

China's Scientific Journals in a Transforming Period: Present Situation and Developing Strategies

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Abstract

Based on a detailed analysis of the global academic impact of China's scientific journals, as well as of the publishing strategies and communication media used by their publishers, we conclude that the Science, Technology, and Medicine (STM) journal publishing industry in China is going through very rapid transformation. Journals are attempting to become more broadly international, and doing so by adopting new digital production methods and commercial models. In light of these efforts, we discuss the current challenges to the development of China's scientific journal industry and suggest strategies that may be useful for reaching key goals.

Keywords / mots-clés

China; Scientific journals; Development; International competition; Digital publishing; Financial models

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Introduction

Over 80% of the 5,000 scientific journals now published in China were launched after 1980, about the time when China's cultural and commercial policies began to open up. Like many enterprises in China since that time, particularly those subject to censorship, most of China's scientific journals have been sponsored by government or public institutions. According to Guo, Zhao, Pan, Zhang, & Zhu (2006), the vast majority of China's scientific journals are in fact sponsored and financially subsidized by universities (28.8%), research institutes (25.6%), and societies or professional associations (24.3%).

Although China's scientific journals have been playing a notable role in the development of research within the country, the corresponding documentation and communication by these journals of the actual progress being made by China's research community has not been sufficient. The Science Citation Index (SCI) shows that while overall articles published with first authors from mainland China have risen by 381% from 2000 to 2009, at the same time an increasing percent of these articles were published in journals owned and managed outside China (Table 1, Figure 1). Overall, the contribution ratio of articles published in China's journals has decreased from 40.7% to 20.4% during the same ten year period.

Table 1. Number of China's SCI articles published in 2000 and 2009

Year	A – Number of China's SCI articles *	B – Number of China's SCI articles published in China's journals	B/A	C – Number of China's SCI articles published in non-Chinese journals	C/A
2000	22,608	9,208	40.7%	13,400	59.3%
2009	108,806	22,229	20.4%	86,577	79.6%
Increase	381.3%	141.4%	-49.9%	546.1%	34.2%

Notes: Data from Chinese S&T Journal Citation Report (CJCR), published annually by the Institute of Scientific and Technical Information of China (ISTIC).

* with a Chinese first author

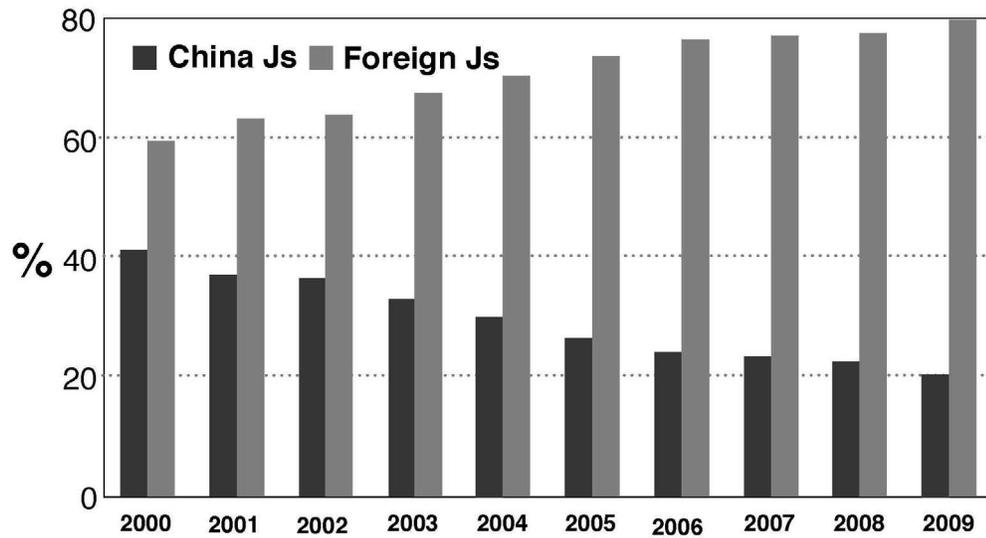


Figure 1. Journal distribution of China's SCI articles (%) Data from CJCR (ISTIC, 2001–2010).

The low output and impact of articles published in China's scientific journals is also reflected by the very low number of highly-cited articles. According to statistics from the Essential Science Indicators (<http://www.esi-topics.com>), which counts citations based on SCI, there have been 836,255 of China's SCI articles published between January 2001 and October 2011. Among these, 5,874 (0.70%) landed in the highly cited list (top 1% of all SCI articles in the world), yet only 47 of them (0.80% of the 5,874 or 0.006% of the 836,255) were published in China's scientific journals.

Although many Chinese journal sponsors and editors are aware of the enormous challenges in attempting to increase the reach and impact of China's journals, few have developed models that will allow them to have greater success in the international publishing realm. To improve the competitiveness of China's journals, these sponsors and editors need strategies grounded in a thorough and realistic analysis of their internal challenges, as well as complete information about the international standards in the global communication of science that they must meet.

A period of transformation for China's scientific journals

In the past decade, the challenges faced by China's scientific journals and publishers in transforming China's scientific publishing market have become increasingly clear to academics and publishers, both in China and overseas (Stanley, & Yan 2007, GAPP, 2010; The Royal Society, 2011; Xinhua Editorial, 2011; Xu & Wahls, 2012). Three primary drivers are at the root of these challenges:

1. The internationalization of the Science, Technology, and Medicine (STM) publishing market in China and the consequent competition for quality content.
2. The pressure on Chinese publishers to shift from traditional to full digital publishing workflows.

3. The imperativeness of creating new and commercially viable financial models to meet the demands of recent government policy changes.

The first driver, the push to internationalize China's scientific journals, is primarily fuelled by the expanding global competition in STM publishing. Since the early 1990s, more and more Chinese research institutions have been encouraging researchers to publish in foreign journals with high impact factors, primarily to more widely disseminate Chinese science, and also to increase the international and academic recognition of Chinese researchers and their institutions (Wang & Weldon, 2006; The Royal Society, 2011). Researchers are offered financial rewards for publishing in high impact journals, and formal policies tie publication records to professional evaluation, funding, and promotion. In response to these intense incentives, Chinese researchers pay enormous attention to publishing their work in the highest-ranking international journals that they can possibly achieve.

China's entrance into the World Trade Organization (WTO) in 2001 was another ingredient driving the country's goal to increase the international exposure and ranking of its STM journals. Entering the world market has pushed China's journals to compete for high quality manuscripts, not only amongst themselves but also with the international players working in the same arena (Zhou, 2007). The Chinese government and journal sponsors recognized the importance of the scientific marketplace and the fierceness of the competition within it, and responded by establishing special funds to support journals showing strong potential to develop in the international arena. These funds for supporting journals or related projects include the "Program of Key Scientific Journals" (started in 1999 by the China Association for Science and Technology [CAST]), "Special Fund for Key Academic Journals" (started in 2000 by the National Science Foundation of China [NSFC]), and the "Elite Journals Program" (established in 2008 by the Ministry of Science and Technology [MOST]) (Ren, 2005; Zu & Ren, 2001; Liu & Zhang, 2009). In fact, CAST, which has already identified and funded 25 scientific journals, has recently established a foundation for the specific purpose of supporting journals to achieve international ranks (CAST, 2012). In addition, China's General Administration of Press and Publication (GAPP) may soon launch another project, dubbed the "National Key Academic Journals Project," to further support China's production of high impact science journals (GAPP, 2010; Li, 2011).

The second driver at the core of China's challenges to transform its scientific publishing market is the current necessity to publish content electronically. To be competitive in the global market today, publishers large and small must be able to provide readers with access to information in different formats via the Internet. In recent years, some international journal publishers have drawn up to 80% of their distribution revenue from digital products (Liu, 2010) and large publishers like Elsevier and Nature Publishing Group make a variety of new electronic products available on a regular basis. China's journals are, unequivocally, woefully behind in making the transition from print to digital publishing. This lag is due in part to the fact that the digital products of China's scientific journals are controlled by only a handful of technical providers including CNKI (<http://www.cnki.net>), WanFang Data (<http://www.wanfangdata.com.cn>), and VIP (<http://www.cqvip.com>). These providers not only

integrate the full-text of articles from China's journals into their databases, but in doing so capture and hold the lion's share of revenue from the market of digital readers. In other words, at present, Chinese publishers basically serve only as academic content providers; they cannot obtain full revenue from the digital distribution of their content and therefore do not make sufficient profit to develop and maintain a self-sustaining financial model (Nie, 2009; Cheng, Ren, Lu, Yan, Wang, & Fang, 2011) — much less establish or build brand recognition. To succeed in the international market, leaders of China's scientific journals will have to find a way to shift from traditional to digital methods of production and distribution, and while doing so change their business models to become more self-sustaining and internationally recognized.

The third driver of change in China's scientific journal publishing — the necessity to commercialize — is intimately tied to the second. To date, the purpose and goal of China's journals has been to distribute knowledge, not to make a profit; and at the end of the day in China, all journals are owned by the government and therefore should be recognized by GAPP. What that means is that all new journals must be approved and registered by GAPP, and assigned a CN serial and an ISSN number. To launch a new journal, a publisher must obtain the registration through GAPP's strict approval process, which scrutinizes every aspect of a new publication from the condition of the sponsoring institution, to available human and financial resources, to other processes and details related to the running of a publication. The requirement that they must obtain GAPP's approval explains why most of China's journals in the West are sponsored and subsidized by government or public institutions, including more than 75% of China's journals housed within research institutes, universities/colleges, or societies/associations (Guo et al., 2006).

However, since early 2010, the Chinese government has taken a series of measures to move publishers toward operating in a more market-driven manner (GAPP, 2010). In May 2011, the General Office of Central Committee of Communist Party of China (CPC) and the General Office of the State Council jointly issued a statement that stresses that non-political newspaper and journal publishers should convert to a financially self-sustaining, market-based financial operation at specific prescribed levels, calculated and based on their different properties and functions (GOCPC & GOSC, 2011). This change from a pure government subsidy model to a self-sustaining market-based business model is a fundamental and foundational change for China's scientific journals.

An interesting reinforcement of the centrality of these three main drivers underlying the transformation of the Chinese STM publishing industry is their clear presence in the central topics discussed at six recent conferences of major Chinese journal associations or institutions in 2011 (see Table 2).

Table 2. Topics of conferences on journal editing and publishing in China, 2011

	Topics	Sponsor Institutions
1	Academic integrity, Digital publishing, Publishing policy reform	China Editology Society for Scientific Periodicals (CESSP) http://www.cessp.org.cn
2	Journal evaluation, Journal operation, Publishing policy reform	Beijing Journal Publishing Center Co., Ltd.; Science Evaluation Center of Wuhan University http://www.chinasciencejournal.com/nianhui/index.html
3	Digital publishing, Journal operation, Open Access, Publishing policy reform	Editology Society of Natural Science Periodicals of the Chinese Academy of Science http://www.cas.cn/hy/hyyg/201105/
4	Academic integrity, Digital publishing, Internationalization, Journal evaluation, Journal operation	CESSP; Institute for Science and Technology Information of China; Wanfang Data http://www.cessp.org.cn/ch/reader/view_news.aspx?id=20110503145123001
5	Academic integrity, Internationalization, Publishing policy reform	CAST; GAPP http://www.cast.org.cn
6	Academic integrity, Digital publishing, Journal operation, Publishing policy reform	Society of China University Journals http://www.cujs.com

The main topics suggested by organizers of these conferences were centred around publishing policy reform, digital publishing, academic integrity, and journal operation models. These were “hot” topics at similar meetings in the West well over a decade ago; today, however, they have been overshadowed by newer concerns such as the use of social media, education and instructions for authors, data archiving, and a very strong emphasis on ethical issues in scientific publishing (See The Association of Learned and Professional Society Publishers (ALPSP): http://www.alpssp.org/ngen_public/default.asp?ID=393; Society for Scholarly Publishing (SSP): <http://sspnet.org/home.aspx>; Council Science Editors (CSE): <http://www.councilscienceeditors.org/i4a/pages/index.cfm?pageid=3589>).

Current challenges for China’s scientific journals

CHALLENGE 1: IMPROVE ACADEMIC QUALITY AND JOURNAL IMPACT

Given the current system of evaluating the quality and impact of science — that is, the quality of science is linked to the impact factor (IF) of the journal in which it is published — it’s natural that researchers prefer to publish their most important achievements in journals with high IF scores. China’s scientific journals, which generally have quite low impact factors, are therefore facing significant challenges in convincing authors to publish in them. As a result, China’s scientific journals seem to be caught in a vicious cycle: low impact factors don’t attract high quality articles but without high quality articles, journals can’t improve their impact factors.

In October 2010, Shengli Ren and his colleagues surveyed 460 high-ranking Chinese researchers (scientists who were members of the Chinese Academy of Sciences and/or were board members of China's top journals *Science China* or *Chinese Science Bulletin*) regarding their opinions on China's science journals (Hou, Ren, & Liu, 2012). Only 25.2% of the respondents were satisfied (116) or very satisfied (9) with China's scientific journals, indicating that despite the growing number of researchers and improving science being done in China, Chinese researchers are not enthusiastic about selecting China's journals as their publishing vehicles.

The low impact of China's scientific journals is also reflected in citations of journals covered in SCI's database Web of Science (WoS), often referred to as international mainstream journals (Moed, 2002). In *Journal Citation Reports-2010* (JCR, 2011), which is based on WoS, only 138 (about 1.7%) of the 8,005 scientific journals indexed are from China, putting China's journals in 9th place, far behind the USA (2,697), UK (1,580), the Netherlands (653), and Germany (544). Moreover, these 138 journals have an average impact factor of 0.904, much lower than the average of the 8,005 journals (2.014).

Considering that Chinese authors contributed about 130,000 of the articles covered in SCI in 2010, accounting for 8.8% of the total that year, China's journals played a disappointingly and disproportionately small role in publishing and distributing China's basic research achievements.

CHALLENGE 2: DEFINE ROLES AND IMPROVE QUALITY OF PROFESSIONAL EDITORS AND JOURNAL BOARD MEMBERS

In developing a new journal, editors and publishers need to consider the entire structure of a publication office, as well as the roles and responsibilities that each staff member should play. In most journal offices in China today, full-time editors often play broad and therefore pivotal roles from overseeing the quality of content to managing the production workflow to ensuring the reliability of distribution channels. However, many uncertainties seriously affect the stability and enthusiasm of editorial staff, and consequently the journal's sustainable development. First, it can be difficult to perform all the work needed to produce a quality journal with a very small staff. Second, due to the country's strict government control, the production of China's scientific journals is scattered and very few journals are actually supported by real publishers (CAST, 2008), so few have access to the best and newest information about editorial management and tools. Most scientific journals are sponsored by research institutions, universities, and societies, who do not include publishing as one of their primary goals or missions. As a result, many journals are not actually getting the professional support they need and journal editors are marginalized, despite having their basic operational costs securely covered by their sponsors. Many journal editorial offices remain short-handed and staff members and editors undertrained (Liu & Zhang, 2009; Lu, 2011).

In addition, in many cases, members of editorial boards also do not play the roles they should, such as soliciting high quality manuscripts, handling reviews, guiding author revisions, or promoting their journal through professional networking. In fact, for most of China's scientific journals, the chief editors and board members are well known scientists, with little or no training or experience in publishing.

CHALLENGE 3: ENHANCE RESOURCES FOR DIGITAL PUBLISHING AND ONLINE ACCESS

The rapid evolution of digital communication technologies has transformed scientific publishing through massive proliferation of ways to produce, transmit, and consume information and an equal explosion of ways to monetize related products. Most large international journal publishers are now not only fully digitalized, but are pushing the boundaries of what kinds of supplementary information are available and what kinds of business models are used to support publication. With the growing availability of robust online search and access, academic articles will inevitably be online and will include deeply imbedded and interlinked content (Brand, 2004).

Despite these changes in much of the western publishing world, the production and distribution of China's science journals is still dominated by traditional article versions; very few of China's journals have robust and informative websites and make their articles available and discoverable online (Cheng, Ren, Wang, & Yang, 2010). Some of the limited number of publication technology developers (such as CNKI, Wanfang Data, VIP) have constructed commercial databases through which readers can access full texts of articles from China's journals to some extent. However, as previously noted, although the publishers of journals on these platforms can earn some small revenue from the database developers, the revenue does not nearly cover the costs for production, making this current model a nonviable solution for publishers who hope to become financially self-sustaining (Nie, 2009; Cheng et al., 2011).

CHALLENGE 4: REFORM THE MANAGEMENT AND OPERATION SYSTEM OF CHINA'S SCIENTIFIC JOURNALS

Few of China's scientific journals have management systems based on professional management and operational practices of modern journal publishing. To reach these levels, China's journals will have to learn the practices of successful, high impact western journals and create new publishing models that will foster their transformation from subsidized print models to models for financially-sustainable digital publication. To achieve this goal, Chinese publishers need to address issues related to the legal status of science journals in China and the ability of individual journals to tailor their scale and scope. At present, most of China's scientific journals are not independent legal entities. Instead, they are supported by and are under the legal jurisdiction of the government or their sponsoring institutions. With this status, publishers cannot work as autonomous financial entities, which severely curtails their ability to shape their own operations. Moreover, nearly 45% of China's scientific journals are situated in academic institutions and tend to focus on basic research, yet are forced to be multi-disciplinary in scope because they are the primary outlet for the entire scientific community of their host institution (Wang & Wang, 2004, Guo et al., 2006, Stanley &

Yan, 2007). It is understandable that readers are often drawn to publications where a healthy number of articles are useful and of interest to them, so ensuring that journals have clear and specific scopes is critical to the success. Journals also need to have a well-defined scope to develop a set of peer reviewers who have appropriate expertise to evaluate article submission. The challenge of forcing the majority of China's journals to transition from multi-disciplinary publications to ones with well-defined scopes is significant, but necessary. That is, to improve the possibility of getting more citations, China's journals need to refine their scopes and develop clear and specific information about their readers so they can gear their content to better meet specific reader needs.

CHALLENGE 5: REVISE CHINA'S POLICIES AND MEASURES FOR EVALUATING RESEARCH

Another hindrance to the development of China's scientific publishing efforts is anchored in the fact that since the late 1990s, China's universities and other academic institutions have sanctioned too many evaluation policies that emphasize and reward publishing in journals with high impact factors, particularly international journals. These standards have multiple and serious negative impacts. First, such standards discourage authors from considering submitting to China's journals because they have low impact factors. This avoidance of submitting to Chinese journals also perpetuates the cycle mentioned previously: low impact factors lead to few high quality submissions, which circularly results in low impact rankings. Second, such standards encourage Chinese authors to focus primarily on submitting to journals with the highest possible impact factors. High IF journals have very high rejection rates, and submitting an article to a high impact journal when the science discussed within the submission does not meet the criteria for publication ends up wasting time for authors and editors alike. Many Chinese authors submit to journals exclusively because of a high IF and do not take the time to carefully assess whether the topic and findings of their article are an appropriate match for the journal. Again, a mismatch between topic and scope of a journal will lead to a reject-without-review decision, wasting valuable time and resources (Benson & Silver, 2012).

Questionnaire surveys have shown that when it comes to selecting a journal for submission, Chinese authors and international authors have very different preferences. For Chinese authors, the top three decisive factors are the journal's reputation (92%), journals admitted in academic evaluations (79%), and journals covered in important index systems (74%) (Hou et al., 2012). For international authors, the top three primary factors are refereeing speed (79%), refereeing standard (78%), and a journal's reputation (77%) (Swan, 1999). These findings indicate that, at least in terms of researchers surveyed in the above studies, international authors are more concerned with getting high quality feedback from a journal that is known to publish good science than with how their publication list will be judged during academic evaluations.

STRATEGIES FOR DEVELOPING CHINA'S SCIENTIFIC JOURNALS

As a result of the situations outlined above, China's journals are continuing to fall off the radar of Chinese researchers, with an outcome that puts some of the best Chinese scholars in an embarrassing position of "well-known in international, but not as well

known in China” (Zhu, 2009). The lack of advancement of China’s journals remains a lost opportunity to draw interest and attention into the Chinese market, or to turn that attention into concrete benefits for the progress of science in China. The majority of China’s outstanding scientific achievements — its intellectual property so to speak — are published in commercial academic journals outside of China, converting the output of China’s public investment in scientific research into the private equity of these commercial journal publishers. Adding insult to an injury, Chinese research institutions then have to buy back this content and, in many cases, researchers cannot get access to the articles of their Chinese peers because their institutional libraries lack funds to acquire that content (Ren, Liang, & Zu, 1999).

According to the “Joint Open Letter to International Publishers” (http://www.las.ac.cn/subpage/Information_Content.jsp?InformationID=5372), the prices of full-text database access to international journal content have been rising significantly in recent years, and the continuous price increase has seriously endangered China’s ability to provide literature resources for education and research. The growing tension between the cost of international journal databases and the dependency of Chinese researchers on these databases grows, as more and more Chinese science gets absorbed into these valuable intellectual resources. To develop in the international arena, China should focus on creating its own international journals, ones that will address the challenges we’ve discussed here, those of becoming financially sustainable, operationally independent, and technologically advanced journal publishers.

CONSTRUCTING INTERNATIONAL JOURNAL GROUPS TO REFLECT CHINESE SCIENCE DEVELOPMENT

One effective strategy for advancing China’s scientific journal publications would be for influential government institutions and journal sponsors (e.g., GAPP, Chinese Academy of Sciences [CAS], Ministry of Education [MOE], CAST, MOST, NSFC) to select a group of best journal contenders and then to work together to create policies and business models to enable these selected publications to achieve a high level of international recognition and academic influence. At present, CAST and NSFC have special funds to support scientific journals: however, this support could be vastly more effective if the three institutions cooperated. By banding together their now separate resources, the groups could evaluate candidate journals and together select a subset (no more than 100) of the best ones to sponsor and mentor. Special policies to promote these journals could include incentives for scientists to publish their important achievements in these journals as well as inducements for their back offices to adopt appropriate systems and practices that are more in line with international journal management strategies.

It is now widely recognized that English is the lingua franca of sciences. Therefore, to get the work of Chinese scholars recognized in international arenas, many more journals published in China will also need to be in English. Currently, about 240 scientific journals in China are published in English, although more than 80% of these are produced in cooperation with various international publishers, including Elsevier and Springer. On the one hand, this kind of cooperative venture has undoubtedly been helpful in educating China’s journal staff and others about current international

journal practices. On the other hand, by cooperating with foreign-owned publishers, China not only signs away its intellectual property, but also falls further behind in building up its own technical and business infrastructure for science publishing. For these reasons, it would be sensible for GAPP and China's journal sponsors to pay attention to developing professional English journals based on the need of China's science community, especially those research fields with Chinese characteristics, such as Chinese medicine and agriculture.

ATTRACTING AND TRAINING GOOD EDITORS AND JOURNAL MANAGERS

Human resources are also a key issue for promoting China's academic journals to higher international levels. To produce high-level journals, China needs to build a workforce of well-trained journal editors, publishers, financiers, and intellectual property specialists who are fully up-to-speed with international trends, practices, and standards in STM publishing. The rapid and accurate dissemination of China's science will not be able to advance without professionals who can communicate, collaborate, and problem-solve with peer colleagues around the world. Many editors in China, particularly those from smaller publishing houses, are far from informed or even aware of international standards and practices and are in urgent need of high quality training in these areas. Organizations like CAST, CAS, and others need to develop realistic and timely plans to cultivate powerful journal management teams comprised of technology, editorial, financial, and intellectual property experts. The best training may well be built by joint teams of Chinese and foreign leaders in these areas who together may be able to design training that provides new information but also, and importantly, helps current journal staff manage the transition of their workplace and work tasks from old to new practices and ways of thinking about publishing workflows, finances, and goals.

Also central and essential to the transformation of STM publishing in China is change within the scientific community itself in terms of its understanding and attitude toward the activity of publishing.

Activities to further these goals have been in motion for some time, including those presented in "The Talents Scheme for Intelligence in the Field of Literature and Academic Journals," as outlined by CAS (CAS, 2008). Scientists themselves must understand and participate in activities that are critical to rigorous and ethical publishing practices. They must take on active roles not only as peer reviewers but also as Executive Editors, Editors-in-Chief, or as Editors of special issues. Researchers taking on such roles for high-ranking international journals may get little or no compensation for this kind of work, but take it on as a duty, an expected part of their professional responsibilities. In fact, high impact journals include a robust proportion of articles that are frequently cited because their scientific editors and peer reviewers are able to identify what is the best and newest sound science at the cutting edge of knowledge in a particular field. Journal Editors and staff need to be able to solicit leading scientists to sit on their review and advisory boards, and scientists in turn need to be active in helping editors find the best-qualified reviewers. One of the most significant challenges for editors of well-established and high impact journals is

keeping their peer reviewers engaged but not overloaded, and journals need to find ways to recognize and give credits to scientists who play these absolutely critical roles.

The goal is to build a positive cycle: high reputation top Editors can build a strong journal editorial staff, and together they can identify good Associate Editors and reviewers. These Editors and reviewers help identify the best science, which draws in more readers, which in turn leads to more citations, more impact, and a growing strong reputation for the journal.

Along with improving editorial content, networks, and processes, however, China must also have a technological infrastructure that allows its science be effectively disseminated worldwide. To accomplish this critical goal, new models for publishing platforms are sorely needed in the STM publishing arena.

ESTABLISHING A NATIONAL-LEVEL DIGITAL PUBLISHING PLATFORMS

Over the past decade, China's journal publishers have not kept pace with trends in digital publishing that have and continue to play central roles in the production and distribution of scientific content. An important component of this lag has been a lack of attention or efforts by publishers to establish their own digital publishing platforms. To keep pace with international publishing, China's publishers must start using the leading technical tools in digital publishing technologies, and find ways to engage those technologies that suit and are appropriate to China's specific situations, goals, and economic realities. Leaders of STM publishers in China will no doubt need to be mindful of the pace of institutional learning and change, and set reasonable goals and timeframes for the transition of academic publishing from print to fully digital modalities.

One important aspect of the transition from print to digital publishing is rooted in the economic models that will need to anchor these changes in today's global fiscal and information environments. In the debate over open access publishing, publishers and authors understand that in many cases, the burden of publication costs has shifted from readers to writers. Chinese publishers are coming into the publishing environment with this ferocious debate behind them, and understand that public investments are now necessary to achieve the broadest possible access to scientific information. Although there are different views on the roles of Open Access journals, Open Access repositories, and authors' self-archiving (Fry, Proberts, Creaser, Greenwood, Spezi, & White, 2011), Chinese funding institutions, such as MOST, CAS, and NSFC, should recognize this reality and work quickly to establish an open archive database, one in which all published articles supported by government funds should be deposited. This would be a resource similar to PubMed Central, hosted by the U.S. National Institutes of Health (NIH), as well as resources of similar institutions in Europe. Not only does a national open archive ensure that all government-funded research is freely available to the citizenry, but by sitting on a well-constructed and managed digital platform, this research becomes able to be cross-indexed and cross-

linked. A national digital archive would improve the accessibility, visibility, and influence of Chinese articles. In this respect, there are many successful examples to which China can refer, such as the “Strengthening the Archive of NIH-funded Research Publications, Public Access Policy,” which was proposed by the NIH in 2005, and amended several times since then (<http://www.ncbi.nlm.nih.gov/pmc>).

Open Access models provide challenges in building new financial models in publishing, whether for commercial or society publishers, but at this point in time, such open archives and the requirements that come with them are part of the landscape of international publishing and must be incorporated into the development of new publishing efforts.

PROMOTING THE DEVELOPMENT OF COMMERCIAL PUBLISHERS AND PUBLISHING GROUPS

Over the past decade or more, many journal publishers have decided to merge or cooperate, to become a large single publisher or publishing group. As a larger unit, these publishers have used size as a strategy to deal with market competition and the challenges of cross platform digital integration. For example, Elsevier — now the largest journal publisher with more than 2,500 journals — expanded in the mid-1970s based on a small number of its own journals (Liu, 2010). In fact, almost all the expanding international journal publishers are commercial operations, even those sponsored by nonprofit institutions such as the American Institute of Physics (AIP). Chinese policymakers, such as in GAPP, CAST, and CAS, would do well to encourage Chinese journal publishers to explore the model of merging or forming cooperative partnerships as commercial operations to meet the needs of readers and users of scientific information.

Journal publishers with commercial and international potential, such as Science China Press and Chinese Medical Association Publishing House, could help merge disparate journals, recruit well-trained managers and editors to journal offices, launch new journals, construct digital publishing platforms, and more rapidly accomplish other goals of modernizing China’s publishing practices. Such measures would allow these publishers to quickly become both larger and more efficient, which in turn might enhance their competitiveness in the international journal marketplace. With pooled resources, larger Chinese publishers could consider opening overseas offices to help develop their name and brand in international markets.

MAKING THE RESEARCH EVALUATION SYSTEM FAVOURABLE TO CHINA’S JOURNAL DEVELOPMENT

The main functions of academic journals in the sciences should be to document and disseminate substantive advances in knowledge. Publication in a high impact journal should not be a leverage tool of advancement for individual researchers. Policymakers must revise the power that the journal impact factor (IF) now plays in securing position promotions, research awards, and other professional prizes. It is essential that the Chinese scientific community join international efforts to use methods other than IF to rationally assess and measure the quality, innovation, and real world impact of

scientific research. A growing number of various measures of impact are already being used internationally, including Google's "Cited By," the h-Index, the Eigenfactor, and PLoS's Article Level Metrics (ALM) (Benson & Silver, 2012).

Increasingly publishers are adding comprehensive usage and reach data (page views, downloads, comments, and so on) to every published article so that the entire academic community can form their own assessments based on metrics at the article, not journal, level (Allen, 2012). China's journal publishers should closely study these trends and strategies and work to provide more and better options for the evaluation of science.

Prospects

Here we have described challenges faced by China's scientific journals and proposed some initial ideas and strategies for addressing them. The tasks ahead for the Chinese STM community are daunting and the goals are high: to increase international impact and brand, quickly build the quality of professional editors, move to fully digital publishing workflows, revise financial models from government subsidies to commercial operations, and change the measure used in the evaluation of research and researchers. However, with the increasing input of Chinese scientific research in the world, China's scientific journals must take these strides forward in order to play a more important role in the communication of science and related global policies, particularly those related to human and environmental health. From a series of new issued government policies, especially the decision of the Sixth Plenary Session of the 17th Central Committee of the CPC to deepen the reform of China's cultural systems and promote the development of China's cultural industry (Xinhua Editorial, 2011), we see strong indicators that there is high level support for the transformation of the Chinese STM publishing industry. The work to actually make that transformation happen rests with the nation's journal sponsors and publishers, who must assume the responsibility of moving into sometimes uncharted territory to build a new landscape to hold up the findings of China's brightest scientific minds.

Websites

China Association for Science and Technology. URL: <http://www.cast.org.cn>

China Editology Society for Scientific Periodicals. URL: <http://www.cessp.org.cn>

CNKI. URL: <http://www.cnki.net>

Council Science Editors (CSE). URL: <http://www.councilscienceeditors.org/i4a/pages/index.cfm?pageid=3589>).

Editology Society of Natural Science Periodicals of the Chinese Academy of Science. URL: <http://www.cas.cn/hy/hyyg/201105>

Essential Science Indicators Statistics. URL: <http://www.esi-topics.com>

Joint Open Letter to International Publishers. URL: http://www.las.ac.cn/subpage/Information_Content.jsp?InformationID=5372

National Institutes of Health. *Strengthening the archive of NIH-funded research publications, public access policy*. URL: <http://www.ncbi.nlm.nih.gov/pmc>

Society for Scholarly Publishing (SSP). URL: <http://sspnet.org/home.aspx>

Society of China University Journals. URL: <http://www.cujs.com>

The Association of Learned and Professional Society Publishers (ALPSP). URL: http://www.alpssp.org/ngen_public/default.asp?ID=393
VIP. URL: <http://www.cqvip.com>
WanFang Data. URL: <http://www.wanfangdata.com.cn>

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