

Taking Impact Metrics to the Next Level at the National Institute of Standards and Technology

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Introduction

Just a few years ago, librarians in the Information Services Office (ISO) of the National Institute of Standards and Technology (NIST) were compiling information resulting in only a single data point – the number of annual NIST authored publications – as a metric to measure the organizational impact of NIST. Since then, ISO has expanded its skillset and creatively developed a number of innovative metrics that provide greater insight into NIST's impact.

This paper tells how ISO systematically became a key player in helping its parent organization, a federal government agency, demonstrate its impact and value to stakeholders. It also shares the research and methodologies behind ISO's portfolio of assessment measures.

NIST is a non-regulatory federal agency within the U.S. Department of Commerce (DOC). NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve the quality of life. ISO is responsible for creating, maintaining, organizing, and disseminating information to support the research and programmatic needs required to fulfill the scientific and technical mission of NIST.

ISO's expanded portfolio of impact metrics now includes identifying publication collaborations and articles published in top journals, as well as comparing NIST's impact to that of other institutions. ISO's impact assessment results are included in the NIST portion of the DOC Technology Transfer Report and NIST's Balanced Scorecard, reports used to document impact to Congress.

A range of enhanced impact assessment services are now actively marketed to NIST researchers, offering value and a new role as "strategic research partners." The expanded portfolio of impact assessment services has paid off in numerous ways for both ISO and NIST. In the process of developing new metrics, ISO staff have taken their skillsets up a notch to include citation/data analysis and network visualizations. This enhanced toolkit brings greater visibility to ISO's capabilities.

ISO staff are regularly called upon by NIST management, as well as bench scientists, to help with new challenges that no one would have considered asking ISO to do a few years ago. NIST as an organization has benefited from ISO's expertise by being better able to demonstrate its value and impact to Congress, the greater research community, and society in general.

A Simple Start: Number of Publications

The Information Services Office (ISO) was first asked to assist with assessing the impact of NIST's publications when the NIST Program Office (now called NIST Program Coordination Office (PCO)) asked if ISO could provide the number of publications NIST had produced in the latest Fiscal Year, 2008. This simple measure was included in NIST's report to the Office of Management and Budget (OMB) as one of the criteria for meeting Government Performance and Results Act (GPRA) measures.

NIST's publication output includes journal articles, conference papers, technical reports, book chapters, books, and other publication types. Since the Program Office was primarily interested in the number of peer-reviewed papers, *Web of Science*¹ was selected by ISO for determining publication counts for NIST's peer-reviewed literature. While not every NIST authored journal article is indexed in *Web of Science*, the great majority are, and the initial challenge was determining the best way of finding them in the database.

Today, *Web of Science* simplifies this task with its Organization Enhanced feature which automatically includes all name variations when searching for publications. However, in 2008, this was not available, and ISO staff determined the best way to collect NIST's body of papers in *Web of Science* was by searching for papers using the NIST address. A comprehensive address search strategy was developed that included a careful review of all NIST variant addresses including acronyms, abbreviations, and even the previous institution name, the National Bureau of Standards (NBS), which continued to be used long after the name changed to NIST in 1989.

From 2008 when it was first created, the NIST variant address search string was used to determine the number of NIST peer-reviewed publications for each fiscal year until FY2014 when it was set aside in favor of newer metrics that provide better impact measures. From FY2008 to FY2014, the number of peer-reviewed publications varied from year to year but never showed a true increase over time, which was the hope of the Program Office.

Through these years, ISO staff persisted in suggesting the use of other metrics and these were implemented in FY2014. ISO staff was especially encouraged when this single metric – the

¹ Identification of commercial products is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology.

number of NIST publications – led to new opportunities to measure NIST’s publication impact, which takes us to the next stage in the evolution of developing ISO’s impact analysis toolkit.

Developing Depth: Quality of Publications

In 2009, another request came to ISO from the Program Coordination Office, this time asking for a way to measure the extent to which NIST authors publish in “top tier” journals. ISO developed a methodology for determining NIST publishing patterns in top tier journals, and ultimately, the results of ISO’s study were shared with the NIST Associate Director of Laboratory Programs and incorporated into NIST’s collection of Balance Scorecard metrics regularly reported to the Secretary of the Department of Commerce.

For the purposes of this study, ISO defined a “top tier” journal as any journal with a Thomson Reuters Impact Factor (IF) that ranks within the top 10 percentile in its *Web of Science* Subject Category. IFs are highly discipline-specific and journal comparisons should only be made within the same field as IFs can vary widely between fields. The top tier journals were determined by using Thomson Reuters *Journal Citation Reports* to identify the titles within the top 10 percentile by IF in each of the 173 *Web of Science* Subject Categories, and combining them into one list. The NIST authored papers identified in the *Web of Science* search were then compared to the list of top tier journals to identify those papers published in the top journals (Figure 1).

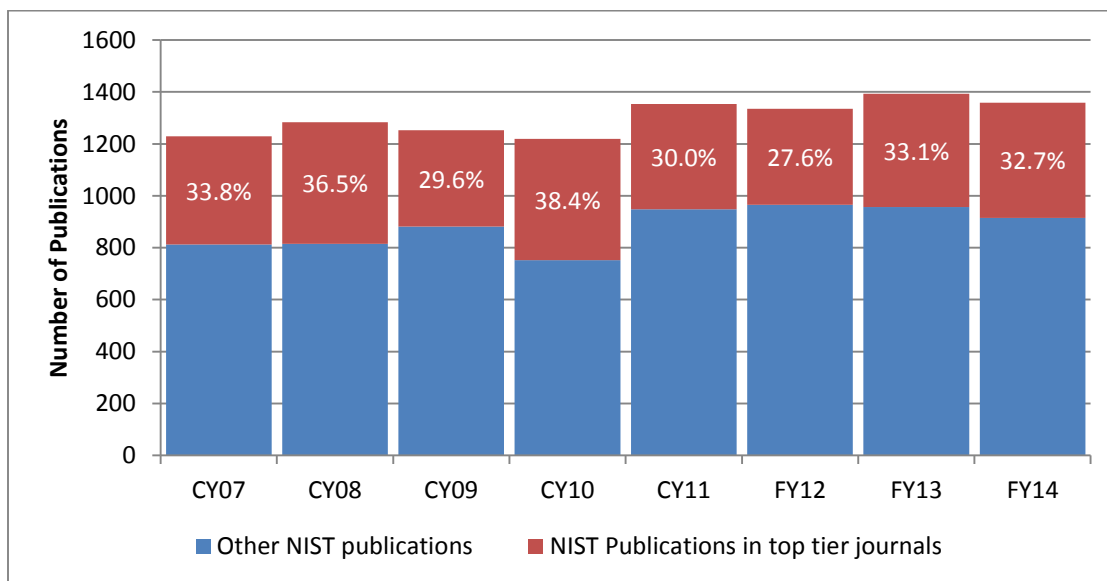


Figure 1. Percentages of NIST Publications in Top Tier Journals

Since publishing the results of this study on ISO’s internal web site, several NIST laboratory programs have requested a similar study for their lab and benchmarked their lab’s rate of publishing in top journals against NIST as a whole.

Providing Insight: Identifying External Collaborations

One way to measure the impact of an organization is through its publication collaborations. While researchers may regularly collaborate across an institution when publishing papers, collaborations outside their institution are an important indicator of impact.

In 2012, ISO received a request from NIST's Technology Partnerships Office (TPO) expressing an interest in developing ways of measuring the impact of federal research dollars. Within that context agencies were encouraged to develop metrics representative of their missions that could be used in economic impact analysis. NIST transfers knowledge through a variety of means, one of which is collaborations. While some NIST collaborations are formal, such as Cooperative Research and Development Agreements (CRADAs), many collaborations are informal. Co-authorship is one of those less formal collaborations. ISO developed a way to study these collaborations by collecting information on the number of co-authors, institutions, and countries to be reported in the yearly, statutorily required Department of Commerce Technology Transfer Report (U.S. Department of Commerce 2013).

Collaborations have been studied by ISO at many levels, including by state, country, research area, and type of organization. ISO consistently looks to enhance its assessment of collaborations. Collaboration data has recently been added to promotion package studies where the work of individuals is studied to determine how many researchers, institutions, and countries a NIST scientist has collaborated with on research publications.

In the study for TPO, unique co-authors and institutions were identified by repeating the search strategy for all NIST authored papers in the *Web of Science* database that was developed for our initial publications count project in 2008. While *Web of Science* offers an author analysis feature for analyzing search results sets, this feature does not associate names with institutions, which would allow ISO analysts to easily remove NIST authors. To disambiguate authors, ISO downloaded the full record for each NIST publication from 2008–2012. ISO analysts created a Microsoft Access database to extract the author names and affiliated institutions. The list of authors required manual manipulation to normalize author names and consolidate record counts (Makar and Malanowski 2014).

Because TPO was also interested in tracking the data on an annual basis to observe trends, the data for this study were gathered for each year back to 2008. These yearly datasets (2008–2012) will be compared to the annual data going forward. Earlier trend analysis is not possible because the *Web of Science* database does not link authors to institutions prior to 2008. For example, there might be ten authors listed for an article with four addresses given, but author affiliation cannot be determined using the *Web of Science* record.

This was the first study that prompted ISO to explore data visualization tools beyond Microsoft Excel to display its data. Using Tableau, a world map was overlaid with the number of times NIST collaborated with authors from each country (Figure 2).



Figure 2. International Collaborations on NIST Papers (2008 – 2012)

Creative Problem Solving: Benchmarking

A recent example of the growing number of NIST management requests to measure the impact of NIST publications came in 2014, again from the Program Coordination Office. PCO received a request from another federal agency, the National Oceanic and Atmospheric Administration (NOAA) to benchmark with NIST on the number of publications in the research areas of environmental science, meteorology and atmospheric sciences, and remote sensing. The Program Coordination Office agreed to NOAA's request and asked ISO for help in determining the number of NIST publications in these research areas.

ISO searched the *Web of Science* database and identified papers published by NIST authors. A *Web of Science* Subject Category analysis and Research Area analysis of this set of papers were performed to determine the number of papers published in the three subject areas specified. Papers indexed in *Web of Science* are assigned *Web of Science* Subject Categories and Research Areas. The *Web of Science* Subject Category assigned to a paper corresponds to the journal in which the paper was published, while a paper's Research Areas are based on the individual article's content. ISO considers the Research Area of a paper to be a more accurate means of identifying the topic of a paper than the *Web of Science* Subject Category. For example, looking at specific Subject Categories results in papers published in interdisciplinary journals such as *Science* or *Nature* being missed.

Applying Innovative Metrics: Strategic Research Partners

The impact measurement studies shared in this paper so far have described ISO's response to requests from NIST management. The next step in ISO's evolution of assessing impact was to proactively seek opportunities to demonstrate NIST's impact.

In 2014, ISO staff submitted a poster proposal "Assessing the Impact of NIST's Forensics Publications and Collaborations" to the conference planners of the Forensics@NIST 2014 Conference held at NIST on December 4, 2014. This was an opportunity for ISO staff to participate in the same venue side-by-side with NIST scientists and to share the impact of NIST's forensics research with the broader forensics community. Sharing our distinct skills helped guide conference attendees on the path to assessing their own institution's publications. This also resulted in multiple new requests from NIST researchers for impact assessment studies in the forensics field and beyond, and a possible opportunity to cosponsor a forensics conference workshop.

Forensics-related papers by NIST authors were identified by performing a search in the *Web of Science* database for the years 1978–2014. ISO developed a complex *Web of Science* search strategy using a variety of forensics-related keywords. All NIST authored articles in the *Web of Science* subject category Legal Medicine were also included. The search included publications in the peer-reviewed literature (journals) while excluding most conference proceedings papers.

A network graph (Figure 3) was created using the Science of Science Tool (Sci²) to extract the co-author network from the *Web of Science* search results. It was then exported to Gephi to create the graphic. Subdisciplines for the co-author network were assigned manually by studying the underlying papers for each author and identifying their predominant research fields.

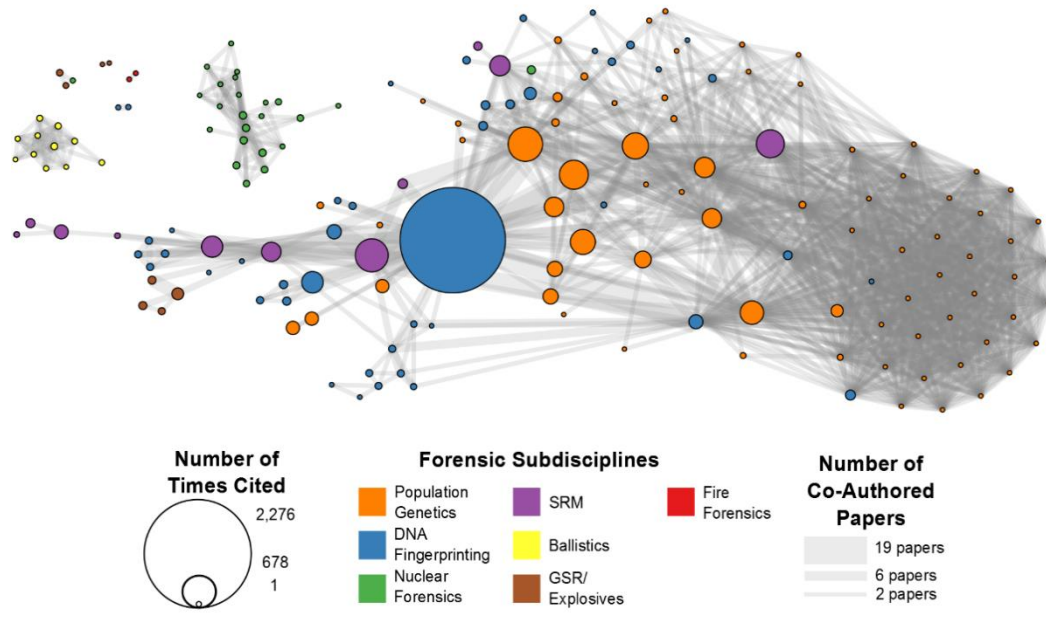


Figure 3. Co-Author Network of NIST's Forensic Publications

Conclusions & Next Steps

The development of ISO's impact assessment techniques and methodologies has been an evolutionary process, tied to ISO's strategic focus on building closer collaborative relationships with the NIST scientific and technical staff and to be seen by them as "strategic research partners." The importance of being seen as a research partner facilitated the move from responding to the request to provide a single number, a publication count, to creating network visualizations that demonstrate NIST impact. ISO has come a long way in building staff confidence, competencies, and credibility as "strategic research partners" at NIST.

While the majority of the analysis examples shared in this paper were performed for NIST management, we have been able to transfer these skills, ideas, and experiences into helping our scientists see their impact, envision the future of their research field, and examine possible collaboration opportunities and publishing venues.

As a result of this evolution of skills, ISO is receiving requests to help researchers with presenting their data. Our staff is actively acquiring more skills and knowledge on data visualizations, and learning new tools. With a request for information on the detection and confirmation of microbial outbreaks, the customer specifically asked for graphics and visualizations of the data ISO found. The customer was so impressed and interested in ISO's visualizations that he requested training by ISO staff on how to use Tableau for future projects.

The future of ISO's analysis studies looks bright. We are now doing impact analysis beyond publications and are currently assessing the impact of NIST's Standard Reference Databases (SRDs). ISO is also studying internal publication collaborations, or how our scientists collaborate with each other across groups, divisions, and labs within NIST. Our work on forensic publication collaborations has led to other projects requesting author and subject area network diagrams. These new analyses acknowledge ISO's critical and unique contributions as strategic research partners and impact assessment experts in NIST's discovery process.

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