Squaring the Circle: Using Analytics to Pursue Institutional Goals

Regina Werum, Associate Vice Chancellor for Research
Michael Zeleny, Assistant Vice Chancellor for Research
University of Nebraska–Lincoln

At last year's Merrill retreat, Prem S. Paul, Vice Chancellor for Research and Economic Development University of Nebraska, Lincoln, discussed the importance of developing informatics infrastructure designed to accommodate "big data" enterprises, especially in the areas of bioinformatics, physics, and social sciences. At this year's retreat, the "big data" discussion was carried forward – with a twist. Our charge was to provide insights on how to achieve research excellence in the era of analytics. In recent years, several organizations and software solutions have emerged (e.g., The Center for Measuring University Performance, Academic Analytics, SciVal), designed to provide business and intelligence data solutions for research universities.

They are marketed to enable university administrators at all levels to mine data regarding faculty strengths, collaborative networks, and productivity. The purpose of this essay is to reflect on the meta-analyses these software solutions facilitate. Specifically, we attempt to answer three questions: What do universities – and especially research administration offices – need to know in order to pursue institutional goals successfully? What can analytics software actually and potentially tell us? How can we address challenges that remain outside of the scope of these software solutions?

What do institutions need to know?

In essence, university offices or research administrators have three needs. First, they need to be able to identify and often quantify *institutionally specific metrics of success*. Typically this involves a set of goals related to the institutional mission overall. The areas of research and training in which institutions are likely to succeed are largely path-dependent, i.e., a result of their own institutional history. It also means developing metrics of success informed by the recognition that, like other large organizations, long-term interests of leading research universities are best served by a diversified portfolio. This, in turn, means that research funding streams should be but one source of institutional revenue, and externally funded research should be supported by a broad coalition of federal, state, and (increasingly) private-sector entities. Insofar as these institutional goals and metrics change, they tend to do so glacially.

In addition, metrics of success for offices of research are usually based on goals outlined in a strategic framework set by top administrators. These goals and metrics can and do reflect changes in institutional leadership as well as the broader political and fiscal context. For

instance, at the University of Nebraska–Lincoln, some of these goals are known as Research and Economic Development Growth Initiative (REDGI) goals, which were first outlined by Chancellor Harvey Perlman in his 2011 State of the University address.

There are two key REDGI objectives at UNL:

1. Enhance the quality and stature or research, scholarship and creative activity
2. Increase the quality and quantity of industry-academia partnerships

These objectives are linked to several more specific goals, including increasing total and federal research expenditures to specific targets within five years; increasing the number of faculty receiving prestigious national awards and recognition; and increasing the number of faculty working with the private sector to translate basic and applied research into innovations and job creation.

Second, administrators need to be able to identify intellectual and organizational strengths and weaknesses, in order to facilitate collaboration among units, and to inform strategic planning initiatives regarding hiring and other resource allocation. This top-down approach towards institution building is complemented by bottom-up analyses of research-active faculty and their networks and nodes of collaboration both inside and outside of the institution.

Third, research administrators need to be able to track funding trends throughout the institution over time, by unit, and by funding source. Efforts to "drill down" in this manner usually focus on comparing external grant submissions vs. actual funding rates, expenditures associated with external funding, and return on investments (e.g., internal seed funding, start-up funding, cost-sharing). We also need to track external funding trends involving public and private sector sponsors as well as changes in the philanthropic sector.

What Can Analytics Software Tell Us?

Academic analytics, in this context, refers to the analysis of research-related data (e.g., faculty productivity) to help educational institutions monitor progress on key institutional goals. Various software packages are available and offer products ranging from business intelligence at levels ranging from the individual faculty member to department/college/university-wide.

Academic Analytics provides "objective" data for use in administrative decision making. Most, if not all, of the universities represented at the 2012 Merrill Retreat used *Academic Analytics* software to some extent. The company pioneered use of the Faculty Scholarly Productivity Index (FSPI), a metric intended to create benchmarks for measuring scholarly quality in research universities. The index, based on a set of statistical algorithms, measures the impact and amount of scholarly work in various areas, including faculty recognitions and honors, journal citations, federal research funding, and publications. Analysis based on the FSPI (available by most academic fields of study) produces a ranking based on the overall faculty score using the various areas, above, compared to national benchmarks of that particular field. This analysis can be used as a comparison tool

between academic departments/colleges and their peers. *Academic Analytics* data could also be useful as part of an academic program review, either as a comparison of a department over two (or more) time periods or, again, against other departments.

SciVal was developed by Elsevier to provide a wide view of an institution's research activities. The software suite consists of various modules designed to help universities drive successful outcomes through aggregated and individual information. One module allows users (faculty or administrators) to identify potential research collaborators, another allows access to funding opportunities, while yet another allows users to measure the performance of faculty (and/or teams).

Perhaps one of the earliest organizations to formally measure performance among research universities was The Lombardi Program on Measuring University Performance (MUP) at the University of Florida in the 1990s. Now called The Center for Measuring University Performance at Arizona State University and the University of Massachusetts Amherst, MUP led the *Global Research Benchmarking System*, which aimed to provide data and analysis to benchmark research productivity in single fields and multidisciplinary areas. MUP publishes an annual report, "The Top American Research Universities," which includes more than 600 institutions, provides analysis and information useful for better understanding university research performance.

Each of these providers claims to provide users with a clear and comparative understanding of research performance and/or productivity and the critical factors related to decisions that lead to research improvement and/or success. And while, to some degree, each provides useful data for organizations, it seems clear that a comprehensive, one-stop research productivity software solution does not yet exist.

What Challenges Remain Outside of the Scope of Analytics Software?

Analytics software has already come a long way in a short period of time, and as computational sophistication and our ability to synthesize divergent sources of data improves, so will the potential of data analytics to inform strategic planning by university administrators. That said, at this point in time, analytics software tends to excel at three things:

- It helps us determine and visualize faculty and departmental productivity and visibility in several dimensions (grants, publications, citations, faculty honors and recognition).
- It helps us compare productivity and visibility across units within institutions, and in some cases across institutions and even fields (see example from *Academic Analytics*, in Figure 1, below).
- It helps us determine the collaborative network ties among faculty in a given unit and/or field.

Figure 1

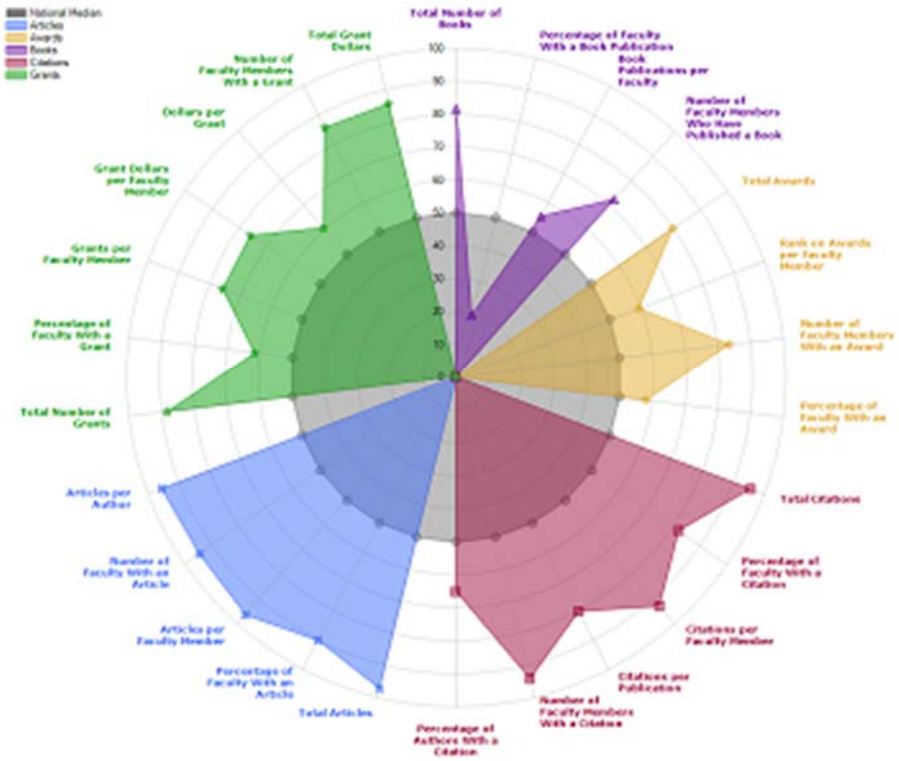
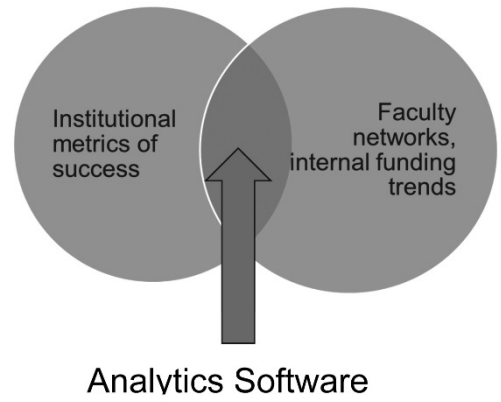


Figure 2, below, illustrates the implications, showing that analytics software excels at the intersection of some of the things research administrators need to know, and some of the dynamics involving faculty activities and funding trends.

Figure 2



Because analytics software has so far been designed to capture research productivity and describe existing network ties, it has been particularly useful to research administrators. However, we continue to have to supplement our analyses by relying on home-grown efforts and solutions that help us gauge faculty and institutional success in a way that also takes institutional priorities and capacities into account.

Rather than providing an exhaustive account of what ancillary analyses we need to conduct that analytics software to date cannot address, we will take the liberty to provide three examples that illustrate the challenges that remain outside of the purview of analytics software.

Example #1:

This example delineates how complexities in intra-institutional dynamics highlight potential limitations of analytics software. Remember the five-year REDGI goals

outlined for UNL? In addition to the research goals (significantly increased external funding, increased faculty partnerships with the private sector, etc.), other institutional goals include growth in student enrollment and faulty hiring, as well as improvement in retention and on-time graduate rates. Yet, the analytics software available is not designed to adjudicate between institutional priorities that, in the abstract are complementary – but in concrete settings tend to compete or even counteract each other.

Let us think through this as a case study. For the sake of argument let us even make the research administration unit most successful at championing institutional goals. What is the logical consequence of being highly successful regarding increased research expenditures? Regardless of whether this goal is accomplished by increasing the proportion of faculty who are grants active, or increasing the size of awards of grants-active faculty, this form of success could exacerbate stratification in the faculty ranks and between academic units. It could increase how much universities highly reliant on research funding depend on temporary and non-tenure track faculty for teaching purposes, as research-active faculty (many of whom will be tenure track) buy out an ever greater share of courses. It could also change the nature and extent of collaborative network ties among faculty at each institution, faculty network ties across institutions, and faculty retention in academia (see references).

Moreover, it may affect the distribution of service- and institution-building activities in which faculty participation is central, and in which tenure-track faculty tend to be more heavily involved. These activities range from graduate and undergraduate student recruitment, over involving students as research assistants (STEM pipeline), to institution-building efforts related to administrative needs, internationalization (e.g., study abroad), and the general goal to foster diversity in the STEM workforce. In short, success in expanding the research portfolio has the potential to alter how faculty allocate their time for research vs. service or teaching and thus to change the institutional culture in the long term. Put differently, hiring strategies largely driven by an effort to maximize research expenditures may have the unintended consequence of diluting the ability of institutions to meet other priorities related to the institutional mission and strategic goals (enrollment growth, STEM pipeline training, even economic growth and innovation). In its current form, analytics software is not likely to be able to address and de-conflict the complex relationship of seemingly complementary institutional goals. Software solutions have a long way to go before they can serve institutional leadership as a tool to develop holistic strategies designed to implement strategic plans effectively and optimize long-term institutional trajectories.

Example #2

This example delineates how complexities in inter-institutional dynamics highlight potential limitations of analytics software. To date, network analyses like the ones provided by analytics software remain largely descriptive, rather than explanatory or predictive. Visualization and interpretation of these networks and nodes

usually focuses on the "bandwidth" of ties and on their density within a given institution (or set of institutions). It is not clear how data analytics will take into account the dynamics that are currently changing networks and research collaboration patterns across institutions and with non-academic partners. Academic research by organizational scholars on how innovation occurs, how it "spills over," and how it affects inter-organizational collaboration dynamics show several notable trends (for details see, e.g., body of work by Owen-Smith & Powell cited below):

Path dependency matters: Organizational characteristics shape how information flows across institutions, and thus how innovation and opportunities for expansion/growth materialize. For research administrators, this means that the ability of universities to attract competitive funding depends in large part on organizational characteristics (rather than charismatic leadership). Such organizational characteristics include but are not limited to age (older is generally better), size (larger is generally better), sector (e.g., public vs. private, non-profit vs. for-profit), and peer group.

Geographic proximity matters: Geographic co-location and membership in a node (or peer group) do foster innovation – and by extension the ability of research universities to attract competitive funding. For research administrators, this insight is important because it means that institutions in densely populated markets tend to have the initial benefit. However, having extensive ties throughout one's group of peer and/or aspirant institutions is just as important and, in fact, becoming more important as multi-institutional collaboratives and centers are changing the field of higher education and STEM training.

Being the leading partner in a collaboration is not as important: Contrary to popular myth, centrality in the node *per se* (i.e., being the institution around whom everyone else gravitates) does not matter. Instead, being a central player in the node is key to innovation -- and arguably to competitiveness for external funding -- only under conditions where network members (faculty or institutions) are geographically dispersed. For research administrators, this insight is again crucial, especially those in the Midwest. It means that unless institutions are co-located in a metro context, they are better off fostering inter-organizational ties in which one institution provides the center of geographic gravity. Conversely, institutions co-located in dense urban areas are better off fostering inter-organizational ties with peer institutions in a more equitable partnership. Metaphorically, success for the former group may be said to resemble a planetary system whereas success for the latter group looks more like a meteor belt.

Institutional culture matters: Most "nodes" or groups of peer institutions are marked by homophily (aka "birds of a feather…"). Nodes have very distinct norms that shape the flow of information within and across nodes and thus affect how information and innovation disseminates. A broad range of social science research has shown that the kinds of "social closure" and "strong ties" typically associated with homophily have historically benefitted elites and play a key role in

recreating inequalities in access to resources. In contrast, so-called "weak ties" or social networks that reach across different types of institutions or status groups tend to have the greatest potential to confer an advantage to institutions seeking to grow, expand, and innovate. For research administrators this is important, because it implies that the ability of institutions to remain competitive and attract external funding hinges on the degree to which they share information and with whom.

Sectoral change matters: Until a few decades ago, open conduits between (types of) institutions used to be more normative. That practice also fostered the development of these all-important "weak ties." The resulting diffuse networks helped narrow gaps between institutions in a market that was not (yet) saturated. However, in part related to recent prerogatives to stimulate commercialization, these relatively open conduits are being replaced with closed circuits, which in turn foster dense ties and social closure. Research administrators have observed this trend in particular as it relates to the increasing importance and complexity involving intellectual property rights, nondisclosure agreements, patents, etc. This consideration is particularly important for university administrators, because of the obvious implications it has for the continued expansion of higher education, and competition over funding among institutions within the sector.

To summarize, in their current form, analytics are not well suited to help university leadership address the impact of increasing lateral and vertical stratification within the higher educational sector. More specifically, software solutions have been designed to help institutions look inward, rather than foster the types of collaborations across institutions likely to mitigate the ever more fierce competition over resources (students, faculty, funding) and its effect on the feasibility of long-term institutional goals.

Example #3:

This example delineates how dynamics outside of the higher education sector per se illustrate the limitations of current analytics software. In the above section, we discussed how the drastic changes in what constitutes desirable and productive professional and institutional networks are themselves a byproduct of changing funding priorities. But in addition to the call to privatization and commercialization, federal and other funding entities continue to push boundaries regarding the meaning and scope of interdisciplinarity and collaboration solicitations require for successful proposal submissions. Funding agencies do so for two reasons: Interdisciplinarity has been tagged as a main source of innovation in science and technology – and there is significant research support for the idea that heterogeneous teams are more likely to devise innovative and effective solutions (even if the process may be more difficult). Moreover, collaboration between fields and institutions has been identified as a way to maximize efficiencies and broader impact in an era of increasingly tight and volatile federal funding streams (Jacobs 2009).

This gets us to the historical phase of

an organizational field or sector in question. How to maximize the long-term success of individual organizations/institutions depends on market dynamics -- whether the sector is new, rapidly expanding, saturated, or contracting. Arguably, the higher education sector is reaching saturation, while undergoing significant changes regarding the role of research and teaching as part of institutional core missions. Moreover, what may be in the interest of individual institutions or types of institutions may not serve the long-term interests of the higher education sector at large.

On a related note, changing funding climates also affect the ability of universities to prioritize short- over long-term goals and adjudicate between the primacy of different funding sources (e.g., research vs. enrollments). To complicate matters, volatile fiscal/economic environments also affect how information flows across networks and nodes, how innovation occurs, and who benefits from it. Research in the Stanford school of thought (neo-institutionalism) appears to suggest that the tendency to emulate best practices at other institutions reflexively (aka isomorphism) has its drawbacks. Just when institutions experience sufficient duress to want to "circle the wagons" they'd actually be better served by being more inclusive. In other words, especially in fiscally unpredictable circumstances, open conduits are the best recipe for innovation and success.

In its current form, analytics software is not yet designed to help higher education leadership engage in the sort of simulation exercises necessary to determine the intended and unintended consequences of prioritizing specific metrics of success, typically gauged in terms of faculty productivity. Ideally, analytics software of the future could enable the types of simulation exercises needed to help predict the intended and unintended consequences of reaching specific institutional goals for a five, ten or even fifty year trajectory. If so, they should take into account the possibility of fundamental shifts regarding federal, industry, and other research funding opportunities, as those constrains the ability if institutions (and offices of research) to engage in strategic planning.

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