Open Access for Engineers and Engineering

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Scholarly communication, which encompasses the creation of scholarly content, evaluated for quality, and disseminated amongst the scholarly community, is the key for the advancement of knowledge in any discipline. It has a history of more than 350 years. The *Journal des sçavans* (later renamed *Journal des savants*), established by Denis de Sallo, was the earliest academic journal published in Europe. Its content included obituaries of famous men, church history, and legal reports. The first issue appeared as a twelve-page quarto pamphlet on Monday, 5 January 1665. This was shortly before the first appearance of the *Philosophical Transactions of the Royal Society,* on 6 March 1665. [1]

For over three centuries, scholarly communication has been happening through the medium of printed journals. Over the period of time, the subscription cost of scholarly journals has been rising steadily. During the last couple of decades, it has reached a stage wherein even the richest of libraries in the world are not in a position to subscribe to all the journals and other scholarly resources that their users would like to have access to. This situation is amply exemplified by a memo issued in 2012 from Harvard Library to the university's 2,100 teaching and research staff. It calls for action after warning it could no longer afford the price hikes imposed by many large journal publishers, which bill the library around $3.5m a year.[2] If Harvard university is unable to sustain its subscriptions to scholarly journals, one can imagine the plight of the libraries in the developing and the underdeveloped countries.

The access barrier to scholarly literature created due to high subscription costs can hamper scientific progress because fundamental characteristics of scholarly research is that it is created for public good to facilitate further enquiry and extending the existing body of knowledge. Substantial portion of such research is funded by the government agencies.

During the last three decades, the rapid advancements that are taking place in the fields of Internet, web and related technologies have transformed the way research is carried out and disseminated. Paul Ginsparg brought about a revolution when in August 1991 he started hep-th@xxx.lanl.gov using automated email systems and public FTP servers to help researchers in high-energy particle physics to exchange preprints. In 1998 this server was renamed as arXiv, and currently it serves as an electronic preprint server for Physics, Mathematics, Computer Science, Nonlinear Sciences, and Quantitative Biology. ArXiv had an immediate impact on physicists in less developed countries. They received research ideas almost instantly and their own contributions could be read by others, immediately.[3]

The effective demonstration of exploitation of knowledge and sharing information by the physics community indeed formed the basis of the worldwide call for web-wide open access (OA) to scientific information. In 1994, Stevan Harnad proposed all scientific authors to use public FTP servers to share preprints with their peers.[4] Today, researchers have got technically better systems and legitimate ways to make their postprints - 'peer-reviewed' research papers - (not just preprints) openly accessible to all potential users.

The concept of facilitating Open Access to peer-reviewed scholarly literature has its roots in the development of e-print archives. The landmark meeting initiated by the Soros Open Society Institute (OSI) in Budapest in 2001 resulted in the establishment of the Budapest Open Access Initiative (BOAI) and a definition of two primary ways ahead to close the knowledge gaps in science.[5] The first OA strategy is called Self Archiving, and subsequently also referred to as Institutional Archives (or Repositories) / Open Access Archives (OAA). In this strategy, accepted versions of already published research articles are archived in the author's institutional OA archive and / or in a subject-based archive. The institutional repository of the Indian Institute of Science, ePrints@IISc, <http://eprints.iisc.ernet.in> established in the year 2002, was Indian's first interoperable institutional repository.[6]

The second strategy is publication of Open Access Journals (OAJ). All the journals published by the Indian Academy of Sciences are OAJ. <http://www.ias.ac.in/Journals/Overview>

Around 2000, researchers at the University of Southampton developed EPrints, a free and open-source software package for building open access institutional repositories that are compliant with the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH, https://www.openarchives.org/pmh/). It was followed in 2002 by DSpace, developed at MIT in partnership with Hewlett Packard. Both EPrints and DSpace have undergone many developments in the past 15 years and currently are being used by many institutions around the world.[7]

Facilitating open access to research publications, either through institutional repositories or by publishing in open access journals, enhances the visibility and citation impact of such publications.[8] Also, research generated in the emerging countries will be missing to the international knowledge base because many of the journals published from the emerging countries are not indexed in the leading abstracting databases nor they are being subscribed by the libraries in the developed countries Thus, there are both North to South and South to North knowledge gaps, leading to incomplete pictures of global health, environmental and other developmental issues.[9] The knowledge gap can be easily overcome if the researchers facilitate open access to their peer-reviewed scholarly literature.

Facilitating OA to the final accepted versions of the research papers by the researchers across the world will substantially reduce the access barrier to published scholarly literature that exists today. Despite significant inherent advantages associated with OA, researchers are not keen in embracing OA publishing voluntarily. This has prompted research institutions and research funding agencies to mandate OA publishing for the research they support through their OA policies. OA policy mandates researchers to submit their peer-reviewed, final accepted manuscript either in an institutional repository, or in a centralized repository.

Several publishers have also responded favourably to the growing demand for OA and permit authors to self-archive their papers. For example, IEEE grants authors and their employers the "right to post the accepted version of IEEE-copyrighted articles on their own personal servers or the servers of their institutions or employers without permission from IEEE".[10] ACM and ASCE also give similar privileges to their authors. Sherpa-Romeo <http://www.sherpa.ac.uk/romeo/search.php>, a service of JISC, UK, provides a guide to publishers' policies on OA.

Biomedical funding agencies in the USA, UK, Europe and India have realized the potential of open access to research outputs and encourage the researchers they support to share preprints and postprints through interoperable repositories.

Current status of OA

Many services are available for scientists and scholars to make their research output OA. Individual scientists and scholars can effectively make their paper OA just by typing a few additional keystrokes. It costs nothing for scientists to archive their preprints in central preprint servers such as arXiv and bioarXiv, and to upload post-prints on their personal websites or in institutional repositories (e.g. http://dst.sciencecentral.in/). Metadata interoperability among these repositories enables service providers create index of records available in the distributed repository system and build search interfaces<e.g. BASE: https://www.base-search.net/?l=en>.

There are full OA journals where every article is OA and there is no charge both for the author and the reader, and there are full OA journals that charge authors an article processing charge (APC). The Directory of Open Access Journals (DOAJ) <https://doaj.org/> has listed more than 10,400 OA journals published from more than 120 countries and, of these, 236 are engineering and technology journals. And, there are traditional commercial journals that offer authors a choice to make their papers OA provided the authors pay the requisite author processing charges (APC). Such journals are called hybrid OA journals. The APC varies across the journal publishers.

Funding agencies in the USA, UK, and Europe underwrite the cost of APC for the papers that come out of the projects they fund. In India funding agencies require researchers to upload papers resulting from the research they fund in interoperable OA repositories, which are also supported by them.[11]

An estimate made late last year showed that India was potentially spending about USD 2.4 million annually on APCs paid to OA journals and the amount would be much more if APCs paid to make papers published in hybrid journals open access were added. Needless to say that it would be prudent for Indian authors to make their work freely available through interoperable repositories. That is the trend in Latin America and China. Scientists are ready to pay APC as long as institutions pay for it and funding agencies are not ready to insist that grants provided for research should not be used for paying APC.[12] Recently Ministry of Human Resources Development (MHRD) has notified that publications in 'paid journals' (meaning paying APC) would not be considered hereafter for faculty selection and promotion in NITs and a senior official of MHRD has told a correspondent that this practice is being followed by IITs already.[13]

In 2016, *Science Citation Index Expanded* (*SCIE*) has indexed more than 1.5million papers (article, letter and review), and of these 200,422 (13.3%) are published in full-OA journals. Of all the papers indexed in SCIE, 329,630 (22%) have been

published in journals that can be classified as Engineering and of these16,904 (5%) papers have been published in full OA journals.

Materials science, and Metallurgy and metallurgical engineering account for 126,083 (38%) of all engineering papers, and 8,011 or 7% of all papers in this field have been published in full-OA journals; Electrical and electronics engineering and Automation and control systems account for 63,525 (19 %) and 2,793 or 4.4% in OA journals; Computer sciences account for 52,663 (16%) and 2,024 or 3.8% in OA journals; Chemical engineering account for 34,427 (10.4% and 1.1% in OA journals; Mechanical, Manufacturing, and Production engineering, and Robotics together account for 31,848 (9.7%) and 1,698 or 5.3% in OA journals; Civil engineering and Construction building technology account 20,181 (6.1%) and 442 or 2% in OA journal.(Data as seen in *WoS*). It may be noted that some journals are classified under more than one field and therefore the total will add up to more than 100%. *AIP Advances*, *Materials*, *Mathematical Problems in Engineering* and *IEEE Access* are the journals where researchers have published at least 800 papers.

SCIE does not show counts of OA papers in hybrid OA journals and therefore the count one gets from SCIE is less than the actual number. Researchers might publish their papers in non-OA journals and upload the post-prints on personal websites, and/or in institutional repositories.

Engineers depend on technical reports and recent conference literature for their highly focused information needs.[14] So, they tend to often present papers in research conferences rather than publishing in journals. However, a search in *Conference Proceedings Citation Index* (CPCI) reveals researchers in the fields of Electrical and electronics and Computer science more often use conference venues to present their research than researchers in other engineering fields. About79% of the 366,381 proceedings papers published in 2016, and indexed by *CPCI* fall under Engineering category, and of these Electrical and electronics, and Computer science together account for 221,117 which is 76.5% of all Engineering proceedings papers (or 60% of all proceedings papers). According to *CPCI*, only 2% of all the Engineering papers are OA. MATEC web conferences (3,654 papers) and E3S web conferences (577 papers) are among the conferences with the largest number of OA papers. Distribution of OA papers in conferences and journals by country is plotted in a bar graph as shown in figure 1.
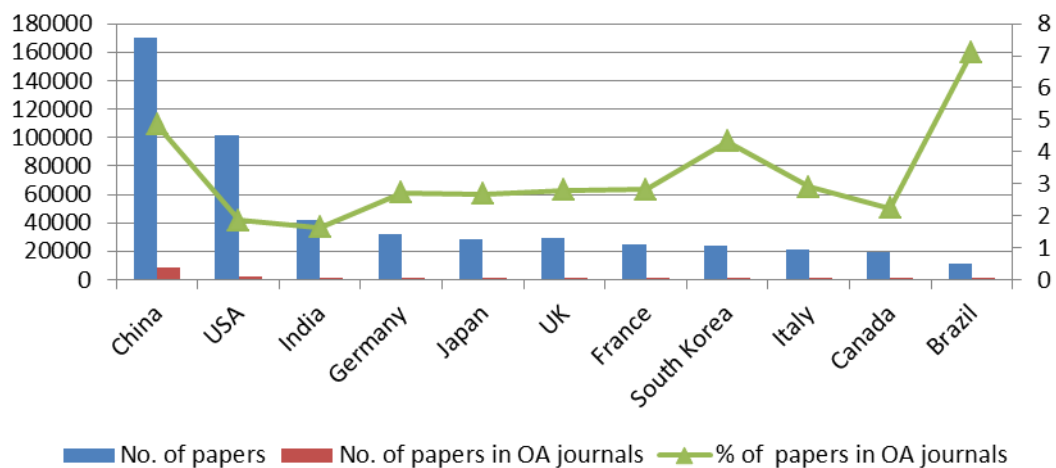

Fig 1. Distribution of Engineering papers and papers published in OA journals/conferences by country.
Source – SCIE & CPCI

Conference papers are typically formal publications in Computer science and are "often more prestigious than journal articles, with acceptance rates at some conferences below 10%" says Steve Lawrence.[15] One should be cautious while estimating the quantity of Engineering literature using tools like Web of Science (*WoS*) and *Scopus*. By matching publication profiles of faculty working in the departments of Physics, Mathematics, Electrical and electronics, and Computer science in leading US universities with author profiles of popular citation databases, Wainer et al found that *WoS* had not indexed on average 66% of the published work of a computer scientist and the rate of invisibility in Computer science and Electrical and electronics is much higher than that of Mathematics and physics. "On average, 47% of conference proceedings are not indexed in *CPCI* and 32% not indexed in *Scopus*."[16] Also, research papers in fields of Electrical and electronics, and Computer science are highly scattered in different kinds of sources and disorganized on the web. Hence, the citations to these papers are scattered as well.

Lawerence and colleagues developed CiteseerX <http://citeseerx.ist.psu.edu/>, a search engine based on an autonomous citation indexing algorithm, to index the scientific information on the web.[17] CiteSeerX gathers its content mostly by crawling the literature in computer and information science in public websites and partly through submissions by authors. Recently, the software's architecture and data model have been modified to enhance its user experience.

It is clear that engineering researchers have no particular interest in publishing in OA journals. They will do well to change their attitude to OA. A very large portion of the conference literature goes unindexed in citation databases such as *WoS* and *Scopus*, but the computer science database CiteSeerX crawls all repositories (including personal web pages) and automatically indexes every paper down to individual citations and disambiguate author names. The advantages are obvious. We suggest that Citeseer-like crawlers be developed for all fields and researchers in all branches of engineering deposit their papers in a repository, or at least in their own web page. When publishers are ready to grant authors permission to upload postprints of accepted papers in their own or their institution's website, we should capitalize on the opportunity.

Considerable amount of engineering research is carried out in India and it will be to our advantage if all of them are made accessible through open access channels. MHRD could set up its own harvester, similar to Science Central and CSIR Central, and request CSIR-URDIP to develop and manage the same as they are doing the other two already.

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Acknowledgement

Don't mess with intelligent people

When Swami Vivekanand was studying law at the University College, London, a white professor, whose last name was Peters, disliked him intensely.

One day, Mr. Peters was having lunch at the dining room when vivekananda came along with his tray and sat next to the professor.

The professor said, "Mr Vivekanand , you do not understand, *a pig and a bird do not sit together to eat.*"

Vivekanandji looked at him as a parent would a rude child and calmly replied, *"You do not worry professor. I'll fly away,"* and he went and sat at another table.

Mr. Peters, reddened with rage, decided to take revenge.

The next day in Class he posed the following question: "Mr.Vivekanand , if you were walking down the street and found a package, and within was a bag of wisdom and another bag with money, which one would you take ?"

Without hesitating, Vivekanandji responded, "The one with the money, of course."

Mr. Peters , smiling sarcastically said, "I, in your place, would have taken the wisdom."

Swami Vivekanand shrugged and responded, *"Each one takes what he doesn't have."*

Mr. Peters, by this time was fit to be tied. So great was his anger that he wrote on Swami Vivekanand's exam sheet the word "idiot" and gave it to Swami Vivekanand.

Vivekanandji took the exam sheet and sat down at his desk trying very hard to remain calm while he contemplated his next move.

A few minutes later, Swami Vivekanand got up, went to the professor and told him in a dignified polite tone, "Mr. Peters, *you signed the sheet*, but you did not give me the grade."