How Herb Tabor’s vision for timely and accessible research led scientific publishing into the online age

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There was a time not that long ago when scientific communication happened only in print, with research papers, letters to the editor, and all other exchanges just appearing in issues mailed weeks or months after the papers were formally accepted. Learning about this research required a personal subscription to specific journals, a well-funded library, or attendance at conferences to hear the latest results and read newly released journal issues. Even as the web came into existence, the idea of using this new platform to make a scientific journal available around the country or even the world was simply not considered. That is, until the JBC—then under the leadership of Dr. Herb Tabor—decided they must find a way. Working with professors at Stanford and the newly formed Stanford service group, Highwire Press, “JBC Online” was born in 1995. In this article, as a tribute to Dr. Tabor’s 100th birthday, I share my perspective and those of others involved in this transition as to what is so remarkable about the JBC going online. Specifically, I describe how Dr. Tabor’s governance and leadership of the JBC, and within the American Society for Biochemistry and Molecular Biology, brought together many threads in the research, society, publishing, and technological context of the time to make sure that the JBC not only made this remarkable leap, but made it first and farthest, and paved a path for many other, and now virtually all, journals to follow.

A page in the March 2018 issue of ASBMB Today, the society magazine for the American Society for Biochemistry and Molecular Biology, looked back on Herb Tabor’s biography and accomplishments in his then nearly 100 years (1). Of the 20 accomplishments captured in this list, there are four that are specific to his leadership of the JBC.

- **1961**: Tabor joins the editorial board of the JBC.
- **1971**: Tabor becomes Editor-in-Chief of the JBC.
- **1995**: The JBC becomes the first scientific journal to be published online.
- **2010**: Tabor steps down as Editor-in-Chief, becomes Co-Editor, and continues his bench research.

In such a notable career, to highlight the launch of a new format for a venerable scientific journal is itself notable. However, it is appropriate; the launch of JBC Online was nothing short of revolution-sparking. It initiated the rush of scientific journals to appear online in the mid-1990s, transforming the way science was disseminated then and ultimately how it is communicated now. This event was furthermore a challenge to the status quo of printed journals—with their science encased in print formats—and a signal to the imagination of innovators who saw the excitement of new possibilities that the flexible online medium presented.

In this article, I describe what was so remarkable about that risky 1995 event, which in the worst case scenario was a very public opportunity to fail. I revisit how the idea got started, the different aspects we had to consider in building the first journal website, where we went wrong, and what our experiences might teach us about addressing ongoing changes in scientific publishing. I hope that this case study shines light on the tremendous leadership provided by Dr. Tabor, now a centenarian but still remarkably a Senior Investigator at the National Institutes of Health (NIH) and assigning papers and offering advice at the JBC.

**Reading the literature in the 1990s**

It’s a common (and appropriate) complaint these days that there is simply too much scientific literature to read. While keeping up with the literature before journals were online was marginally more feasible in numbers of journals and papers, it is hard to comprehend—even for those of us who lived through it—how arduous and time-consuming it was.

In many scholarly, nonscience fields, it seemed that “keeping up” was a matter of visiting your departmental library from time to time, seeing what new issues of journals there were on the shelves, and browsing them; “looking up” meant an afternoon’s visit to the library to use some of the large, printed indexes that cataloged the papers in your field the previous year, with things neatly arranged by author and title and topic. In scientific fields, however, the volume of literature was already expanding greatly; there were more fields, more journals, more articles, more techniques, more authors, such that “keeping up” was a team project. Often, a lab might identify a dozen key journals covering its research area, and members of the lab would divide and conquer in terms of reading and highlighting relevant articles for the lab’s awareness.

While this “divide and conquer” strategy might sound familiar to scientists today, volume was not the only “real” challenge compared with how we deal with the literature today. Todd McGee, in 1995 a post doc in Biology at Stanford and now Vice President of Biochemistry at Genentech, suggested that the literature was simply unmanageable. In his remarks published in Nature in 1995, he wrote:

> It is clear that the sheer amount of information generated by current research output will exceed the capacity of any individual to comprehend it—indeed, the aggregate amount of research being done is already far in excess of what an individual can possibly master. The necessity for scientists to form groups, with the division of labor that this implies, is a fundamental part of modern science.

Today, we are faced with even larger challenges. The sheer volume of literature is far greater, and the pace of scientific discovery is even more rapid. Yet, we are still divided and conquer.
President of Engineering at HighWire Press, recalls that a greater problem was that the wealth of the literature was in the library and not accessible from inside the laboratory. So your literature work could not be “time-sliced” with your bench lab work as often happens today—you were either in the lab or in the library, but not both.

Even once you got to the library, there was no guarantee that your article would be physically present, and even then, whether it would be stacked on the shelves of the main library, stored in a secondary or off-campus site, or buried in some deep recess. Jeff Plautz, then a graduate student at the University of Virginia and now a senior solutions architect at HighWire Press, has memories of going into the attic of the biochemistry library and opening old boxes of the JBC wearing a dust mask. At that time, it might have taken a good part of a day to track down a single citation, where now it takes seconds. Once you had found an article and paid 10 cents per page for what was too often an abysmal copy of the article, you could share it with others, by making another copy or by sending a fax to a remote collaborator.

Despite these challenges, handling the physical volume wasn’t always the biggest problem. For many journals at the time, an article, once accepted, would spend a month or two “in revision,” and then it might be 3 or more months before it was published in an issue. The issue would then be mailed out, and the mailing process could itself add up to 6 months to the “literature lag” if the destination was overseas. Articles were therefore frequently months old when they could finally be read.

Even this level of accessibility would have seemed wonderful to those outside the technology-forward institutions in countries with the greatest science funding. Access was not evenly distributed. Anurag Acharya, a Distinguished Engineer at Google and co-founder of Google Scholar, whose undergraduate work was done in India, reports that in India, scientists simply did not have access. Even following a paper trail did not work because the paper trail would go cold; you’d have to write a postcard to get a paper. You would quickly run into papers your library did not have, and the library with a lot of journals was in Calcutta, which meant a day for travel. You would actually try to design your research so you did not encounter that situation.

The JBC in the 1990s

In addition to the challenges described above, the JBC had a unique problem because it was so large. In 1995, the JBC published more than 5,000 items in 52 weekly issues, totaling 31,376 pages, the second-most voluminous journal of the time! (Physical Review B was 36,000 pages that year.) The JBC was also already the most cited journal in the world, which meant that articles in the JBC were part of the “must read” literature for researchers in biological chemistry and related fields.

However, “keeping up” was no trivial task; one Stanford scientist at the time remarked that keeping up with the JBC would be like reading “the Manhattan phone book every week.”

Indeed, the journal was so large that it was considered an earthquake hazard at Stanford! In 1995, I kept weekly issues on a shelf above my desk, and a representative of Stanford’s Risk Management Office asked me to relocate them so that I wouldn’t be injured by them tumbling down on me in a quake. This was not just out of an abundance of caution: a Stanford colleague’s desk was bombarded with JBCs from a bookcase in the 1989 Loma Prieta earthquake. Fortunately, he had just left his desk!

The volume was not only becoming unmanageable from a scientific point of view, but the journal was reportedly approaching the four-pound United States Postal Service (USPS) limit for second-class mail. And the journal was growing; from 1990 to 1995, the number of pages increased by 40%. Soon the journal would not only be unmanageable for readers but unmail-able! This fact made efforts to find an alternative to print for the JBC far more than of “academic” interest. (Along the way, the USPS increased the limit to 72 pounds, but the move-away-from-print die had been cast for the JBC.)

Solving the JBC “problem”

Given these problems of scale and speed of dissemination, there was plenty of motivation among the JBC’s scientist leaders and the Society to provide a solution. But what would the solution be? One of the early attempts was to publish all of the articles from a 6-month period onto a package of CD-ROMs as a supplement to the print journal and have researchers load these disks onto their personal computers, a device that was still quite novel itself, to search and display the articles in that time period.

A follow-on innovation was to copy these disks to a storage device that was attached to a campus computer network, which would allow multiple people to use them, as was done at the NIH, where Dr. Tabor worked. However, these efforts were ultimately unsuccessful; scientists and librarians were not interested in using CD-ROMs as an archive, and scientists did not want to wait 6 months to get their JBC papers. This solution to the problem of scale actually made the problem of speed worse!

How CD-ROMs sparked an online adventure

Although the CD-ROM experiment failed, the innovation that occurred at the NIH provided a conceptual breakthrough. The word “online” in the early 1990s did not mean then what it means today. Now we think of online as meaning “continuously connected to the Internet,” as with streaming media, online web sites, and cell phones. But in the early 1990s, the Internet was largely used for file transfer and E-mail. The World Wide Web had only been invented in 1991 (2), and the word “online” typically meant “displayed on a computer.” However, the way that the NIH had shared the JBC’s papers across their computer network was really a primitive “online journal,” and Dr. Tabor had experienced it firsthand. In 1994, Dr. Tabor asked Robert Simoni, a Stanford Biology Professor and JBC Associate Editor, to see if Stanford would make the CD-ROMs of JBC issues available “online” on campus as NIH had done. This simple request, followed by a cascade of events, led to an experiment that became known as JBC Online.

Was it serendipity or strategy that led Dr. Tabor to approach Stanford and Dr. Simoni? Long before the 1990s, “Silicon Valley” was a nexus of technology and innovation. Stanford was the center of that activity, and Stanford faculty and students were
often acting as entrepreneurs in creating centers of excellence that sometimes could commercialize and distribute technology in startups. In other words, Stanford and its libraries were a perfect home for experimenting with technology-based services for publishing. So it was perhaps just natural for Dr. Tabor to engage with Stanford in improving access to the JBC in a novel way. But soon that initial idea of “networking” the CD-ROMs for Stanford-only access was pushed aside.

Here is where I enter the story. As the head of the Stanford Data Center, I had been on the search committee to hire Stanford’s new head of libraries, chaired by Provost Condoleezza Rice. She and I agreed that Michael Keller was the right choice for librarian, and he was appointed in September 1993. Keller was “not your grandfather’s librarian,” as some were to say. He was entrepreneurial and adept at spotting promising technology that could serve scholarship. Thus, when Dr. Tabor contacted Dr. Simoni, and Dr. Simoni in turn approached Keller about putting the CD-ROMs “online” for Stanford as had been done at NIH, Keller’s immediate response was basically to ask, “Why would you want to do that?” It was well-known at the time that libraries disliked CD-ROMs; they were easily lost and often needed staff to support users unfamiliar with each CD-ROM’s unique interface. Plus, the CD-ROMs were like the bound volumes of issues; they were received long after print issues were mailed. Keller thought that idea was too limited of a step and had a better idea.

At this time in Silicon Valley, we were also seeing a new approach to knowledge distribution flourish: the web, and (just as importantly) the web browser. These two together were transformative. Even though the web had been “invented” in 1991, it was the web browser—Mosaic (in 1993) and Netscape (in 1994) were famous early versions—that gave the web a face that was useful and usable to the nontechnical masses. A key here was that the web and the web browser charted and then paved the path from an individual’s computer to an information resource server that was anywhere else in the world, and it gave a common look and feel to the way one typically interacted with these resources, mitigating the problem of unique, idiosyncratic interfaces found in PC applications such as CD-ROMs, along with the need to install these programs before you could even look for information. This gave rise to the common (now cliché) phrase of the time, “information superhighway.” But a smooth path was just what researchers wanted.

Keller and I, along with other colleagues, discussed the possibilities provided by this new web server and web browser technology and agreed that Stanford seemed ready to exploit these advances to turn the JBC into an online journal. To kick things off, we needed to create an “electronic printer”; thus, HighWire Press was born. While I was still the Data Center director, I allocated one of my staff to work on the project, but soon Keller hired me to run HighWire. This was way more fun than running a data center with 400 staff, although the allure of the lean startup was not always obvious.

What could go wrong?

Asking someone today to “build a website” is such a trivialisounding project that it is hard to put into words what a challenge it was in so many dimensions back in 1995. This simply hadn’t been done before for a large scientific journal, and 90-year-old scholarly journals like the JBC were not usually experimental and entrepreneurial. The JBC Online team required leadership, trust, engagement, and confidence to tackle the many basic challenges we faced, which were in nearly all areas of the project. Some of these were left to the Stanford-based technical team of the newly founded HighWire Press to manage, and some were clearly the province of the JBC and ASBMB leadership to manage.

Technical

No one had built and delivered an online scientific journal before, so there was no clear precedent for how it should look or function at the software level. The state of web browsers at the time was primitive. They could not handle Greek characters, much less equations; they could not even reliably display tables, and high-resolution images were challenging. The JBC had plenty of each of these! This challenge was left to the HighWire team at Stanford to solve. Fortunately, we did have one easy task, which was selecting the URL. You’ll understand that it was still early days in online websites when I tell you that we had no trouble registering the obvious choice, “jbc.org”; even just a year or two later, all of the three-letter combinations for URLs were taken.

Usability

Just as we did not have a clear precedent for how the website should be constructed, we did not know what it should look like to make it simple for the scientific community to navigate. “Ease of use” was still developing as something to design and measure. Technology staff were well-known for producing bright shiny new objects that their users could not figure out, and many large information systems were designed for use by librarians who had been trained in arcane search languages and their rules. Gopher—which made information look like the file system browser on your computer—was the paragon of navigation and display. Fortunately, Stanford’s computer science department taught “user-centered design,” which was later popularized by Apple, so we had a small toehold in how to tackle this part of the project.

Search

When HighWire began interviewing researchers on the Stanford campus about how an online JBC could work better for them than the print JBC, one of our interviewees remarked that “It isn’t a journal, it is a database.” And you do not read a database, you search it. Those particular comments were critical in our design of JBC Online. Other publishers were trying to force users to read issues by “paging” through them. However, we knew that nobody did that even with the print version of the JBC because of its size. And with the 100 new articles per week, we would quickly have a sizable collection that people could look through and almost always find an article of interest if they could use key terms to search. Text-search engines were still new stuff back then, but that also happened to be my background. So we found one that was being developed a few miles from Stanford’s HighWire Press, called WAIS (Wide Area
Internet and we worked with its owner, Brewster Kahle (now head of the Internet Archive), to incorporate it on our site.

The secret was finding a way to let people search without having to think about what was called “fielded” search (specifying title versus abstract versus text words), although we did make people tell us whether a search term was an author name or text in the article. Google later taught us that even that was too hard for some people! We also incorporated weekly alerts on topics that could be specified by the reader.

Scale

The JBC was one of the two highest-volume journals at that time and the most highly cited. As a result, we knew that it would be a very busy online web site, and so would require fast programs, servers, search engines, and networks to make it work acceptably for its users. Images were critical to the JBC’s articles, yet because of the relatively slow speed of the internet and desktop computers at the time, we could not assume that all readers would want high-resolution versions of each image. Instead, we had to generate three sizes of each image for rapid download.

Computationally, generating the 60,000 images of the 20 launch issues of JBC Online was most challenging because even the fastest microprocessors of the time took several minutes per image. If it took over 2 minutes per image, then we would not finish the images for one week’s issue before the next week’s issue arrived! This challenge was left to the Stanford team.

Time

The project launched in January of 1995, and we knew the ideal “reveal” event would be the May 22 Experimental Biology meeting in San Francisco. Could we build JBC Online in under 5 months? What would that demo look like? How much content could we build in? This was a joint decision between Stanford and the ASBMB.

Financial

The one-time cost of the project itself (funding people and technology) was not the challenge here, because Dr. Tabor and Chuck Hancock (the Society’s manager) had developed a reserve at ASBMB that the JBC could tap for major projects such as this. However, the JBC’s sources of income—subscriptions, author charges, reprints, etc.—were key to the ASBMB itself and thus enabled many of the society’s scientific, educational, and training programs. There was no certain plan for how an online journal should be paid for on an ongoing basis if, as envisioned, online access eventually caused print subscriptions to decline.

Beyond the technical challenges, there were also sociological challenges to consider. Many readers of this piece will be familiar with decision-making in a university environment: Sometimes it takes only a single strong negative voice or a few people expressing “concerns” to stop a project. And as I’ve described, there were a number of things to be concerned about in our scheme to put the JBC online! Any of these impediments could have stopped the project. So we needed someone with diplomatic skills to keep things running—more of a George Washington or Abraham Lincoln than an entrepreneur like Jeff Bezos or Elon Musk. One observer summed it up: “This was not a slam dunk. People fought it. But it kept moving. So somebody gave it cover.” The implication was that that “somebody” had to be a figure everyone respected: Dr. Tabor. Dr. Tabor would check in with the user constituencies and his group of Associate Editors. He asked younger people, “What do you think? Will you use this instead of print?” This provided anecdotal evidence of what adoption would look like among the graduate students and postdocs who represented the next generation of science.

It was this information-gathering, steady forward-looking leadership and governance that Dr. Tabor provided to the project. A number of people involved in JBC and Society decision-making at that time described his approach as authentic to his style: supportive, cautious, and consensus-building.

In all of these discussions, Dr. Tabor was described as cautious, but never reluctant. He was enthusiastic about the JBC Online project. He knew the project would hugely enhance the reputation and visibility of the JBC and that it was inevitable that some journal would be the first to go online. His style of consensus-building was to proceed with quiet analysis, which led to quiet enthusiasm, and then quiet diplomacy with his colleagues to develop the necessary consensus so that everybody was on board with proceeding with the project to put the journal online.

Ralph Bradshaw (then the chair of the Finance Committee, Treasurer of the ASBMB, and an Associate Editor of the JBC) said of Tabor, “He says this is a good idea, and everybody listens.” He was effective at talking because he was so effective at listening, because he has been talking to people, respecting their concerns, and not being a cheerleader or salesman. Once he was convinced that JBC Online would work for the journal and for the Society, he was an enormously positive force. He understood its importance not just for the JBC but for scientific publishing in general. Dr. Tabor was essential to getting the approval for JBC Online through the Society’s governing council.

Risk versus reward

It should be noted that a number of journals—the American Association for the Advancement of Science’s Science magazine, for example—already had built freely accessible websites of abstracts and posted each new issue’s abstracts upon publication. However, it was not a forgone conclusion that scientific publications would be moving to the web with the full text of their articles. By working only with abstracts, which were almost entirely text-based at the time, all of the risk was mitigated even for a journal with as many readers as Science. And given the small number of research articles in each issue of Science, the abstract pages of the website could be constructed by hand, rather than by programs.

The largest commercial publishers were also building experimental websites working with journals that were typically new, small and “proprietary” (i.e. fully owned by a commercial publisher, so the publisher could make decisions for a journal without a Society’s involvement). This combination allowed the publishers to manage risk. One such project under way at the same time as JBC Online was Wiley’s Journal of Image-Guided
Surgery. This was a startup journal in clinical medicine, so it was unlike the JBC in almost every way.

Additionally, for Wiley, its first online journal was an experiment because it had hundreds of other not-online journals. For ASBMB, JBC Online was existential and transformative because the JBC was the crown jewel. It is simply much harder to migrate something that already exists online, especially something the size and longevity of the JBC. Thus, this was a bold thing to attempt. Should JBC Online launch, but then be judged as a failure—especially by authors—it would harm the journal’s reputation. So if the project was attempted, it had to succeed. That’s not the usual definition of an experiment, especially one with so many significant risk factors. But just as there was reputational risk, there was reputational reward to the JBC if we were successful. Our confidence was unbridled and, perhaps, unfounded. These are common traits of Silicon Valley entrepreneurs even today. While it was not Dr. Tabor’s task to manage all of the risks, it was his role to weigh the risks and rewards and to decide to put his own reputation and endorsement on the balance scale to counter-weigh the risks.

What success looks like

Amazingly, we completed the demo system in under 5 months, to be able to host an unprecedented online-connected booth at the Experimental Biology meeting on May 22, 1995. Our success was immediately visible in the lines of researchers waiting to use the computers and printer we had set up for demonstration. There were two reasons for this: the freshness of the content and the transparency of the user interface. The freshness was due to one of the biggest risks we took: We had decided to load the most recent issues of the JBC onto the new site, issues we had only received from the printer anywhere from a few weeks to a week before launch. This was risky, because we did not have time to work and rework the content, looking for any technical problems.

But what we did accomplish was to make available to several thousand researchers hundreds of articles they had never seen before, along with a search engine that could let them find exactly the articles important to them. As described before, it could take a few weeks or more for a new issue of the JBC to reach universities, and then of course it took time for the library to get it onto the shelves. So the most recent 4–8 weeks of issues in the demo system had never been seen by the conference attendees.

As I mentioned above, we were lucky to have computer scientists at Stanford trained in the discipline of computer—human interface and user-centric design, and we had included some of them on our development team. With their guidance, we had designed the system primarily to address the needs that researchers had: to find relevant research, read it, save it, and print it.

While this seems obvious now, other designs being developed at the time did not use search engines and were oriented more to reading issues than articles (3). The home page of the new JBC Online site further attempted to give people a quick and simple set of choices using a audio/video-playback-style interface to cue them: Look at back content, look at the current issue, or look at future article titles (Fig. 1) (4).

As we started adding new articles every week, we soon saw another reason for JBC Online’s success: the relevance-ranked search engine was an “equalizer.” The predominant biomedical search engine of the time was Medline and then PubMed. These focused on date-based ranking of search results so that the newest items always were first. But with JBC Online, we added relevance ranking, which meant that the documents closest to your interests were first. The difference was that you could explore a field new to you quite rapidly, because the documents were organized by importance/relevance to you rather than their recency. This essentially equalized document age, raising the profile of historical articles, which could now show up as number 1 in the search results of JBC Online but in PubMed would be pushed down as they aged. Google Scholar today implements this same relevance-ranking approach, enabling researchers to cross discipline boundaries more readily.

The aftermath

Had JBC Online been the only major research journal online for a year or two, it would still have been a major resource for researchers. But, Sputnik-like, its influence went beyond its readers and authors to spur other major research journals to rapidly follow its path. Within a few weeks of the public launch of JBC Online in May 1995, HighWire heard from several journals, all of them citing JBC Online, and all of them driven by strong editors-in-chief who saw that staking a claim for their journal in this new territory could be a competitive advantage in both the visibility of its articles and the reputation of their journal for being at the leading edge. We heard from Science, the Proceedings of the National Academy of Sciences (PNAS), the Journal of Neuroscience, the Journal of Clinical Investigation, Blood, the EMBO Journal, the Journal of Nutrition, the Journal of Histochemistry and Cytochemistry, Molecular Biology of the Cell, the journals of Rockefeller University Press and Cold Spring Harbor Laboratory, the journals of the American Society of Pharmacology and Experimental Therapeutics, and Pediatrics, all before the end of 1997.

From our vantage point, this rapid move online can be ascribed to the influence that these leading editors had on each others’ journals through participation in each others’ publications and editorial committees and through the trust they had in their peers’ evaluation of the importance and quality of JBC Online. Because JBC Online was freely available and open to the public, it also demonstrated the “virality” aspect of the web; influence could spread instantly.

Dr. Tabor’s influence went beyond the JBC to the electronic deployment of other leading journals. This is best documented for PNAS, where his influence permeated the National Academy’s discussions of online research distribution. Dr. Tabor was appointed to the then-new National Academy of Sciences Committee on Publications in July 1995, less than 2 months after JBC Online was launched. PNAS was poised for change, as Nick Cozzarelli had just been appointed as the new PNAS editor in chief and Ken Fulton as the first Publisher of PNAS (now Executive Director of the National Academy of Sciences and Publisher, PNAS). A contract with HighWire for the development of PNAS online was issued in September 1996, with PNAS launching on January 14,1997, a few months after Science mag-
azine launched its full-text site online, all developed on the base pioneered by HighWire for JBC Online.

Dr. Tabor also played a pivotal role in launching electronic submission of manuscripts, briefing the National Academy of Sciences Committee on Publications in 1997 on the JBC’s work in this area and announcing the JBC’s new online submission system in 1999 (5). He also moderated a session on electronic publishing at the National Academy of Sciences annual meeting in 2000.

In a way, it was Dr. Tabor’s reputation for care and consideration—rather than for being someone who would chase after shiny new things—that gave other editors a sense that this was not a flash in the pan but a stable, solid path forward. His encouragement of a collaborative approach for the good of the whole science enterprise that invited colleague editors to work together—rather than a competitive one that tried to secure advantage by locking up the technology exclusively to the JBC—directly led the HighWire team at Stanford to take a “community-organizing” approach to building a collegial group of editors around the technology and the process of making decisions on how to develop and use it.

What big decisions had to follow success?

The success of the launch in May 1995 did not give the JBC’s editorial and business management much time to rest before key new ideas were being offered by others and before key business decisions about the interaction of print-based revenue and online access had to be made. Indeed, the major stressors that had to be handled by JBC leadership were those aspects of an online journal that impinged on the business model of subscriptions, which was at the time entirely print-based. These were often the same aspects that the online medium—with its essentially free distribution—raised as opportunities for vastly greater distribution in service to the Society’s and journal’s mission. The question was how to guarantee subscription income at the same time.

Business challenges

Libraries—and the faculty and students they served—were initially excited by the idea that so much content could be available without the physical limitations of paper. But as libraries’ trust in the online services grew, so did the expectation that they would need fewer print copies if a campus could be served by a campus-wide IP-based subscription. Major university campuses had multiple copies of the print JBC (Stanford had six by 1997 and seven by 1999 but only one by 2005). If multiple copies were canceled rapidly, it would lead to an existential financial crisis for not only the JBC but for the ASBMB.

It fell to the Finance Committee of the ASBMB, chaired by Ralph Bradshaw, to recommend the approach that would, as
Bob Simoni phrased it, “serve science while paying the bills” (6). It was important that the model selected would provide maximum access, move the journal and society into an electronic-dominant future, and yet generate the income that the journal and the society needed to thrive. Bradshaw collaborated with Tabor and ASBMB Manager Chuck Hancock to develop, refine, and package the models for the gradual shift of multiple print copy subscriptions to a single campus-wide online subscription at an institution.

**Editorial opportunities**

The huge advantages of JBC Online over its older print sibling were obvious: speed of dissemination, selectivity of search-engine retrieval, linking up of references with sources, and nearly cost-free distribution. Very soon, there were many ideas on how to leverage these advantages, each with its own risks, potential rewards, and opportunity costs. However, under Dr. Tabor, the JBC maintained a continual focus on always doing what was in the best interest of science, an attitude that led to the outcomes we’ve enjoyed for years.

**Publishing ahead of print**

Publishing an article online in its final-accepted-manuscript form was a major advance in the speed of delivering online content. In 2000, ASBMB was likely the second publisher to do this, after the American Chemical Society introduced its version, but ASBMB’s version was even faster to publish articles and also was free to readers.

**The 100-year archive**

The JBC was one of the first journals to put its full archive of content online after it was scanned from print issues. This meant that researchers could use the search engine to find anything that was known in the JBC. This addressed the concern that students and some researchers were not searching the literature that was not online, leading to an incomplete communal memory of what had been discovered and published before the 1990s.

**Free back issues**

Making back issues more than 12 months old (all the way back to 1905!) free so that readers in nonresearch institutions or other sites without stable library budgets could access them was an early version of today’s “open access” and was later called “green OA” and “bronze OA.” This decision precluded the society from making money from subscription sales of its deep archive.

**Online manuscript submission**

Several journals had created online tracking systems, but the JBC was one of the first journals to move its full manuscript processing online. Authors, editors, reviewers, and JBC staff all worked in a single online system, making rapid publishing possible.

**Toll-free interjournal links**

This capability allowed readers of one article to read a cited article in a different HighWire-hosted journal without needing a subscription to that journal. The goal was to support the reader’s “journey” by making the task of following references as seamless as possible.

These opportunities could also be merged in amazing ways. The combination of online manuscript submission and review with the publish ahead of print capability enabled very rapid reviews, decisions, and publishing.

**What did we get wrong?**

As we were developing and rolling out JBC Online, we talked with authors, readers, librarians, and other stakeholders and also made some assumptions about how the community would respond. As it turns out, nearly every prediction we made for institutional-subscription behavior was wrong, but happily none of these were catastrophic!

We learned that what librarians told us they wanted was aspirational but not actual. The best example here was regarding librarians’ advice to us that print subscriptions should be “unbundled” (separated) from online subscriptions so that the libraries could alter their purchases without regard to maintaining “legacy” print subscriptions. However, when the JBC introduced this model, a number of librarians complained that they were paying for the same content twice. Since then, we’ve become very familiar with models where you pay multiple times for multiple formats: Amazon dropped its early experiment in bundling an eBook with a print book, for example; and your movie theater ticket does not get you a discounted movie DVD! But at the time, unbundling was not popular. The librarians’ objection was for a time strengthened when many commercial and society publishers in fact did bundle print and online; after experiencing the JBC’s model, librarians felt they were getting a good deal to pay only a 30% premium for online access that was a common figure at the time. The JBC was largely left standing alone on this score.

Perhaps the most famously wrong prediction was that print would rapidly erode and disappear. We had assumed the print subscriptions would decline as librarians took advantage of the efficiency of online content and that they would maintain just a single copy for archival purposes. However, we were totally wrong. As one example, when we launched JBC Online, Stanford had five print subscriptions, and yet subsequent to the JBC going online, the number of subscriptions went up! Other universities were not in any great hurry to reduce multiple copies. We could only guess that departmental librarians were loath to give up their print subscription even though the savings in shelf space when the print JBC was discarded were substantial because there was still a print-centric culture in library collection development: A research library’s status was assessed in part by the number of items on the collection shelf. Altogether, it took years of archival-technology development—LOCKSS, Portico, and CLOCKSS—and trust-building for institutions to abandon purchasing even a single print copy. It was not until 2011 that the JBC was able to cease print, 16 years after JBC went online!
JBC REVIEWS: Herb Tabor’s vision

What did we get right?

In retrospect, it is amazing that this project came together as quickly and comparatively smoothly as it did—as I’ve noted, we had an incredible amount of totally unprecedented work to do that depended on the buy-in of multiple groups of people with different world views and agendas. Looking back at our experience, there were definitely a few key elements that were critical for success.

Have a short-term deadline

To paraphrase the common saying, “The threat of a hanging sharpens the mind.” We gave ourselves a 5-month window, with the Experimental Biology 1995 meeting as the essential “demo or die” target, which kept our total concentration on the task at hand and provided genuine urgency to our interactions with peripheral groups.

Solve a problem the user has, not (just) a problem you have

We were lucky to have a solution that addressed a researcher problem (too much JBC to look at), a customer problem (libraries were centralized storehouses, and we could distribute the info to the campus), and a publisher problem (mailing weight limits). But the key, and the thing that we did differently than other online developers, was to take the point of view of the researchers, looking at how they do their literature work and solving their problems. If we had tried to force a JBC- or librarian-centric view on researchers, they could easily have just turned away.

A leader’s style has to fit the organization and the solution

There are all sorts of leadership styles—impresario, trustee, conductor, sheepdog, shepherd, Attila the Hun, etc. The person leading us had to tread very carefully to respect all of our different expertise but be able to push us in new directions, to keep us motivated without causing burn out, to keep the lines of communication open without dragging us into endless meetings, to be open to new ideas without plunging headlong into unfinished concepts, and to develop and exude confidence in the project without any guarantees. Herb was not the expert on anything except the JBC, but that was the perfect expertise for someone leading us toward the future of the journal! It’s certainly possible we could have finished with another leader, but I wouldn’t want to bet on it.

Large-scale journals have a capability to redefine publishing processes, not just publish papers

In 1995, as I noted, the JBC was the second largest journal in the world, and was basically required reading for any number of scientific disciplines. So if the JBC decided to change (innovate), the innovation would be seen and felt and judged by everybody—researchers, editors, reviewers, authors—very quickly. All of the decisions made at that time—going online, publishing ahead of print, developing online manuscript submission and tracking, making back issues free, etc.—reverberated immediately with the rest of the scientific publishing ecosystem and set a new standard for operating a journal that still echoes today.

When I stop and think about it, “an incredible amount of totally unprecedented work to do that depended on the buy-in of multiple groups of people with different world views and agendas” does not actually sound that different from some of the challenges that face scientific publishing today: How can we best utilize the advanced capabilities of the web to communicate science? How can we get away from evaluating scientists based on artificial metrics like the numbers of papers they publish or the impact factor of the journal they publish in, and recognize their scientific achievements in a truly meaningful way? How can we guarantee access to scientific content to researchers around the globe without disenfranchising labs, universities, or countries with fewer financial resources or getting societies that sponsor journals into financial straits? How can we speed dissemination of research results while still maintaining trust in the short term and an accurate record for the long term? How can we revise the publishing process to ensure transparency and reproducibility without creating onerous reporting burdens? Hopefully, this journey, and the lessons we learned along the way, might provide some guidance for our modern challenges as well.

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