It is a pleasure to have the chance to address you today. To give you my background, prior to my current position at Elsevier, I was the Director of Product Development for the SciVal suite of products, and before that I was Director of Research Strategy at Columbia University in New York.

Before I speak about the concept of multidimensional research assessment, which is my main topic for today, I would like to make a brief introduction discussing the data sources used in the research assessment.
Agenda

- Data Sources: Scopus and SciVal
- The Multi-Dimensional Research Assessment Matrix
  - Examples 1 and 2: Evaluation of an individual researcher
  - Example 3: Evaluation of a department or lab group
  - Examples 4 and 5: Evaluation of an institution
Scopus, an abstract and citations database that indexes over 19,500 journals from 5000 publishers, is the primary data source for the SciVal suite of research analytics products that Elsevier is currently investing in. In addition to 48M records and 4.6M conference papers, Scopus includes a variety of alternative scientific content, from web pages to patent records and other relevant material.

SciVal is a suite of analytic products that leverage the rich data set embedded in Scopus to perform higher-level analysis on research outputs to assess research performance in a variety of dimensions. These are the two primary data sets that we will use in this presentation.
These are the four SciVal products. As part of the research assessment framework, I’ll be doing some analysis on research outputs primarily using SciVal Spotlight, Strata, and Experts, which are designed to provide decision support to senior research executives and policy makers.
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Why is the topic of research assessment such an important one? One of the most significant new global trends in research planning and performance is the more active role the governments are taking. With initiatives such as ERA in Australia and RAE in the UK, institutions are now required to evaluate research with more quantitative assessments, in addition to the qualitative and subjective measures already in use. Similarly, the Obama administration has placed a new emphasis on financial transparency and tracking of social and economic benefits of fundamental research through the ARRA program and other initiatives such as STAR Metrics, which seeks to quantify the social and economic impacts of government research investments given to university researchers.

In UK this approach has already led to significant changes in how much funding the leading research universities were getting. Some institutions like Birmingham and Aberdeen received more money as a result of these assessments, while others, including such elite institutions as Oxford and Cambridge, received less. These assessments showed that universities that were not considered the most elite institutions, such as Oxbridge and UCL, still had a wide range of focused areas of research excellence, a conclusion also supported by our own analytical tools.

What kind of tools are governments using for this kind of productivity analysis? Primarily they are using abstracting and citation databases like Scopus and its main competitor, Web of Science.
When we are asked to measure anything in a rigorous way, it is important to ask two key questions before launching into the process of measuring itself. First, how should the measurement take place, by what methodology and with what metrics? Second, what is the goal of such a measurement, the desired outcome or insights to be gained?

If these questions are not answered up front, it can result in a mismatch between what has been measured and what needs to be measured. This can cause distortion of results or a misuse of metrics. Just to be clear, any single metric used to measure has its limitations. The multidimensional research assessment matrix, as created by Dr. Henk Moed of Elsevier, who is previously an internationally-recognized bibliometrician at the University of Leiden in the Netherlands, gives us a way to help ensure we answer these key questions before beginning to measure and assess research.
There are 5 dimensions of the matrix. It is not to be read horizontally, but vertically—that is, any unit of assessment can match up with any purpose or any output dimensions.
What or who do we want to evaluate? This is generally a straightforward question to answer. But even here we can see misuse of metrics, as when an impact factor, which is a useful metric to measure journal impact and prestige, is used to evaluate an individual faculty member’s papers.
Second, the key question of what the goal is of doing this evaluation. This is slightly more complex, and may have multiple answers.
What metric or impact do we wish to evaluate? Again, the choice of these can help to determine the particular methodology that needs to be taken for an assessment.
While bibliometric indicators are certainly an important source for evaluating research outputs, there are other indicators such as peer review, patents, speaking engagements, Ph.D. completion rates, etc. that can be used effectively as part of the assessment. I won’t speak of these extensively here, but it’s important to note that peer review in particular is part of almost any important assessment of an individual or a laboratory group, and is almost certain to remain so. After all, peer review has proved its worth over hundreds of years. The technology has certainly changed and the methods used have evolved but the basic review process itself has not.
Here is an example of perhaps the simplest case—assessing the research productivity of an individual. In addition to the bibliometric indicators, peer review would also likely be an important part of any assessment. What does the department chair think of the quality and impact of this scholar’s work?
Looking at Scopus can give needed information about citations and papers published, as well as other commonly-used metrics such as h-index.
We can also evaluate a researcher by looking at number of publications over time. This functionality is present in SciVal Strata, which allows for multidimensional analysis on any individual, lab group or department against any control group (e.g. a different lab group at the same institution, or all astronomers in Chile, or all neurologists globally)
Again, this is taken from Scopus and can easily be sorted to identify papers with the highest citation rates.
On the author’s homepage, we see a sample of all the information available to us regarding Dr. Kunkel.

- Top concepts in his profile
- His recent publications
- Similar Experts
- Which journals he has been published in recently
- Which grants he has received recently

You can access all of the information in each of these areas by clicking the “More” button or the links on the left-side of the page.
On the publications page, we see the total # of publications written by Dr. Kunkel. These publications were examined in order to build his profile.

Users can sort the publications by year or citation count. This enables you to easily identify the most significant publications the author has produced.
Here we see all the current and past grants awarded to Dr. Kunkel.

We can click on a grant to access the details of the award as well as related topics, publications and grants.
Expert Profiling features three network views:

• The Institutional Network
• The Co-author Network
• The Research Network

These views are all based on the fact that because we know which publications are associated with an expert, and because we know which other experts are associated with those publications, we can build an expert’s research network based on those connections.

The Institutional Network gives us a complete list of all the internal and external organizations with which Dr. Kunkel has published.
The Coauthor Network provides us with a comprehensive list of all of Dr. Kunkel’s internal and external coauthors. This enables us to compare how much Dr. Kunkel collaborates with other researchers at the University of Michigan versus at other organizations.
The Research Network view provides us with the researcher’s co-author network in an interactive visualization. The visualization allows us to see all of Dr. Kunkel’s internal and external co-authors and how they are connected to each other.

- The red dot is the profiled researcher – in this case, Dr. Kunkel
- The purple dots are internal collaborators
- The grey dots are external collaborators
- The larger the dot, the more publications the expert has produced
- The thicker the line between two dots, the greater number of co-authored publications.
For a department, there is some overlap with bibliometric indicators used with individuals, but also additional elements such as the rate of international co-authorship, which correlates quite strongly with increased number of citations and greater impact and visibility for a paper.
Here you can see that the PUC-Chile group has a higher output over time in average citations per paper than University of Chile, USP, and astronomy and astrophysics within Chile as a whole. This is data again taken from SciVal Strata.
Another view of a different metric, looking at the rates of cited to uncited documents, which can be a good proxy for consistency of research impacts across time. This is also taken from Strata, and underlines the importance of not over-relying on any single metric.
Universities are frequently evaluated on the institutional level. This is a “circle map” taken from SciVal Spotlight, and looks at the institutional impact of the University of Chile from 2006 to 2010. Each circle represents a competency an area of research strength.

This analysis is done using a sophisticated co-citation algorithm to help determine which interdisciplinary research strengths exist at an institutional or country level. I don’t have time to go over the methodology in full detail, but I will give an analogy. Using traditional methods, a highly-cited biochemistry paper published in the Journal of Biochemistry is assigned as 100% biochemistry based on the journal classification code. These journal classification codes are a fixed, top-down hierarchy that doesn’t often change and cannot adequately capture multidisciplinary research.

In contrast, the co-citation algorithm analyzes the highly-cited paper’s references at an article level. Analyzing at the article level rather than the journal level can change the nature of the analysis. If the same biochemistry paper has 20% computer science references and 25% biotechnology references, the paper is fractionally assigned to those specific subdisciplines. This bottom-up approach does not assume any fixed hierarchy of science but changes dynamically as the underlying science itself changes. Think of genomics in 1999 vs. in 2002, after the human genome was fully sequenced. The underlying science would shift and shift interdisciplinary patterns of co-citation along with it. Use of this method allows research executives to understand their interdisciplinary research activities in a way that traditional methods cannot.
We also have created maps of over 4500 universities, federal laboratories, and companies. Here’s a map of U of M.
One capability that we have recently developed has allowed us to create collaboration maps for any institution. We currently have these maps for over 4500 universities, research institutes, and government laboratories globally. They allow us to do detailed analyses of collaboration patterns in any major field or subfield of science. This map represents every co-authorship relationship across the globe that the Northwestern faculty have. The white circles indicate the number of institutions in a particular country where there’s a co-author relationship.
If we zoom into a particular nation on the map, the number of institutes (white circle) becomes the number of individual co-authors that the Northwestern faculty is engaged with. At a glance this can show those institutions that have the highest total number of collaborations.
When we drill down into an individual circle, it can be seen that 215 authors at Tsinghua University are currently collaborating with Northwestern. It is possible of course to drill down further to the individual co-author names at Tsinghua and individual papers, and thus one can telescope easily from the global view to an institutional one to an individual author and paper view. Again, these maps exist for over 4500 institutions globally, and give a good basis for comparative analysis.
This is the US circle map, with over 1800 research competencies. This map highlights the research strengths of the United States, with top authors and top institutions for every competency. Northwestern has some bragging rights here because even though they published fewer papers than Princeton, they have a lot more citations than Princeton does on this one.
Similarly, you can see maps of India, China, and the UK here.
I am happy to respond to any comments or questions that you may have. Muchas gracias por sus atenciones!
Thank you!

d.calto@elsevier.com
+1-212-633-3663 (office)
+1-917-455-4788 (cell)