

Libraries and the informational future: Some notes^{1,2,3}

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1. Scope

First, 2050 is very far away. Here are two quotes about change which frame my decision to take a modest view of developments within the next 5–10 years.

How did you go bankrupt?

Two ways. Gradually, then suddenly.

– Ernest Hemingway, *The Sun Also Rises*

We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run.

– Amara's Law.

Second, while some of my remarks are reasonably general, they are influenced by a library perspective.

And third, a note about technology and networking: we often tend to talk about the impact of networking or technology on features of the environment, rather than on the environment as a whole. The most interesting questions about impact though are often systemic, about how the environment as a whole may change as the interactions between the parts change. For example, changes in research and learning behaviors and expectations are more important for the academic library than any library technology changes per se. Similarly, how networking reshapes library organization, collaboration and scope will have more impact in the medium term than any particular local technology adoption.

My plan of action is to discuss four very general themes and then to make some general observations about library change and LIS (Library and Information Science) education in this context. The themes

¹This is a slightly edited version of an article of the same name which appears in *Information Professionals 2050: Educational Possibilities and Pathways*, G. Marchionini and B. Moran, eds, School of Information and Library Science, University of North Carolina at Chapel Hill, Chapel Hill, NC, 2012, pp. 113–125. Available at <http://sil.unc.edu/sites/default/files/publications/Information-Professionals-2050.pdf>. This work is licensed under the Creative Commons Attribution-Noncommercial No Derivations Works 3.0 Unported license. In any reuse of this article please refer to the Information Professionals volume. In any citation please refer to the Information Professionals version also.

²Portions of this submission, especially Section 2.4 are based on an unpublished paper written with Brian Lavoie.

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are:

- (1) An informational future: a processing perspective. *We are moving from a relatively static ‘document’ based world to a more dynamic informational one.*
- (2) From transaction costs to the network level: an organizational perspective. *The reduction of transaction costs in a network environment has meant that whole industries have been reshaped. Libraries will be no exception.*
- (3) The power of pull: a social perspective. *The library has to actively position itself to engage with research, learning and civic engagement.*
- (4) The importance of focus: a strategic perspective. *This is essential as libraries position themselves as important partners within their home institutions. They cannot continue to spend a lot of time on activities that replicate what is being done elsewhere and do not create real value for their institutions. Strategy is about making choices that increase impact. It is about moving resources to where there is most benefit, and finding the right level in the network at which things should be done.*

My overarching theme is that we need to prepare for systemic changes by better understanding how organizations are being reshaped by networks. I rely on several non-LIS sources in this context, notably on Manuel Castells and John Hagel.

2. Some themes

2.1. An informational future: A processing perspective

I liked Manuel Castells’ use of the word “informational” a few years ago [1], and although it is always ultimately counterproductive to try to use words in a reserved way, I am going to use ‘informational’ here in the sense that Castells proposes.

Castells uses ‘informationalization’ and ‘informational’ on the model of ‘industrialization’ and ‘industrial’. Informational activities are activities where productivity is maximized through the use of knowledge, gathered and diffused through information technologies. ‘Informationalisation’ is visible at all levels: doors open automatically, money is disappearing; the flow of materials is monitored by tracking systems; domestic and office environments are becoming more ‘intelligent’; distribution chains, the disposition of goods around retail floors, investment decisions, these and others are increasingly driven by behavioral data. Flows of people and materials follow the flows of data. Data is gathered, analyzed and shared to support decisions. An increasingly rich apparatus of instruments collects data about our environment. Pandora does our listening for us.

In our own context we can see this in multiple ways. We are moving from a relatively static ‘document’ based world to a more dynamic informational one. Consider some examples. . . :

- A *computational* approach is becoming more routine. We will programmatically promote metadata from resources, as the volume of resources to be managed makes it difficult for manual processes alone to cope. We will mine text and data for meaning. In Franco Moretti’s term, ‘distant reading’ will complement close reading, as we look for patterns [9]. And given the focus on this meeting on education, it is appropriate to mention here Hal Varian’s now famous remark: “So what’s getting ubiquitous and cheap? Data. And what is complementary to data? Analysis. So my recommendation is to take lots of courses about how to manipulate and analyze data: databases, machine learning, econometrics, statistics, visualization and so on” [6].

- Resources are *social* objects that become nodes in a network environment. Think of ‘bibliographic’ services: Amazon, Goodreads, LibraryThing, Worldcat, Mendeley. They each provide functional value: they get a job done; however they also provide network or social value as people make conversation and connections around resources of interest or importance to them. This in turn enhances the value of those services. Similarly think of a reading list or a bibliography or a resource guide: they frame resources in the context of particular research or pedagogical interests. We need better ways of creating social value in library services.
- *Analytics* is now a major activity, as transaction or ‘intentional’ data is aggregated and mined for insight. We have become used to recommendations based on buying or navigation patterns. As more material is digital, as more business processes are automated, and as more activities shed usage data, organizations are manipulating larger amounts of relatively unstructured data and extracting value from it. Within the library field, patterns of download, holdings or resolution are being mined to improve services.
- From *Strings to things*.⁴ Google/Yahoo/Bing/Yandex are promoting schema.org as a pragmatic way to add semantic markup to web pages. Effectively, it signals an interest by the big search engines in more structured data. The Google acquisition of Freebase a while ago and its recent announcement of the ‘knowledge graph’ is another. This marks a general interest in being able to answer questions more effectively, by being able to make assertions about the identity of ‘things’ and their relationships. Things like people, places, concepts and so on. We are seeing a growing interest in more semantic approaches involving entity recognition, ontologies, clustering of like items and so on. This general interest poses questions about the future of authority control and subject analysis: there is at once an opportunity as important intellectual work has been done by libraries and a challenge as ways must be found of mobilizing that work in this new environment.

The recent focus on big data is interesting here, as it seems to bring together two important issues. The first is data, and it is now common to talk about volume, variety and velocity as characteristics of *big* data. Here is an example of Library of Congress big data [7]:

- 5 million newspaper pages, images with OCR, available via API, used in NSF digging into data project for data mining, combined with other collections used in new visualizations, and in an image analysis project.
- 5 billion files of all types in a single institutional web archive – researchers do not search for and view individual archived sites, they analyze sites over time, and characterize entire corpora, such as campaign web sites over 10 years.
- Extreme example: over 50 billion tweets: many research requests received to do linguistic analysis, graph analysis, track geographic spread of news stories, etc.
- Collection of 100s of thousands of electronic journal articles, which require article-level discovery: they don’t all come with metadata and no one can afford to create it manually.

The second, though is the emergence of better infrastructure. The availability of the Hadoop family of technologies and cheap commodity hardware has made processing of large amounts of data more accessible. Cloud options are also emerging, from Amazon, Microsoft and others. Uptake has been rapid. So, while Hadoop and related technologies have emerged in the context of the Big Data requirements of webscale companies, they are becoming more widely deployed across a wider range of applications.

⁴This is a nice phrase of Google’s.

These make it possible to make data work harder, to perform predictive analytics, and this will change our expectations of what we can and should be doing.

2.2. From transaction costs to the network level: An organizational perspective

Transaction costs (sometimes ‘interaction costs’) have emerged as an interesting way of thinking about some dynamics in a network environment. Transaction costs are the costs involved in arranging for someone to do something for you rather than doing it yourself. Firms come into existence, Coase famously argued, because it is more efficient to coordinate the various component activities of production under a single organizational structure – a firm – rather than transact for each activity individually in the market [3]. Such activities might include acquisition of raw materials, processing, marketing, human resource management, accounting services, and more.

The reduction of transaction costs in a network environment has meant that whole industries have been reshaped. On the infrastructure and operations side, organizations have externalized requirements like payroll, computing infrastructure, manufacturing and so on. Companies like Cisco or Apple externalize much of the actual manufacturing of their products. Newspapers externalize printing and in many cases non-local news gathering. And on the consumer side, change has been rapid and far-reaching. Think of what has happened to music and books, for example. Think of the travel industry. As the need for physical distribution of expertise and materials diminishes, so there is a trend to achieve economies of scale and greater impact by moving to the network level. Amazon, Expedia, Etsy, Wikipedia, Google Scholar, Pinterest, Flickr and many other have emerged as important concentrators of internet use.

Think about academic libraries for a minute.

The use and creation of information resources is integral to the work of university members – students and faculty. In a print era, this meant acquiring, reading and annotating books, journals, reports and other materials. For some it also meant writing books, articles and so on. Since World War II, with the expansion of the scholarly publishing system, until recently, libraries, publishers, authors and various other agents, have operated in a reasonably well understood value chain. It was convenient for the university to internalize a collection of locally assembled materials, to organize it, and to interpret it for its users. The alternative, where everybody was individually responsible for all of their information needs would be inefficient and expensive: the aggregate transaction costs would be very high. This has led to the model of the library which has dominated university perceptions until recently: that of a building which houses collections and of an organization vertically integrated around the management of those collections. Each library deploys collections, and the systems and staff required to acquire, process, organize and provide access to those collections locally. Preservation is a benign artifact of the print publishing model as materials are redundantly available across the library system.

As the network lowers transaction or interaction costs we see change. On the infrastructure and operations side, historically there have been several waves of externalization and consolidation, either to collaborative infrastructure or to third parties. These include the development of shared cataloging and resource sharing networks and the move to a licensing model for the journal literature and more recently for books. More recently again, there has been a move to shared discovery environments, library management environments and other services sourced with cloud-based providers. We are at a stage where libraries are increasingly looking to collaborative solutions. Think of Hathi Trust. A few years ago, it is likely that libraries would individually build infrastructure to manage digitized books and store them locally. It is now accepted that this is better handled in a consolidated way, gaining from economies of scale, but also from being able to put a unified resource on the network.

What does this mean for directions in library management environments? Libraries will increasingly collaborate around infrastructure (see, e.g., the growing interest in cloud-based shared management systems), collections (see, e.g., the growing interest in shared print management arrangements) or expertise, or externalize these functions to third parties. The reduced transaction costs of collaboration and externalization make this consolidation inevitable. I provide some examples below.

On the consumer side, the change has been much more sudden and more far-reaching. Whereas information creation and use may have been organized around the library, it is now coming to be organized around network level services which support local workflows. For researchers, learners and citizens the transaction costs of creating and using information resources have declined considerably. This creates issues for the library, as its historic rationale is questioned and as it needs to position itself to add value in this environment.

Think of arXiv, SSRN, repec; Google Scholar, Google Books, Amazon; Mendeley, Citavi, ResearchGate; Goodreads, LibraryThing; Twitter, Facebook. These network level services are important components of workflow and information use for researchers and learners.

So, again, what does this mean for directions in discovery environments or workflow support?

- *Unified search*: libraries have focused on reducing the fragmentation of their search environments and making them more interesting.
- *Discovery happens elsewhere*: libraries are thinking about connecting their location services to those discovery services. So, they configure resolvers in Mendeley, Google Scholar or PubMed Central. They put links in Wikipedia. They develop widgets, bookmarklets and toolbars. They want to disclose their resources to other discovery environments.
- *Outside in vs inside out*: libraries continue to buy and license materials (outside in) and make them accessible. However it becomes increasingly important to think about how the institutions unique resources (special collections, images, preprints, learning materials) are discoverable elsewhere (inside out). This drives an interest in SEO, in metadata syndication, and in other ways of managing resources to be discovered.

These directions make strategic choice crucial, and I return to that below.

2.3. *The power of pull: A social perspective*

Google and Bing have each been working to include more social features in their search results. Specifically they are interested in leveraging the ‘graph’ of your personal connections to improve the results they provide as well as the overall experience. Google has been more deeply integrating Google Plus, and Bing has an arrangement with Facebook. This is a very visible sign of the way in which those connections have become more important. I spoke about social objects above. It is clear that people are important entry points⁵ to information spaces.

John Hagel and colleagues provide some interesting context here [4]:

[. . .] As we discussed in earlier chapters, in a world of accelerating change, the most valuable knowledge is highly distributed and may be embedded in the heads of people who are not well known and who are difficult to identify. [. . .]

It’s not so much about finding which information is most valuable, as many of those who fret about information overload would have it. Improving return on attention is more about finding and connecting with people who have the knowledge you need, particularly the tacit knowledge about how

⁵This is a nice phrase I heard from Dan Chudnov.

to do new things. The danger is that we all get so busy assimilating explicit knowledge that we have no time to connect with people and build the relationships through which tacit knowledge flows. We get so busy reading about steampunk, or brewing, or building networks, that we don't actually find and connect with and learn from the people who are doing it. It's not so much information that we need as knowledge. And knowledge means people.

These people and the knowledge flows they generate can then become effective filters for information more broadly. By harnessing social media such as blogs, social-network platforms and wikis, we can begin to rely on these mechanisms to expose ourselves to information that has been curated and passed on by these people. Since we deeply understand their contexts and passions, we can begin to determine when their recommendations are most reliable and increase our return on attention for both the tacit knowledge they offer and the information they recommend to us. Our personal social and professional networks will be far more effective in filtering relevant knowledge and information than any broader social-technology tools we might access.

The authors provide a broad framework for thinking about current changes and how people and firms should position themselves to operate effectively. A major part of this is a shift from managing 'knowledge stocks' to being able to participate in 'knowledge flows'.

The authors talk of three 'primary levels' of pull. First there is *access*, the ability to find people and resources when they are needed. The second is the ability to *attract* valuable and relevant people and resources to you. Social networking, conferences, location in relevant geographic spikes (Nashville for country music) are important here, as is the ability to be open to and develop relationships through serendipitous encounter. The third is the ability to *achieve* more by learning more effectively and translating that learning into improved performance. Interestingly, the authors discuss 'creation spaces' which support this third level. Examples include the social interaction on World of Warcraft and the SAP Developer Network which provide support for shared attention to problems.

I want to take two things from this discussion. The first is to think about the three levels in relation to library expertise and resources (if libraries want to be seen as experts, then their expertise must be seen).

- (1) *Access*: Is library expertise visible when people are searching for things? Can a library user discover a personal contact easily? Are there photographs on the website? The University of Michigan has a nice feature where it returns relevant subject librarians in top level searches. And what of resources? Are there blogs about special collections or distinctive services or expertise? I have already discussed how libraries need to make links back to library resources from where their users carry out their discovery process.
- (2) *Attract*: How should librarians position themselves so as to seem natural partners or collaborators? Curriculum support, grant support, data curation: the variety of ways in which to engage is growing, and libraries need to make sure that they are visible and active within appropriate organizational networks.
- (3) *Achieve*: As 'creation spaces' emerge how should librarians interact with them? One thing that comes to mind here is the role of emerging social networks for researchers, and whether library interaction and support is helpful or what form it might take.

The second is that I was struck by the extent to which success is seen by the authors to be bound up with network participation – networks of people and resources facilitated by digital networks. The future, they seem to suggest, favors – in Dave White's phrase – the network residents [12].

In summary, the library has to actively position itself to be in the flow of research, learning and civic engagement.

2.4. The need to focus: A strategic perspective

As libraries reconfigure how will they make choices about focus? Hagel and Singer [5] provide a simple framework which may be useful. They argue that historically firms have had three business foci, which because of high interaction or transaction costs were all internalized.

- *Engagement*:⁶ attracting new customers and building long-term relationships with them. This requires economics of scope.
- *Product innovation*: developing new products and services, and bringing them to market. This requires agility.
- *Infrastructure*: building and maintaining the “back-office” facilities and capacities that support day-to-day operations. This requires economies of scale.

However, they argue that as interaction costs fall in a network environment, firms tend to specialise in one or two of these. Think of the examples above. Cisco and Apple focus on innovation and engagement. They have outsourced infrastructure. Newspapers focus on engagement. They have outsourced infrastructure. Organizations rely on UPS for supply chain management, on ADP for payroll and so on.

Is this relevant to libraries? I believe it is. For libraries, the main focus may be engagement around services that support the workflow and learning lives of users. This does not mean that infrastructure is not important or essential.⁷ Rather, the library or university may look at alternative ways of sourcing more infrastructure, moving it to collaborative or third party sources.

Against this background, here are some examples of 5–10 year trends clustered under five elements of the library: collections, systems, space, services and expertise. I have discussed how aspects of *collection* management are being externalized to collaborative environments or to third-party providers. This happened some time ago with licensed materials. There is now broad interest in managing down print collections and working through the policy and service implications of consolidating print storage across groups of institutions. This is because those collections are releasing progressively less value on site, but also because of the opportunity cost represented by the use of valuable space. Hathi Trust has emerged as a collaborative response to the management of digitized materials. This too represents a reduction of local infrastructure investment. Libraries are also recognizing that the complexity, fragmentation and weight of locally deployed *systems* is burdensome and a drain on resources. This strengthens interest in moving to collaborative shared environments, or straight to third-party providers. In some cases scale advantages can be realized in terms of improved analytics, economies and performance. In all cases, there is some rebalancing and a trend to externalization.

In a major trend, *space* is being reconfigured around broader education and research needs, and less around the management of print collections. In effect, space is shifting from infrastructure to engagement, as it supports social interaction around learning and research, access to specialist equipment, expertise or communication facilities, exhibitions and so on. The “*service* turn” (this is a phrase of Scott Walter’s [11]) will become more pronounced, as libraries look at creating distinctive local services which meet particular needs. As changes in information use continue and the library is defined less by access to collections, or by the distinctiveness of its collections, focus shifts to information management and

⁶They actually talk about a customer relationship business, but we use engagement here as this fits the library environment better.

⁷This section compresses a complex argument. For some libraries, those in research institutions with a mission to preserve the scholarly record for example, an investment in infrastructure remains important.

use in research and learning, and greater engagement with students and faculty. This is accompanied by the recognition that library *expertise* must be more visible, and that new forms of expertise might be internalized, such as copyright or pedagogical expertise. In each case, libraries are creating increased value across a broader range of research and learning activities.

This is essential as libraries position themselves as important partners within their institutions. They cannot continue to spend a lot of time on activities that replicate what is being done elsewhere and do not create real value for their institutions. Strategy is about making choices that increase impact. It is about moving resources to where there is most benefit, and finding the right level at which things should be done.

Trends in Collections

Accelerated transition from print to digital, from bought to licensed for ‘outside-in’ materials.

Major reduction of local print collections and move of print collection management into shared supra-institutional collaborative/third party structures (gradually then suddenly?).

Progressive externalization of selection/acquisition processes: e.g., consortial purchasing arrangements, user-driven selection.

For many institutions a stronger focus on managing institutional resources: digitized special collections, institutional research and learning materials.

Greater engagement with scholarly and learning process, with a focus on increasing support for life-cycle of information production and use.

Progressive move to shared supra-institutional collaborative/third party structures for preservation.

Trends in Space

Reduction of the physical footprint of print collections.

Externalization of collection storage and related services.

Re-purposing of library space for interaction between people, and between people and specialist services, rather than for interaction between people and collections.

Internalization of user-focused shared service spaces, such as “learning commons” services, access to specialist staff and equipment, exhibitions.

Trends in Systems

Shift from internalized institutional-scale systems to externalized shared systems.

General divestiture of infrastructure management as a “core business” of the library.

Growth in importance of systems for engagement – pooled analytics data, app and integration work.

Trends in Services

Shift in focus from supporting collections to supporting users.

“Distinctive” services emerging as new indicator of impact and value.

More emphasis on supporting the process of scholarly activity, rather than just the products.

Growing importance of effective data-mining/analytics strategies to refine and improve services.

Trends in Expertise

Library expertise is a key element of the library value.

Renewed focus on embedding library expertise more deeply in research and learning processes.

Growing need within the university for expertise on creating, managing, and preserving digital resources.

The meaning of library expertise will diversify in the context of user engagement and changing research and learning practices.

Increased integration of other professional skills: marketing, pedagogy, technology, legal, . . .

3. Switches: Some library implications

So, against this environmental background, here are some ways in which library choices are changing as we move into an informational/network environment.

Abundance

Previously resources were scarce and attention was abundant. Now, attention is scarce and resources are abundant.

The library is now a part only of the information universe. Many of its approaches were developed to manage when resources were scarce.

Workflow

Previously researchers/learners would build their workflow around the library. Now, the library must build its services around the user workflow.

The library has to think about how to get into those flows.

Consumer

Previously, work or educational technology was more advanced than consumer technology. Now, expectations are set by consumer experiences which are often richer than work/the library/the school/etc., offers.

Systems and services are continually in need of change.

Enterprise

Castells again [1]:

In a dynamic, evolutionary perspective there is a fundamental difference between two types of organizations: organizations for which the reproduction of their system of means becomes their main organizational goal; and organizations in which goals, and the change of goals, shape and endlessly reshape the structure of means. I call the first type of organizations bureaucracies; the second type, enterprises.

Stability and a shared understanding of function favored bureaucracy. An enterprise mentality is required to navigate change, as library means must be reshaped to meet changing goals [10].

Pull

If libraries was to be seen as expert, then that expertise must be seen. Engagement, feedback, marketing, assessment all become important.

Data

We are used to thinking of data in reservoirs to be managed.
We now have to design, manipulate, visualize rivers of data.

Collections

Libraries acquired and managed relatively static collections.
Increasingly, they are looking at engaging with the creation, management and disclosure of institutional materials, with data curation, with scholarly publishing, with institutional reputation management.

Institutions

We are used to stable institutions.
We are now going through a period where publishing, education, and civic institutions are being transformed.

And much more...

4. Some thoughts about education: An interest in interstices

What does this mean for the education of those working in libraries?

While there is a small and specific professional core, much of LIS education looks at the intersection of particular LIS domain concerns and other domain concerns. Think of management for example, or computer science. Against that background here are some areas where those intersections might be updated, reconfigured or added.

And again, note that my focus is libraries, while acknowledging that LIS schools increasingly have broader purposes. I have also focused on academic libraries, although I hope these comments may be seen to be applicable in other contexts also. Finally, I have kept the treatment reasonably informal in keeping with the clearly preliminary nature of the thoughts presented.

4.1. An informational future: A processing perspective

I think it is important that people have done some programming, so that they have a native sense of issues. I was interested to see the ‘programming is the new Latin’ argument [2].

Library managers have to be more confident with technical staff, and more secure managing organizations that depend on system choices.

It is also very important to understand that data and systems have to be designed, not just adopted and used.

Here is Hal Varian again: “So what’s getting ubiquitous and cheap? Data. And what is complementary to data? Analysis. So my recommendation is to take lots of courses about how to manipulate and analyze data: databases, machine learning, econometrics, statistics, visualization and so on”.

Other areas: digital forensics, ontologies/domain modeling, information architecture, UI/UX, Text mining, data curation, machine learning, etc.

One role that the LIS school (or the I-School) may be well positioned to play is in interdisciplinary brokerage around informational issues. Data science, digital humanities, bio-informatics, publishing and scholarly communication: these and other areas are of interest may lend themselves to some cooperative attention.

4.2. From transaction costs to the network level: An organizational perspective

Libraries are organizations which operate in political funding environments. They are operating in a time of change which brings into play different skills and perspectives.

It is important to understand something of the dynamics of organizations, of the economics of information, maybe of institutional economics/industrial organization and law.

Librarians need to understand how education, local government, and publishing are not unchanging monoliths, but are being reshaped by economic and networking pressures.

They also need to understand how managing information, discovery and disclosure, has shifted.

4.3. The power of pull: A social perspective

Libraries and librarians have to position themselves. It is important to understand something about marketing and assessment. It is important to understand about the structure of disciplines, the behavioral norms of scholarship, the changing nature of publishing. It is increasingly important to understand the dynamics of social and research networks, and about writing/communicating on the web.

It is important to talk the language of the libraries’ home institution, to be able to talk about library values but also to be able to communicate library value in the context of institutional or scholarly or public values.⁸ Librarians have to be able to tell good stories.

⁸In the symposium presentation which accompanied this I quoted one of my favorite expressions of library value. This is from Fintan O’Toole, Irish author and journalist: “The library should not provide an argument for a particular case, but demonstrate that there is always another case to be made. The notion that the library is a place that has no agenda other than allowing people to invent their own agendas is what makes it an indispensable resource for a democracy”. This is in an essay in the collection [8]. This does not seem to be available on the web but a longer quote is at: “Public libraries in Dublin”, *Lorcan Dempsey’s Weblog*, 7 April 2005, available at: <http://orweblog.oclc.org/archives/000624.html>.

4.4. The need to focus: A strategic perspective

Libraries represent resources to be managed, and strategic choices need to be made about how best to create value for the home institution and their users.

Negotiation, business planning and budgeting are important, but so is change management, organizational learning and development, cultural transformation, project management, teaming. Working with staff to evolve roles is crucial. Libraries need to be more enterprising than bureaucratic.

Marketing and assessment, evaluation, research and testing become more important as services need to evolve.

Above all it is important to understand that ends need to structure means, because, as the poet said, it must change. The library, after all, is a growing organism.⁹

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⁹With nods to Wallace Stevens and S.R. Ranganathan.