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RESEARCH QUALITY, PUBLICATIONS AND IMPACT IN CIVIL ENGINEERING INTO THE 21ST CENTURY. PUBLISH OR PERISH, COMMERCIAL VERSUS OPEN ACCESS, INTERNET VERSUS LIBRARIES?

by Hubert Chanson ([1])

([1]) Professor, Division of Civil Engineering, The University of Queensland, Brisbane QLD 4072, Australia - Fax: (61 7) 3365 4599 - Email: h.chanson@uq.edu.au

Email : h.chanson@uq.edu.au - URL : http://www.uq.edu.au/~e2hchans

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Abstract : A research project is only completed when it has been published and shared with the community. Referees and peer experts play an important role to control the research quality. While some new electronic tools provide further means to disseminate some research information, the quality and impact of the works remain linked with some thorough expert-review process and the publication in international scientific journals and books; unethical publishing standards are not acceptable. The writer argues herein that the new electronic aids do not replace scholarship nor critical thinking, although they impact on the working environment of civil engineers.

Keywords : Research publications, Quality, Impact, Peer reviews.

INTRODUCTION

Civil engineering is related to the design and construction of structural and related works that serve the community. It is a practical discipline that requires the application of science to real-world applications. But what is the real-world? For the last three decades, the higher education, research and professional environments have been completely transformed by the electronic and digital "revolution". This includes the introduction of personal computers, the development of email and world wide web, the introduction of search engines, and the broadband Internet connections at homes. The shift has been associated with the development of digital resources, e-journals, publishing databases, and open-access repositories. All these e-resources have had some impact on the access and retrieval of technical information used in civil engineering projects, sometimes at the expense of technical content and research quality.

These changes have had a tremendous impact on our working environment. While some new electronic tools provide further means to disseminate the research information, the writer argues that a successful research project is one whose results are published and shared with the research and engineering community. The quality and impact of these works are linked

with some thorough expert-review process and the publications in international scientific journals and books.

RESEARCH PUBLICATIONS IN CIVIL`ENGINEERING: PUBLISH OR PERISH

A research project is only completed when it has been published and shared with the community, including researchers and practicing professionals. There is no such thing as an unpublished research study. Research publications constitute a key element to establish the intellectual copyrights and they provide the means to assess the scholarship of the work. Although the intellectual ownership of a discovery may be secured by a patent, most advances in civil engineering research are secured intellectually by some form of peer-reviewed publication. The peer-review process contributes to the quality control. It is essential to assess the standing and scholarship of the work. "*The confidential assessment of the manuscripts by the referees is the single most important activity that any journal undertakes*" (Nandakumar 2006). Referees and peer experts have a duty to scrutinise the research quality and scholarship.

The traditional means of scientific publications include the book, book chapter, international refereed journal article, international refereed journal discussion paper, international refereed conference paper, and refereed technical/research report. Each type of publications has its own standing, public and prestige. Figure 1 illustrates a situation that the writer calls some inverted pyramids of refereed research publications. The most challenging publications are often the most difficult to publish in but also the most prestigious. However it must be stressed that the research environment needs all types of refereed publications. Each refereed publication is a worthwhile contribution. This is, above all, very pertinent to young engineers and early-career researchers.

In developed countries, the governmental bodies and funding agencies are increasingly developing some form of research assessment, to quantify the research quality and impact. Researchers are now accountable. For example, in the UK, France, Italy and Australia, the

research quality assessment is focused on the reputation and impact of each researcher based upon his/her contributions in premier peer-reviewed publications. Research publications are ranked in terms of standing and impact. The standing of a type of publication might be assessed by its "impact factor", but this parameter is a poor surrogate measure of the quality of a research publication. The "impact factor" merely reflects upon the number of journal issues published per year and on the number of years that the journal was listed in Science Citation Index™. A better measure of quality is the perception of the journal by its peers. For example, the top scientific journals in hydraulic engineering are the IAHR Journal of Hydraulic Research and the ASCE Journal of Hydraulic Engineering. However, the true contribution of a researcher in a paper is inversely proportional to the number of authors. Some multiple-authored papers may derive from a major interdisciplinary teamwork, but the individual involvement cannot be compared to the scholarship of single-authored articles. While some new electronic tools provide further means to disseminate research information, the quality and impact of the research remain closely linked with a thorough expert-review process. Publications of international scientific journals and books are the standards (Fig. 2).

A genuine indicator of a research publication impact is the number of citations. That is, the number of citations of the work in the Web of Science™ that includes Science Citation Index™, but also the number of citations in refereed publications listed in Google Scholar™ and the number of citations in textbooks. The citations of a work in textbooks are not reported in the Web of Science™, but they constitute a formidable measure of impact. Another indication of the research publication's impact is its professional impact, for example, its use in professional design standards.

Scholarship and "cheating"

The quality and impact of a publication demonstrate the scholarship of its writer(s), although the level of scholarship is inversely related to the number of authors. Importantly, the researcher(s) must be honest and truthful. It takes several years and decades to establish a solid reputation for research scholarship and integrity, but it takes a few "rotten apples" to

discredit a research group and the profession. Although the problem of "cheating" and deception is relatively small in absolute numbers, this is, nevertheless, a critical issue affecting many of us in the profession.

The writer is regularly engaged in peer-reviews for over 35 international scientific journals and another 25 international conferences, he contributes as Associate editor of several publication series and Technical director of international events, and he performs further expert reviews for research funding and governmental bodies. His experience showed that some manuscripts in hydraulic engineering (as an example) involve unethical publishing behaviour. This is further discussed in "*The ignoble art of cheating in scientific publications*" by Henze (2005) and Mavinic (2006) ! Both Drs Henze and Mavinic drew upon their experience as journal editors to present unscrupulous activities, and each researcher should read their editorials. The writer has had some similar experience and he discusses recent examples of unethical situations.

This writer reviewed a single-author paper for the 2005 IAHR Biennial Congress. That manuscript was already published : i.e., most of the text and all the figures were identical to a published journal article co-written with this author's project supervisor. The congress submission was prepared by an individual who had malicious intent of duplication and plagiarism, and who blatantly ignored the contribution of his research supervisor. Such an attitude is appalling ! During the past 12 months, the writer also reviewed another manuscript that was submitted simultaneously to three journal publications by the same people. Simultaneous parallel submissions are not tolerable. In these instances, the submissions were further based upon already published materials. This attitude is unethical, and, these people are now "black-listed" by the journal editors. In May 2002, the ASCE-Journal of Hydraulic Engineering published a "fraudulent paper" on dam break wave. The paper was based upon some experimental work done during a Ph.D. thesis (Debiane 2000) and some analytical development by the Ph.D. supervisor (Piau 1996). Neither the Ph.D. student nor supervisor were acknowledged and cited, although the paper included several figures that were directly copied from the thesis. In this instance, the attitude of the author was inexcusable, but the

review process was also sub-standard because the original works were published prior to the review process. The writer believes genuinely that the Ph.D. student would be entitled to take legal action against the journal for intellectual infringement and questionable review standards. Honesty and integrity is a duty of each author, but it is also the obligation of the reviewers and journal editorial to be more vigilant. Recently, an Associate Editor of a hydraulic engineering journal rejected a submission which did not cite the unpublished Ph.D. thesis of the Associate Editor's student. This is another form of inappropriate behaviour from an Associate Editor.

RESEARCH PUBLICATIONS: REPOSITORY AND RETRIEVAL

The retrieval and use of published technical documentations is an important component of civil engineering and research. It may be also a significant component of professional design projects undertaken by consulting engineers. Searching, finding and accessing the right information were traditionally undertaken in libraries: i.e., university libraries, state libraries, professional libraries and personal collections. This approach has shifted towards Internet-based searches for the last few decades, with the introduction of Internet library catalogues, international databases and specialised search engines (Chanson 2005).

Let us define these terms. A search engine is an Internet-based tool designed to search, rank and present results in the form of links (URL) relevant to the searched terms. In 2006, the market is dominated by Google™ which started recently a specialised engine called Google Scholar™, aimed to search the scholarly literature (Cozzolino and Di Pace 2005). An international scientific database is a commercial database accessible by the Internet and listing international refereed publications. In engineering, some well-known examples include Web of Science™ and EI Compendex™. Other databases are managed by publishing companies and they are often limited to the publisher's journals: e.g., Science Direct™ and Scirus™ by Elsevier™, Kluwer Online™, Scitation™ regrouping several professional institutions like the American Society of Civil Engineers, American Society of Mechanical

Engineers and American Institute of Physics. The access and usage of a commercial database is not free. It is relatively expensive, and hence it is limited only to large library institutions owned by government agencies, universities and large industrial groups. An open-access digital repository is a service developed to support open-access (OA) research information. Open-access repositories (OAR) were developed by universities in reactions to high journal prices and licensing terms. The number of these repositories has blossomed over the last 5 years. The directory of open-access repositories (DOAR), operated by the University of Nottingham (UK), listed 800 open-access repositories (OAR) in October 2006. A library is "*a place where books, recordings, films, etc are kept for reference or for borrowing by the public*" (Penguin English Dictionary). Traditional libraries used to store and provide textbooks, handbooks, monographs periodical publications, theses and archive collections. Today, most libraries offer a broader range of services, including printed materials, multimedia, on-line information resources, and in-person and on-line assistance.

For civil engineering students, researchers and engineers, a project starts with some bibliographic research that involves (a) a search for relevant titles and listings, and (b) the retrieval of the most appropriate documents. These two phases may involve distinct specific techniques and they must be followed by a critical analysis of the retrieved information. The entire process is further iterative. For example, let us consider the design of a hydraulic jump energy dissipator at the downstream end of a steep spillway (Fig. 3). An engineer must first search for the relevant terms: e.g., hydraulic jump, energy dissipation, spillway. Then he/she will select, retrieve and analyse a few, most relevant documents. There is a basic difference between the search and retrieval stages. The search may be conducted physically in a library and on-line using library catalogues, scientific databases and Internet search engines. The search results provide a very broad listing of relevant materials and resources that must be critically ranked because there is too much information. For example, a search for "hydraulic jump, energy dissipation, spillway" in Google™ yields over 12,400 results, while a search with Google Scholar™ gives 219 titles ! Of the 219 documents listed by Google Scholar™, more than 50% are not open access. A search in Web of Science™ yields 22 publications.

The second stage, the "retrieval", is closely linked with (a) a selection of the most relevant results of the search, and (b) the rights and permission to access the resources. Engineering students and academic researchers may access a wide range of physical and electronic resources provided by their university library. These encompass the physical collections, the electronic periodical subscriptions and open access repositories. Professionals have usually some restricted access to these services. The cost of traditional libraries and international databases is often prohibitive. Many consulting engineers can only access a commercial search engine like Google Scholar™ and open-access digital repositories: e.g., "*as a consultant, I don't have access to journal indexes or databases* (...) *it's just much too expensive*" (J. Rémi, Person. Comm., 9 March 2006). Individuals and small companies are simply limited exclusively to open access materials, including the open access repositories and the "grey literature".

Although some ranking of the search results may be based upon the number of citations or cross-references (e.g. Web of Science™, Google Scholar™), the final selection of the relevant references must derive from an iterative process involving the search, retrieval and analysis of the documents by the engineers, which may lead to further relevant documents.

Comparison between commercial search engines and international databases

This writer compared the outputs/performances of commercial Internet resources, international databases, digital repositories and traditional library resources. He tested some search results from three scientific databases (EI Compendex™, ISI Web of Science™, Scirus™), an electronic repository (OAIster) and Google Scholar™ for several civil and hydraulic engineering topics (Table 1). Some results are presented in Table 1 as the absolute number of results and the percentage of peer-reviewed results. Google Scholar™ is a commercial tool from a dominant market leader which is developing new Internet services. It is not an independent database like EI Compendex™ and ISI Web of Science™ which includes Science Citation Index™. The search results from Google Scholar™ sometimes include more non-refereed references than peer-reviewed publications. While differences

were expected, it was noted that the quality of Google Scholar search outputs was closely linked with the appropriate selection of technical and scientific terminology. Interestingly, this writer was surprised positively by the results from the open access digital repository OAIster developed by the University of Michigan. (OAIster accesses over 730 institutions and includes more than 10 millions of open access documents in January 2007, and the numbers were growing very rapidly.)

For comparison, the writer searched the University of Queensland Library catalogue and he conducted a search in the shelves for each term. He found several key library references that were not listed in any search engines or international databases, especially 12 books and 4 video documentaries. In fact, books, video documentaries, photographic records and slide-shows are typical library resources that are often ignored by the Internet. Let us consider the earlier example for the design of a hydraulic jump energy dissipator. A search for "hydraulic jump, energy dissipation, spillway" at the University of Queensland Library yields some further 25 books, monographs, theses and videos. Clearly the traditional libraries cannot be solely replaced by an Internet search.

DISCUSSION

In recent years, the writer has become increasingly concerned by the disinterest of some young researchers, engineers and students for basic references that are neither listed nor available in the Internet like textbooks, handbooks, and videos. This attitude covers also scientific publications published prior to 1997-2000 because these are often not available on-line. This trend is true for most international scientific journals like Journal of Fluid Mechanics, Journal of Fluids Engineering ASME, Journal of Hydraulic Research IAHR and Experiments in Fluids. Many scientific journals should initiate some project to scan all earlier issues of their journal for digital access. Importantly the fact that an article or a book is not available in a digital format does not constitute a valid information on its standing. The

number of citations by peers in refereed publications (e.g. using Science Citation Index™) is a better indication of scholarship and quality.

Professionals, students and researchers must comprehend that computer search engines and Internet databases cannot replace conventional libraries. Search engines, digital aids and databases fail to convey well images, pictures, and graphical information. For example, they cannot express the beauty of turbulence in Nature (Fig. 4), the sorrows of a human tragedy at world-scale nor the extents of an environmental catastrophe. Traditional library resources may include a wide range of support including audio-visual, hard copies of older books and 3D animation that are not on-line. Internet "surfing" does not replace browsing the shelves of a good scientific library, nor some field experience. Morever, digital materials are biased towards the American and English literature, at the expense of other sources (e.g. Vaughan and Thelwall 2004). For example, in fluid mechanics, it is worth remembering that Archimedes, Hero of Alexandria, Blaise Pascal, Daniel Bernoulli, Leonhard Euler, Louis Navier, Henri Darcy, among others, did not use English ! In the future, the digital literature might become biased towards simplified Chinese publications.

Will traditional book and journal publications disappear ? No, because digital databases and on-line access do not replace scholarship. All the e-resources and digital aids cannot replace the critical thinking. There is no substitute for smart thinking, innovation and scholarship. Recently, an American honours graduate summarised the situation: "*I became incredibly aware of the rapid rate at which science and mathematics develops after reading myriad articles and books on the subject of fluid dynamics and river flow. This was especially noticeable in the comparison of approaches and techniques used to solve the "dambreak" problem.* [One] *approach was complicated and laborious, involving bulky factorizations and numerous approximations that would take hours just to copy down on paper.* [Another] *approach, however, was elegant in its simplicity and conciseness, easily adapted to the specifics of our problem*" (Polwarth 2005).

Lastly civil engineering is not a "virtual" science ! Engineers and researchers must gain first hand experience in real professional situations, and comprehend the complex interactions

between engineering and non-engineering constraints. Computer and Internet aids cannot replace field experience and personal individual observations (e.g. Chanson 2004).

CONCLUSION

Civil engineers and researchers from all over the world are under pressure to publish more and more papers ("publish or perish"). Indeed a research project is only completed when it has been published and shared with the community in research publications that must be peer-reviewed. Referees and peer experts play an important role in controlling the research quality. While some new electronic tools provide further means to disseminate research information, the quality and impact of the works remain linked with some thorough expert-review process and the publications in international scientific journals and books. However, unethical publishing standards are not acceptable. Cheating is despicable. Even simple forms of cheating like laziness, ignorance or even cultural differences are not excusable.

New search engines and open access digital repositories may fill a gap between traditional search engines, databases and libraries. These new means should not be mistaken with traditional libraries and international scientific databases that encompass textbooks and key peer-reviewed publications. Similarly, the standing of textbooks and handbooks should not be confused with a lack of listing in some databases and repositories. Internet "surfing" cannot replace traditional resources and personal experience particularly in the civil engineering profession. All the e-resources and digital aids should never replace critical thinking and scholarship. The future lies probably in a complementary use of all tools by experts, knowledgeable researchers, academics and engineers.

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Internet resources

Directory of Open-Access Repositories DOAR {http://www.opendoar.org/}

EI Compendex {http://www.engineeringvillage2.org/}

Google Scholar {http://scholar.google.com/}

ISI Web of Science {http://portal.isiknowledge.com/}

OAIster {http://oaister.umdl.umich.edu/o/oaister/}

Table 1 - Search results on civil and hydraulic engineering topics : comparison between a search engine, three scientific databases and an open-access digital repository : number of results / percentage of peer-reviewed works

Search topic	Google Scholar™	EI Compendex™ 1884-2006	ISI Web of Science™ 1945-2006	Scirus™	OAIster
Air entrainment in hydraulic jump	164/ 73%	37 / 92%	8 / 100%	301 / 9%	5 / 100%
Broad-crested weir	85 / 45%	58/ 95%	28 / 100%	1619 / 2%	3 / 100%
Dam break wave	71 / 85%	30 / 97%	17 / 100%	389 / 3.5%	12 / 100%
Dropshaft	81 / 79%	33 / 94%	15 / 100%	191 / 4%	16 / 94%
Earth pressure on cantilever sheet pile wall	9 / 67%	6 / 100%	1 / 100%	1186 / 5%	0
Real time information on driver route choice	70 / 44%	44 / 95%	3 / 100%	67691 / 1,4%	0
Tensile stresses in concrete pavement	259 / 40%	150 / 93%	5 / 100%	4059 / 4%	2 / 50%
Thixotropic fluid flow	3 / 100%	1 / 100%	1 / 100%	6 / 33%	0
Tidal bore	170 / 50%	78 / 90%	29 / 100%	1036 / 8%	13 / 92%

FIGURE CAPTIONS

Figure 1 - The "inverted pyramids" in refereed research publications: from most challenging to most rewarding

Figure 2 - Examples of refereed research publications in hydraulic engineering, including books, international journals and technical reports

Figure 3 - Photograph of a stepped spillway in operation (Photograph by Christopher Goodell) - Wilde Lake in Columbia, Maryland on 23 March 2005 after a 1-year storm event

Figure 4 - Beauty in water engineering : tidal bore propagation in the Sélune river, France (Photograph by Hubert Chanson)

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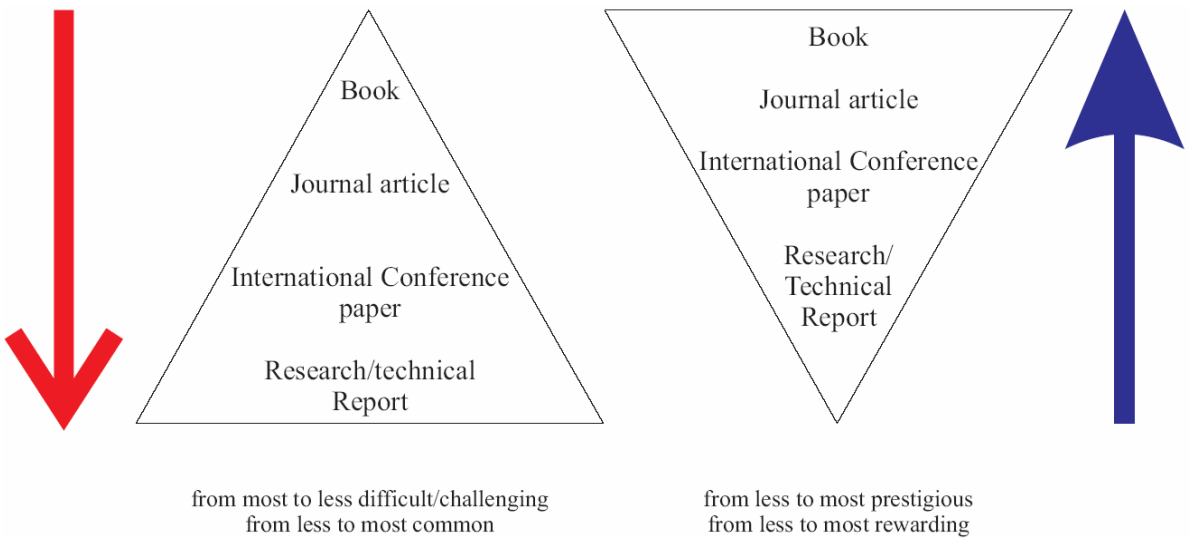

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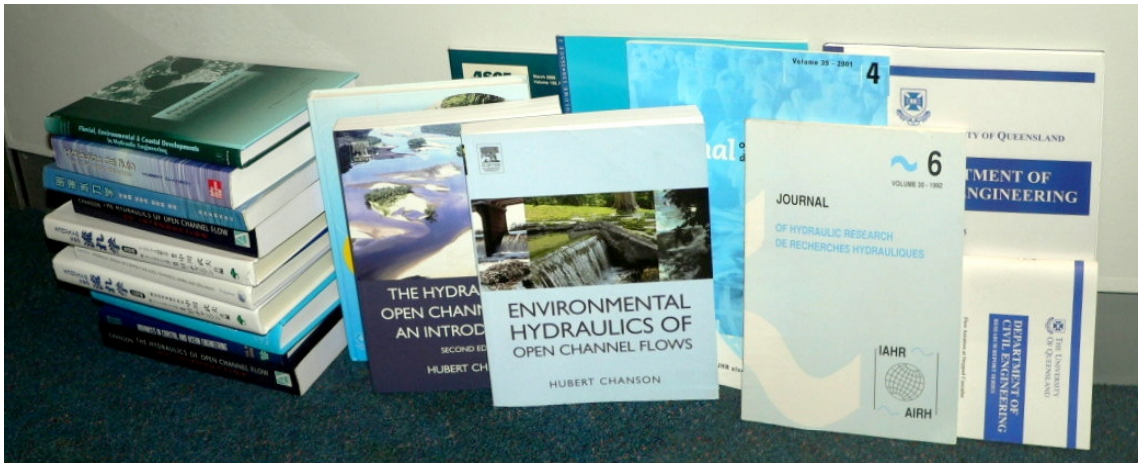

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