled with such stories, from the invention of brandy nearly a millennium ago—basically, wine boiled down for easier transport—to the World Wide Web, which started as an internal communication and information management system for a research organization.

But there is nothing incomprehensible about the incompleteness of such first steps. On the contrary: What defines the launch of the new is an existing framework that also frames the understanding of possibilities. No surprise, then, that thinking of the new happens in terms of what already exists. The history of technology and its uses plays this out again and again. The radio was originally a wireless telegraph, and described as such when * McClure’s Magazine* reported the successful 1899 transmission across the English Channel.¹ Its development as a broadcast medium came later. The telephone was also conceived in terms of the telegraph—originating, as Tom Standage notes in *The Victorian Internet*, as an *acoustic* telegraph, a way of getting telegraph wires to conduct sound. Perhaps most oddly, the phonograph, developed by Thomas Edison while working on that “acoustic telegraph,” originated as the first answering machine, a way of capturing phone messages.² We call our laptops and desktops computers because their lineage goes back to machines designed to compute, all the way back to Charles Babbage’s creation of a mechanical calculator. (Before then, computers were actually people who put together mathematical tables and thus became early victims of automation.)

What these innovations all have in common is a tendency to be seen initially as superimpositions of the new on the old. People (even inventors) consistently have trouble seeing the new as such, and view them more as an extension of the status quo, something to be regarded and used in terms of pre-existing frameworks, at least initially. Innovations are game changers only when the game itself changes. That takes changes in use, changes in behavior, changes in the larger culture.
Fast Forward
So how does this matter of differential change apply to us here and now? In the realm of material production, technology can effect mighty changes. In the realm of human behavior, not so much. (In speaking of changes in human behavior, note that we have to look beyond such behaviors as staring at screens or cell phones; we have to ask what technology *enables* in the realm of human endeavor, even of thought and enlightenment, and this means expecting more of technology than feats of reach and scale.) People change more slowly than technology does. Institutions change more slowly still: They are ways of preserving patterns and valuations of behavior, and they modify those incrementally, even reluctantly (if such a word can be used of institutions—and somehow it doesn’t seem wrong).

It is not for nothing that so much of the important behavioral change sparked by technology, whether the printing press or the Internet, is change that first develops and makes itself felt in uses of leisure time. To return to our ur-example, the impact of the printing press was in some real sense impossible to gauge until it grew beyond making already extant texts more available, when it was manifested through new publications and the preferences they both cultivated and addressed. As the reading public grew, so did the supposed frivolity of what was especially popular in the circulating libraries springing up in the 1700s. Similarly, the power and reach of the Internet made itself most fully felt with the rise of social media, particularly in the first decade of this century. In such cases, we find the most significant growth in uses of the new expanding—and changing—behavior with the uses occurring in our unstructured time. Serious stuff, the world of work and especially of education, is slower to change, indisposed to depart from the well-established way of doing things.

This resistance breaks down, but that takes time. Resistance to change is by no means absolute or even very enduring, but it represents another source of calibrations on the scale of change and sets a higher bar, a need to see reasons to change. Profit is a big motivator, but so is impact. Mere reach is not that big a thing, but influence is. (Penny dreadfuls may not have changed the world; Charles Dickens, however, may well have.) Innovations have to be seen to make a difference in order, really, to make a difference.
The Luring Test
So what does it take to make the changes that make a difference? We have some bad answers for that, predicated on an idea that the next big thing will be "out with the old and in with the new." It usually doesn't work that way. We too often think of innovations as inventions that displace: The electric light replaces the gaslight or candle; the automobile replaces the horse and buggy. But the fact is that new inventions almost always add to the landscape without subtracting from it. That is hardly counterintuitive—it certainly fits with our experience—and yet it is easy to miss. Why? Certainly, one reason is that, as we have seen, some great changes introduced by technology are as likely to sidestep both inventors' intentions and users’ expectations as they are to fulfill them. As we’ve seen, the radio was invented as a communication tool, and ham radio operators still exist, but it became a broadcast medium quickly and pervasively. The computer was invented to compute, and . . . well, you get the idea. The history of innovation is the history of strange turns, perhaps none captured better than this reflection on the evolved use of texting from its inventor, Cor Stutterheim (as quoted in an interview with Richard Wray in 2002):

“It started as a message service, allowing operators to inform all their own customers about things such as problems with the network. When we created SMS (Short Messaging Service) it was not really meant to communicate from consumer to consumer and certainly not meant to become the main channel which the younger generation would use to communicate with each other.”

Who would have known that a generation would prefer texting to talking, or why? Nor are these uses a mere matter of users’ whims: Social change and social pressure repeatedly come to bear on how use is channeled and defined (something compellingly documented in Danah Boyd’s It’s Complicated: The Social Lives of Networked Teens, where she says teenagers would not have used online communication so much had not curfews, parental “overscheduling,” and other restrictions cut into their opportunities for face-to-face interaction).
So innovation does not carve out a space for itself (or does not just do so); we do the carving, and we need to find a space for it in our lives, along with all the other stuff. This is why, so often, an innovation does not displace existing technologies so much as find a complicated co-existence with them, maybe even one as symbiotic and parasitic as television has done with cinema (or vice versa). Innovation is more likely to confront us with a both/and choice than with an either/or choice—more likely, for instance, to give us additional possibilities for communication than to have us choose just one. Increasingly, the need is less to choose than how to deal with the multiplication of choices. Sometimes it seems that increasing options is the whole point: that, and getting all the options to converge on the user. The classic example in the past decade is the mobile phone, as it not only became more ubiquitous but less and less of a phone, a handheld device that is a camera, a newsstand, an entertainment center, a library, a bulletin board, a source of directions and recommendations and other information, and—oh, yes—a phone.

This doesn't mean that we don’t have choices to make, or that displacements of one technology by another don’t happen over time. Look what has happened to print journalism, or the encyclopedia business, or video rental stores. If we in higher ed want to avoid the fate of the Rocky Mountain News or Blockbuster Video or Encyclopedia Britannica, we have to take the long view, dodging the hype and hysteria but making good bets and forecasts nevertheless. How do we do that?

**Mr. Rogers’s Neighborhood**

Back in the 60s, a young assistant professor of sociology took on a subject that made for an important book: *Diffusion of Innovations* (1962). These days, after five editions, Everett Rogers is most famous for giving us the term “early adopters” (his term for those on the left side of his famous bell curve of adoption, the sort of people who jump on an innovation before it becomes commonplace or widely known). But that was not nearly so valuable as his documentation of the five attributes of innovation, all of which bear on an innovation’s rate of adoption. They are relative advantage, compatibility, complexity, trialability, and observability. (More or less self-explanatory, they are all accelerants of
adoption except complexity, the only attribute to dampen adoption.) What’s really fascinating, and useful, is that none of these attributes actually inheres in the innovation itself; they are all matters of perception, all cues to behavior. They help to explain why the real genius of Alexander Graham Bell was not just inventing the telephone (he is in competition with others for that distinction), but making sure it was installed in hotels and public places across the country so people could see it in use, even try it out for themselves. For innovations that have attained a real foothold and ubiquity, from radio and television to the personal computer and the smartphone, we keep seeing that adoption travels the same arc, running through the attributes of innovation.

Our subject, however, is innovation in higher education, so let’s consider some of the challenges to adoption that Rogers helps to highlight. If we think of the adopters as faculty, the attribute of relative advantage presents immediate challenges. The new and unfamiliar always does. For educators, people schooled in studies of causes and effects, marshalls of evidence, the innovation would have to be demonstrably better to show relative advantage. In other words, it would need to have established itself and shown results, and that takes time. Without proof of its worth, the main prospect it presents is relative disadvantage: more work and time taken to travel the learning curve.

So it goes for the Rogers’s other attributes. Compatibility is a similar problem for technological innovation in education: Anything hatched by thinking out of the box is going to take people out of their comfort zone, away from processes and procedures they are used to. Complexity, the great drag on adoption, is a given, especially if, in considering technological innovation, the emphasis is on the adjective. Getting past complexity in higher education is compounded by the lack of a culture of pedagogical training and professional development (a lack that distinguishes tertiary education from primary and secondary). Professors are essentially taught to teach by the professors who taught them; this lag confronts technological innovation like an immovable object confronting an irresistible force. The lack of a focus on pedagogy and professional development also creates problems for trialability and observability: Teaching innovations lack the visibility that would ease effective modeling and adoption.

Teaching, often thought of as a public performance (certainly for the students involved),
is also an oddly closeted activity, even isolated and isolating when it comes to interaction with colleagues. One’s research is quite literally an open book, but what one does as a teacher goes on behind closed doors.

The Call of the MOOC
Hasn’t this changed? Isn’t instruction now so much more trialable and observable? The great reason to ask this question is also the exception that proves the rule: massive open online courses, or MOOCs. Touted as the “killer app” for higher ed, hailed in headlines for “The Campus Tsunami” and “Revolution” it would effect, the MOOC essentially took shopworn pedagogy—the lecture—and made it scalable and widely available. The innovation (if it can really be called that) was really a matter of giving exponential reach to the already dreadful large lecture course. This ratcheted up the observability for faculty, and trialability for students, but that wasn’t necessarily a good thing. In fact, the results were predictable. Students (many not students at all but faculty, graduate students, professionals, curiosity seekers, and a pent-up line of international students hungry for American college instruction) signed up in droves—leading *The New York Times* to declare 2012 to be “The Year of the MOOC”—but then dropped away in droves. The general failure of MOOCs became a broad brush with which to paint online instruction generally. Completion rates were regularly in the single digits. Attempts to make MOOCs actually work resulted in their being much less massive, or open, or fully online, or even full-blown courses (more like digital libraries for use in courses). What MOOCs eventually taught us in higher ed is the same lesson the professoriate had once learned, half a millennium ago, in the wake of the printing press: Transmission is not instruction.

MOOCs, the hyped innovation of yesteryear, have not disappeared from the landscape so much as they have been absorbed into it, as ventures in executive education, in flipped and blended instruction, and in other established niches. The ways they would replace or transform higher education haven’t happened. The Death of the University seems to have been proclaimed prematurely, which doesn’t mean it won’t continue to be proclaimed. After all, there’s a certain frisson to “Après nous le deluge,” and it’s a
great attention-getting device. In early 2015, for instance, Kevin Carey, long a critic of higher ed’s status quo, published *The End of College* (subtitle: *Creating the future of learning and the university of everywhere*), and Ryan Craig of University Ventures published *College Disrupted* (subtitle: *The great unbundling of higher education*).

But a new generation gap has allowed many to forget (or never to know) that we’ve been through this before. John Seely Brown and Paul Duguid began their now-classic text *The Social Life of Information* (2000) with the reflection that “the rise of the information age has brought about a good deal of ‘endism’” (16). Writing at that end of the 90s, exploding the myths of upheaval that the advent of the web spawned, they created a taxonomy of prophecies of “the end” they called the 6 Ds: demassification, decentralization, denationalization, despatialization, disintermediation, and disaggregation (22). Disruption could be a lucky seventh. *The Social Life of Information* explained why the Ds have not come to pass as predicted, saying much with just the title: Information, without a socialization to its uses, can’t be much more than inert data; socialized by communities of practice and application, it can be transmuted into knowledge. Ever more valuable in a society and economy that turns on it, knowledge is difficult to define, communicate, disaggregate. Students go off to college less to learn something than to learn to be someone, ultimately a college-educated person. We consider that a valuable commodity without being able to pinpoint exactly how the transformation occurs or just what aspect(s) of it we value. So, at least, say Brown and Duguid in the whole chapter of *The Social Life of Information* they devote to higher education. And so they conclude:

In looking at university change for its own sake or as an indicator of institutional change more generally, no one should underestimate the remarkable staying power of these institutions. They have been around, as we noted at the outset, for more than 1,000 years. In that time, they have survived many revolutions and may survive more yet, including the digital one. (140-41)
Vive la Résistance

That’s not a place to stop, but it is a place to consider changing direction. Brown and Duguid are not arguing for complacency in an argument made a decade and a half ago, but they attest to a kind of durability the passing years have borne out. The real question is less how universities must or should change, but why. For all the talk about the importance online education (not MOOCs, or not just MOOCs) might have for colleges and universities, for instance, surveys of faculty attitudes show no significant warming to the new modes of instruction in over a decade. On the contrary: I. Elaine Allen and Jeff Seaman, surveying perceptions about the quality of online education over a decade, found in 2002 that not quite 60% of chief academic officers believed their faculty accepted online education. That seems to have been wishful thinking. When Allen and Seaman actually surveyed faculty in 2012, a full decade later, they found nearly 60% felt more fear than excitement about the growth of online learning, and 66% felt it was inferior to traditional learning. Talk about not moving the needle . . .

What needs to be more apparent to faculty is not just the means to change instruction, but a good reason to change. Making education cheaper is hardly the rhetorical high ground, certainly not so much as making education better. What would it take to do that, or to create a greater sense that online learning could do that? If Everett Rogers’s attributes of innovation are largely useful for explaining why there isn’t wider adoption of change in higher ed, what sort of attributes would lead to change?

We need to talk of the efficacy of modes of learning, and in terms that transcend the old and endless arguments about comparability. (If the goal of education is to replicate the classroom experience, someone has to ask, Who made that the gold standard?) What is it we really want from teaching and learning in our colleges and universities? What are the appropriate expectations for what might be done, not just what has been done? For what is possible now, not just what has the practice been in the past?

For this, we need something that is essentially an update of Rogers, something that gives us a way to judge the value of technological innovation in terms of what educators value. In a book with the wry title The Future of the Internet—and How to Stop It (2008),
Harvard Professor Jonathan Zittrain offers just that. Searching for a middle term between disruptive chaos of a hyper-hacked and insecure Internet (a kind of Wild West of the web), and corporatization or “appliancizing” (as he calls it) of a secure but commercially locked-down Internet, he comes up with *generativity* as the key. Zittrain’s five features of generativity have a striking homology with Rogers’s five attributes of innovation.

- **Leverage** (cf. Rogers’s *relative advantage*) is the ability not just to do more but to do better and more easily; it grants the kind of extension of reach that is not so much scaling up as networking out, establishing meaningful connections rather than just diffusion.
- **Adaptability** (cf. Rogers’s *compatibility*) signifies the kind of customizability that allows you not just to use digital tools and systems, but also to modify them to address your needs and goals; essentially, we all have access to a toolbox that also allows us to rework the tools.
- **Ease of Mastery** (cf. Rogers’s *complexity*) is not really about simplicity (what about our world is simple?), but it is about using complex tools (like WYSIWYG editors or wikis or blogging tools) that are simple to use but nevertheless have complex effects and extensive reach.
- **Accessibility** (cf. Rogers’s *observability*) is about having ground-floor access; there is no need for massive amounts of money, no need to be at the top of the hierarchy or to enter the initiates’ circle, no need to proceed from the top down (which is good, because innovation doesn’t).
- **Transferability** (cf. Rogers’s *trialability*) is the great carryover effect: What you learn and use in one field can work in another; what you create can be easily shared, as can the work you do in creating it. Collaboration, like customization, could not be easier these days. Or more important. (71–73)

If these aspects, at this level of abstraction, don’t seem clearly tied to educational goals, perhaps an example will help. Let’s take a familiar and widely used web-based composing tool, the wiki. Whereas students were formerly asked to do research projects individually, each laboring in isolation, a wiki allows them to work together, learning from
Like any other, even as it tracks the precise time and extent of each person’s contribution. There are no division-of-labor concerns here; nor is this just about presentation. Since information is so easily gathered, the goal is no longer (just) gathering it and presenting it, but doing something with it. For those familiar with Bloom’s taxonomy, and especially Anderson and Krathwohl’s updating of it for the 21st century, the idea is to move from learning as acquisition to learning as application and, ideally, evaluation and creation.

For example, students in a political science class would not simply research literary and historical utopias but develop their own, and do that as a team negotiating each key point, their work on this tracked more carefully and minutely by the technology than it ever could be before, even by the most scrutinizing and interventionist instructor. Of course, why stop with one tool or mode? Why not employ gamification and critical simulation, as Francesco Crocco did recently with his course on utopias (and described in the Spring 2015 issue of the Journal of Interactive Technology and Pedagogy)? Why not network an assignment across multiple courses and disciplines, as Cathy Davidson’s Future’s Initiative has shown the way to in the “Mapping the Futures of Higher Education” meta-course she taught with William Kelly? With collaboration and intentional design, generativity grows.

By Way of Conclusion

What is striking in such models is that instruction improves—which is to say more is learned—not because the individual instructor does more work, but because the students are more active and engaged, moving more quickly to applications of learning. Technology has made possible what our world has arguably always needed, and now needs more than ever: modes of instruction that break with a broadcasting model of teaching to a networked communication model. Nothing could be more logical, given the tools we have. But we still have acted as if the idea was to “package” knowledge in a lecture, and give that to the students, not least of all in case of the early MOOCs. Is there really any question that what students need now is not prepackaged, but something they can be helped and guided to gather for themselves, test and apply in teams, and ultimately use to build new knowledge? Faculty are not irrelevant to this
model. On the contrary, they are arguably more important than ever before, structuring the learning experience, filtering without prescribing the sources, identifying the key issues and tensions, suggesting the right elements to synthesize (and, ideally, learning from and sharing with one another as they do all this).

It is as if we are on the verge, at last, of what it had taken the profession so long to learn about what the book could and could not teach. Just as what the book “says” is insufficient, what technology provides the students is not all that they need. That socialization and structuration of the learning experience is still critical, as are the faculty who will shape that experience. In the past, the key had been to guide interpretation, and build the capacity to do that for oneself. Now, with collaboration ever more important, the key may be to orchestrate how those interactions occur and what goals they are directed toward, at least until the student can conduct her own orchestrations. It is a consummation devoutly to be wished. And it is not the Death of the University, but a new life.

References


1 A facsimile of the report on “Marconi’s Wireless Telegraph” for *McClure’s Magazine* (June 1899) is available at http://earlyradiohistory.us/1899marc.htm

2 In the account of the development of the tinfoil phonograph from the Thomas Edison Papers (see http://edison.rutgers.edu/tinfoil.htm), Edison found that a diaphragm he fashioned while working on his version of the telephone produced indentations from sound vibrations and realized “there’s no doubt that I shall be able to store up & reproduce automatically at any future time the human voice perfectly.”