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What Can We Say With Certainty about Scholarly Communication in the 21st Century?

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Mobility has been a driver of change for consumers and for the producers of commercial content. What impact might the sweeping adoption of mobile computing have upon scholarly communication in the 21st Century?

This is the topic I was asked to speak about for the 2011 Charleston Conference. What follows is an attempt to formalize my remarks into a format more suitable for lasting publication.

For starters, let's presume that the undergraduate-level access and "consumption" of scholarly communications will continue its path toward portable platforms. Almost no one is tied to a desktop PC anymore; today even a laptop PC lacking wireless Internet access isn't really considered "mobile." not in the context of data-centric cellular devices whose computing power exceeds that of even an "advanced" desktop PC of only a comparatively few years ago.

So from the present generation of undergraduates forward, post-secondary access of serious scholarly materials will occur in a technological landscape characterized by mobility: mobility of person, of devices, even of "sessions". I expect this to mean that even serious inquiry, such as of the sort accompanying literature review and preliminary resource gathering, will increasingly take place in a diverse, session-persistent state across multiple devices, screen types, input methodologies, with in-session states preserved as one moves across these devices and access methods. I mean by this that we should expect the need to "save" a session, its data, windows, connections, etc, will diminish to the vanishing point. I'd be surprised if one wouldn't have to overtly "close" as session in the face of "Are you Sure?" screens to lose sessions state across devices, as well as across time.

This is possible because the computing power required to do one's work is, at least in the current swing of the pendulum, moving from the device and receding into the enabling infrastructure "behind and between" the devices. The current term of "Cloud" to describe this may not persist, but the movement onto and across service-centric platforms that take care of the housekeeping of computing is bound to continue as these services become more and more capable of sustaining casual, ad-hoc, or spontaneous use of "query and result" services. If you pause a Netflix stream of a film partway through, Netflix' systems will remember where you were in that film, to the frame, and return you there, even months later when you come back. The same technology that makes such lightweight, perhaps "un-serious" use cases possible will also propel use cases that have greater social or scientific significance. Think of the resources and power it takes to query YouTube with a quote from a favorite old television show, only to have a link to the very episode return in moments. Although these use cases are trivial, the capabilities are not.

Just as computing has moved from the room-filling mainframe to the minicomputer the size of a refrigerator, to the desktop workstation or laptop accessing the High Performance Computing cluster, the research publication process has not remained stationary either. Certainly the worthily honored approach to publishing findings, encompassing peer review and deliberative publication decisions grew out of research requirements: for solid research upon which to build one's work. These measures went a long way to assure that research findings were accurately represented, and carried an imprimatur of significant value.

But with networks, and internetworks, and with the cross-institutional, cross-continental (and intercontinental) collaboration they fostered to an unprecedented degree, researchers began to seek a more responsive, immediate way to share findings, and to find findings resulting from the work of their colleagues - persons they knew by reputation, but also, in the increasingly interconnected environment, per-

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sons with whom they enjoyed ready access and rapid interaction. One can sense that this begets an environment in which one knows a colleague or counterpart, not merely through their juried reputation, but through personal knowledge of their characteristics, traits: a sense of the "cut of their jib".

So in the midst of a grant-writing process today, amidst a comprehensive literature review, small wonder that the appetite for greater immediacy of research findings has nourished an information ecosystem in which pre-publications are part of the landscape, even alongside the traditional, juried, finished publication. There's an appetite that leads some researchers to say, "Let me just see the data now, and then I won't mind waiting for the narrative publication."

So what can we say with certainty about scholarly communication in the 21st Century? For one thing, I think we can say that things will not return to as they were in the 19th, or even the 20th century. The vector goes forward from here. The forces driving things forward will continue to do so, the real question being, how far, and toward what manifestations?

I began my presentation in Charleston this year with Arthur C. Clarke's famed comment that, "Any sufficiently advanced technology is indistinguishable from magic." Most people in our circles of involvement know this comment, but many don't know that this was really only the Third Law of Clarke's Three Laws of Prediction.

1. When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.
2. The only way of discovering the limits of the possible is to venture a little way past them into the impossible.
3. Any sufficiently advanced technology is indistinguishable from magic.[1]

It's the first and second laws that form the basis, or perhaps, the justification for the combination of observations, assertions, and sheer speculation that make up what follows herein. I am shielded against refutations from the more learned amongst our constituencies by Clarke's first law, and admonished to push forward, despite the potential for such refutations, by the second.

I also recalled an observation I shared some years ago in a Charleston Conference talk: a remark I heard made by Lorcan Dempsey, now of OCLC, who at the time was Director, Distributed National Electronic Resource of the UK Higher Education Funding Council's Joint Information Systems Committee. Dempsey commented that the term "Digital Library" was almost perfectly analogous to the term "Horseless Carriage."[2] This comment has stayed with me over the past decade, as I've seen its corollaries illustrated again and again: when we encounter something new, something that we find difficult to classify, or of which the implications are not fully appreciated (or even as yet knowable), we tend to "hang it on a familiar hook," that is, explain it to ourselves in terms that are familiar to us. Although this practice is not intentionally dismissive, its effect can be to release us from any sense of obligation to investigate something further.

Additionally, while it is easy or tempting to do so, we cannot simply discount any given scenario that attempts to plot future paths of multithreaded emerging trends as too implausible or unexpected to take seriously.

It's very easy and tempting to take individual separate threads of the evolving landscape for scholarly communication we find today and pigeon hole it with a ready classification. It's about e-books, we might say, or wikis, or preserving peer review, or moving existing processes onto new platforms, or letting the vendors and the marketplace define or solve our issues.

I believe it's a mistake to take any individual facet of today's scholarly communication in its current state of flux and project that facet's forward path in a vacuum. In trying to understand where things might be headed, we cannot usefully separate the technological aspect from the business model, or the business model from the evolving ways scholars and researchers may wish to work, or the differences between how scholars work versus how students or lay consumers choose to read, write, and collaborate, whether for work or for leisure. Each of these

facets is evolving, but none in isolation from at least one other facet. Conversely, evolution can occur in one facet despite changes (or stasis) in another facet, or, change can be resisted, in one facet, despite pressure toward change originating in another facet.

So, the way researchers prefer to do literature reviews, conduct work, log results, or collaborate with coauthors may evolve hand in hand with technology, for example, but may do so despite evolution that may occur in the business models of those to whom they turn for the review and publication of their results.

What can be said to be "mobile" today? Just limiting the term as a descriptor in he arena of education and scholarship, we find that information, data, and every manner of digital objects, all move around via physical or wireless networks. The wireless movement enables the dizzying array of mobile technology ubiquitous today – and it is well to remember that just ten years ago, one had to stick one's neck out to assert that much if not most internet access by persons might one day take place wirelessly over mobile devices! In the year 2000, we were connecting Palm PDAs to desktop computers using RS232 serial cables.

The capability of mobile access has created a landscape in which users demand to be able to access any of their "stuff", from wherever they are, using whichever devices they happen to have at hand at the time. This is the demand that is tied to the emergence of what, in 2011, we have been calling Cloud Computing; it is also the demand that drives the development of newer, more comprehensive services of this kind forward. In the past we may have felt that in buying an e-book or a piece of digitally stored music, we hadn't really bought any "thing" unless we could download a file that we could store on our own devices. Today, the technology enables us to free our devices from the burden of storing all that "stuff," or moving it from device to device; we can simply access it from whatever device we happen to be using at the moment. I have the sense that this instills confidence today, where in the past it may have instilled a sense that the persistence of "ownership" would be tenuous at best if there wasn't a "thing" we could actually have in hand.

This consumer-side shift in perceptions has implications for the way people prefer to store, "carry", and retrieve things that are important to them. The belief that a service can trusted to keep something for you so you don't have to carry it around yourself is not actually new: we've been doing it with money for years.

As today's secondary students becomes tomorrow's graduate research assistants, it seems likely that they will bring with them the tools to which they've become accustomed: for storing and accessing their materials, for keeping in touch with colleagues, for collaborating on projects, for sharing comments or resources.

What possible relation can there be between scholarly publication as we understand it today, and, say, a remark tossed off in a social environment such as Twitter, in which the unit of publication is the Tweet?

On a web site hosted by the Netherlands Bioinformatics Centre, the Concept Web Alliance nurtures what it calls, "an open collaborative community that is actively addressing the challenges associated with the production of unprecedented volumes of academic and professional data."[3] In *The anatomy of a nanopublication*, Groth, Gibson, and Velterop identify and address the difficulty involved in the locating, connecting and curating of specific core scientific statements across the corpus of scholarly communication as it continues to increase. They assert, "…the redundancy of these statements in multiple flora makes it difficult to determine attribution, quality and provenance."[4]

This brings us to what has come to be known as the "nanopublication," which is defined as, "the smallest unit of publishable information: an assertion about anything that can be uniquely identified and attributed to its author."[5] A nanopublications takes the form, essentially, of an RDF triple in which two concepts (termed the Subject and the Object) are associated by a third concept (called the Predicate). These are accompanied by metadata capturing conditions under which the assertion holds, and metadata capturing the provenance of the assertion, such as its author, a date and timestamp marking its creation, and links to related objects or resources,

in the form of DOIs (Digital Object Identifiers) or URIs (Universal Resource Identifiers).

Speaking in a keynote address at the Second Annual VIVO conference, (which I attended in Arlington, VA, in August, 2011), Dutch biologist Edmund Mons called for a path forward, perhaps nanopublications, to promote rapid (near-immediate) communication amongst researchers, even as what he termed the traditional "narrative publications" could continue to serve in a role he described as akin to "meeting minutes," that is, something which few people read but which completes the historical record.
The metadata associated with nanopublications could buttress confidence in their provenance, and their affinity to linked data structures could promote the growth of a web of interlinked assertions and findings that would exemplify the (largely unrealized) potential of the Semantic Web to serve as a vehicle for scholarly discourse.

Do I assert today, in late 2011, that the nanopublication, as described, is the form in which scholarly communication will occur in the 21st Century? Certainly not! I will say, however, that the nanopublication, as understood in the present day, bears many of the hallmarks of early expressions of innovation we've seen before, like the Velocipede, the Horseless Carriage, or the Flying Machine: ingeniousness, dubious immediate practicality, a certain incorrigibleness amongst its progenitors, as well as potentially disruptive unforeseen consequences. I believe we are still in the age in which we call it a "Digital Library," not knowing what it's really turning into yet.

Or perhaps one way to sum up what can be said about scholarly communication in the 21st Century would be to highlight qualities of the 20th Century model of scholarly communication that I believe will not or cannot persist. We will not see another hundred years like the past twenty five: in which the entire scholarly and academic library partnership increasingly struggles, sagging under economic pressures resulting from the wide-scale displacement of analog forms of communication and storage by their digital counterparts. We are in the midst of a continuing sea change, of a serious, potentially deadly, conflict between competing, perhaps irreconcilable interests. Small surprise that the theme for this year's Charleston Conference was, "Something's Gotta Give!"

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[1] http://en.wikipedia.org/wiki/Clarke%27s_three_laws, accessed 11/25/2011.
[2] Lorcan Dempsey,"A distributed national resource… the whole, the complicate, the amassing harmony…" Digital Library Federation Fall Forum, Opening Plenary Session, Nov. 18, 2000.
[3] http://www.nbic.nl/about-nbic/affiliated-organisations/cwa/introduction/, accessed 12/02/2011.
[4] Groth, Gibson, Velterop: "The anatomy of a nanopublication," Information Services and Use; 2010, Vol. 30, Issue 1, pp. 51-56.
[5] See http://www.nanopub.org/, accessed 12/01/2011.