



# Could disruptive technologies also reform academia?

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**Abstract.** A thriving future science community could depend on disruptive technologies to shake up outmoded academic practices.

## 1 A weakened academic culture

### 1.1 The paper glut

We live in the era of the paper glut (Siegel and Baveye, 2010). Millions of scientific papers are published each year, at higher rates than ever before. The lack of correlation between research productivity and ultimate impact demonstrates that demand for quantity outweighs demand for quality (Costas and Bordons, 2007; Sarewitz, 2016).

However, the paper glut had to peak. Before the turn of this millennium, the notion of prolific publishing and its possible impact on academia was already recognized (de Solla Price, 1963; Erickson et al., 1993). There was a general disregard for these warnings. Now there are appeals to dramatically decrease institutionalized publication pressure to avoid crippling scientific culture (Sarewitz, 2016) and to afford scholars time to explore more extraordinary albeit riskier ideas (Geman and Geman, 2016).

Unfortunately, the consequences of adhering to the paper glut for too long has instilled a sense of ruthlessness in academia. Research funding is becoming scarcer in many countries. If papers remain currency, then institutionalized publication pressure is unlikely to markedly decrease. This greedy behaviour is slowly eating away at the idea of grand science, and worse, at committed scientists who can help to execute it.

### 1.2 The academic pyramid scheme

The paper glut is symptomatic of a tricky-to-solve underlying issue: the publication-driven PhD factory (Cyranski et al., 2011). While countries do need to expand their knowl-

edge base, stretching global academic researcher and paper outputs has resulted in devaluing academic careers. Hefty PhD and paper investments with weak employment returns have led to the academic equivalent of a financial pyramid scheme (Stephan, 2012).

Postdoctoral employment has been particularly affected by quantity-based academia. Postdoc moral might be at an all-time low. For the foreseeable future, short-term, low-paying contracts are expected as permanent positions become scarcer (Cyranski et al., 2011). Aspiring scientists also face severe shortfalls in financial planning that could impact personal savings, family formation, and retirement fund organization (Devitt, 2016). Improper financial planning by young academics would ultimately strain public funds, which is more reason for policy makers to help articulate these issues and create a sustainable academic culture.

Of course, academic research positions are not supposed to be the be-all and end-all of post-PhD employment options. Fiske (2017) noted that various employment markets are unstable worldwide, and uncertain young academics should form plan Bs. Guidance counselling before and during a research degree is highly encouraged in the current tenure market in order to develop all possible job market outcomes (Mangematin, 2000; Boh et al., 2016; Moldwin and Morrow, 2016). However, current excessive publishing incentives require higher PhD investment to attain performance trajectories, presenting a potential conflict of interest in advising away from academia. In addition, many postdocs really do desire to remain in academia (Van der Weijden et al., 2016).

Unsurprisingly, current practices in the scientific community are rapidly approaching global revolt (Sarewitz, 2016). Young academics are restless at tertiary institutions.

In contrast, shareholders in academic publishing, most of which operate independently of university structures, profited extremely well (Bergstrom, 2001; Van Noorden, 2013; Bergstrom et al., 2014; Buranyi, 2017).

As we are facing global environmental uncertainty, disenfranchising scholars from the scientific endeavour is potentially dangerous. Clearly, if there are ways to make academic financing models more inclusive to more evenly benefit the science community, then they are worth investigating as a matter of urgency.

## 2 Coordinating global academic practice

### 2.1 Disruptive technologies to influence academic financing models

Global unity in refuting quantity-driven academic strategies while sustainably building a happy workforce to tackle pressing issues, is a mammoth task (Van Noorden, 2013). Bergstrom (2001) claimed that academic publishing follows a coordination game as per game theory. This coordination game suggests individual researchers or institutions would struggle to absolve current quantitative performance practices, unless there is large-scale cooperation from science communities to find a new publishing equilibrium. The direction toward such a new equilibrium remain poorly articulated.

The principles of sustaining or disrupting technological change, as determinants of business innovation and performance trajectories, could hold the key to a new publishing equilibrium (Christensen, 2013). For example, academic publishers are well aware of the decreasing popularity of classic closed access or paywall approaches, yet still aim to maintain profits by developing various open access but page-charged publishing avenues (Van Noorden, 2013; Björk, 2016). The same coordinated game is played wherein authors and their funding bodies accept that academically independent shareholders may profit well while the scientific workforce is weakened considerably. By sustaining current publishing business models and technologies, the efficient and timely transfer of knowledge is actively harmed as many researchers and institutions are priced out of the science community.

Disruptive technologies challenge the status quo in markets by typically redefining a product's potential range. Specifically, disruptive technological innovation provides a service or product to the outpriced, eventually displacing traditional businesses who either failed to see the opportunity or remained unconvinced that expanding in new directions would indeed be profitable (Christensen, 2013). In fact, although stakeholders might be well aware of possible innovative avenues, confusion as to its realistic implementation remains a hard barrier which must be crossed before shifts in business model and technological innovation can commence (Chesbrough, 2010). Nonetheless, if disruptive technology

excels, leaders of sustaining technologies frequently lose out (Christensen, 2013). Disrupting technologies can thus be game changers, are relevant in establishing new publishing equilibriums, and need to be experimented with (Chesbrough, 2010).

### 2.2 Possible disruptions in academic publishing

Some scientific publishing companies can reach up to 36% profit margins. These margins are unheard of in other publishing businesses such as popular magazines nor seen in mega-technology companies like Google (Buranyi, 2017). These disproportionate profit margins essentially suggest there is room for redistributing some of the gross academic publishing market value, mainly by cutting out costly middlemen services (Monbiot, 2011). Many authors already edit their own manuscripts, and author-edited manuscripts are often archived in already paid-up institutional repositories. Indeed, in many cases these handling costs appear redundant and could be reinvested where it matters most – science practice and management (Buranyi, 2017).

Disruption of current academic practices could thus be to pay scientists or the institutions that support them their fair share of the end-used article profits. Perhaps more likely, these disruptions will result in scientists or their institutions reducing expenditure on expensive publishing costs that can be managed in-house. These savings can then be used to increase research capacity in local science communities. At the national level, such savings can be worth millions each year.

Lowering the publishing and reading costs associated with scientific articles already represents a major advance in promoting the efficient communication of science globally. The cycling of research funds among those agents more directly involved in science practice would be even better. In this sense, disruptive technologies for academic reform would not prevent payment for valuable publishing services per se, especially since fully free open-access publishing would still require some time to be established globally (i.e. in the near future, article processing costs will still remain a reality for many). Rather, such innovation would give scholars and institutions the freedom to choose which part of the publishing process they wish (or have funds) to pay for.

### 2.3 Peer-to-peer apps to the rescue?

The desired technology, which would facilitate a fairer distribution of financial resources among researchers and research institutions, could simply manifest as web-based, peer-to-peer applications. Peer-to-peer apps would allow more direct and rapid sharing of knowledge among writers and end users. These apps could, for example, entail peer-to-peer handling of manuscripts, whereby handling editors and reviewers are financially rewarded by one another for their services, or by third-party advertisement schemes already popular in many

online applications. Most importantly, it could be done at a fraction of mainstream publishing costs today.

A company that recently closed down, Axios Review, presented an interesting prospect for innovating future scientific publishing practices. Axios Review focused on handling a pre-submission review process for authors, complete with classic peer-review reports to advise on the quality of the work and to facilitate publication in the most appropriate journal given the content, all for a low fare. Although this particular company closed down, such an idea could very well merge into peer-to-peer apps, whereby a company handles the peer-review process at a reasonable price, allowing researchers to copy-edit, self-archive, and later share their manuscripts freely and widely.

Popular examples of companies that took a disruptive approach to business-as-usual and created great funding opportunities for individuals worldwide are Airbnb and Uber. Although these companies represent very different industries, the application of such disrupting technologies within the academic realm should at least be explored as a means to support aspiring yet forlorn academics globally. In this way young researchers in particular can maintain their passions. In turn, institutions can lessen overhead costs associated with obtaining expensive journal bundle subscriptions or open-access charges (Bergstrom, 2001; Bergstrom et al., 2014).

### 3 Disrupting technology is like an eco-evolutionary response

Remarkably, Lewis Carroll's Red Queen could also have predicted how antagonistic interactions in the current academic culture would eventually help to save it. Thus, if these antagonistic interactions do not mature into real change, it is reasonable to expect that young academics will constantly face career "extinctions" (*sensu van Valen, 1973*).

In nature, when species extinctions are premature due to harsh anthropogenic influences, the biotic community and overall landscape can be scarred in ruinous ways. So too might the scientific community suffer. Given the current levels of environmental challenges, it is easy to predict that nothing good can come of these unnecessary losses in scientific partners.

Also commenting on the Red Queen, Smith (1976) later highlighted that ecosystems might have two evolutionary phases: convergent and divergent. Divergent phases are where species change their living conditions in an ecosystem, thereby driving novel ecosystem interactions, eventually, generating a newly equilibrated ecological unit. The concepts of sustaining and disruptive technologies neatly follow convergent and divergent evolutionary phases and their likely outcomes.

## 4 In essence

With dismal employment outlooks and an academic system evolved to profit a select few, it is clear that many aspiring academics are and will not be thriving. In this unsettled educational climate, championing change by also unsettling the status quo in current academic publishing technologies could help to shape future scientific endeavours. Indeed, a thriving future science community could depend on disruptive technologies to shake up outmoded academic practices.

A lot more is at stake than merely happy scientists. Perpetual and disheartening levels of environmental destruction must energize campaigns toward well-managed scientific employment and outputs globally, especially at a time when scientific evidence is being challenged from the highest echelons.

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## References

- Bergstrom, T. C.: Free labor for costly journals?, *J. Econ. Perspect.*, 15, 183–198, 2001.
- Bergstrom, T. C., Courant, P. N., McAfee, R. P., and Williams, M. A.: Evaluating big deal journal bundles, *P. Natl. Acad. Sci. USA*, 111, 9425–9430, 2014.
- Björk, B.-C.: The open access movement at a crossroads—are the big publishers and academic social media taking over?, *Learn. Publ.*, 29, 131–134, 2016.
- Boh, W. F., De-Haan, U., and Strom, R.: University technology transfer through entrepreneurship: faculty and students in spinoffs, *J. Technol. Transfer*, 41, 661–669, 2016.
- Buranyi, S.: Is the staggeringly profitable business of scientific publishing bad for science?, *The Guardian*, available at: <https://www.theguardian.com/science/2017/jun/27/profitable-business-scientific-publishing-bad-for-science> (last access: 4 July 2017), 2017.
- Chesbrough, H.: Business model innovation: opportunities and barriers, *Long Range Plann.*, 43, 354–363, 2010.
- Christensen, C.: *The innovator's dilemma: when new technologies cause great firms to fail*, Harvard Business Review Press, Massachusetts, USA, 2013.

- Costas, R. and Bordons, M.: The h-index: Advantages, limitations and its relation with other bibliometric indicators at the micro level, *J. Informetr.*, 1, 193–203, 2007.
- Cyranoski, D., Gilbert, N., Ledford, H., Nayar, A., and Yahia, M.: The PHD factory, *Nature*, 472, 276–279, 2011.
- de Solla Price, D. J.: *Little science, big science... and beyond*, Columbia University Press, New York, 1986.
- Devitt, E.: Finances: Going for broke, *Nature*, 534, 579–581, 2016.
- Erickson, K. V., Fleuret, C. A., and Hosman, L. A.: Prolific publishing: Professional and administrative concerns, *South. Comm. J.*, 58, 328–338, 1993.
- Fiske, P.: Look before you leap, *Nature*, 542, 127–129, 2017.
- Geman, D. and Geman, S.: Opinion: Science in the age of selfies, *P. Natl. Acad. Sci. USA*, 113, 9384–9387, 2016.
- Mangematin, V.: PhD job market: professional trajectories and incentives during the PhD, *Res. Policy*, 29, 741–756, 2000.
- Moldwin, M. B. and Morrow, C.: Research career persistence for solar and space physics PhD, *Space Weather*, 14, 384–390, 2016.
- Monbiot, G.: Academic publishers make Murdoch look like a socialist, *The Guardian*, available at: <https://www.theguardian.com/commentisfree/2011/aug/29/academic-publishers-murdoch-socialist> (last access: 26 November 2016), 2011.
- Sarewitz, D.: The pressure to publish pushes down quality, *Nature*, 533, 147–147, 2016.
- Siegel, D. and Baveye, P.: Battling the paper glut, *Science*, 329, 1466–1466, 2010.
- Smith, J. M.: A comment on the Red Queen, *Am. Nat.*, 110, 325–330, 1976.
- Stephan, P. E.: *How economics shapes science (Vol. 1)*, Harvard University Press, Cambridge MA, 2012.
- van der Weijden, I., Teelken, C., Boer, M., and Drost M.: Career satisfaction of postdoctoral researchers in relation to their expectations for the future, *High. Educ.*, 72, 25–40, 2016.
- van Noorden, R.: Open access: The true cost of science publishing, *Nature*, 495, 426–429, 2013.
- van Valen, L.: A new evolutionary law, *Evol. Theor.*, 1, 1–30, 1973.