

From symbiont to parasite: the evolution of for-profit science publishing

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ABSTRACT Two 17th century institutions—learned societies and scientific journals—transformed science in ways that still dominate our professional lives today. Learned societies like the American Society for Cell Biology remain relevant because they provide forums for sharing results, discussing the practice of science, and projecting our voices to the public and the policy makers. Scientific journals still disseminate our work, but in the Internet-connected world of the 21st century, this is no longer their critical function. Journals remain relevant almost entirely because they provide a playing field for scientific and professional competition: to claim credit for a discovery, we publish it in a peer-reviewed journal; to get a job in academia or money to run a lab, we present these published papers to universities and funding agencies. Publishing is so embedded in the practice of science that whoever controls the journals controls access to the entire profession. We must reform our methods for evaluating the contributions of younger scientists and deflate the power of a small number of "elite" journals. More generally, given the recent failure of research institutions around the world to strike satisfactory deals with publishing giant Elsevier, the time has come to examine the motives and methods of those to whom we have entrusted the keys to the kingdom of science.

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A NEW RELATIONSHIP BETWEEN SCHOLARS AND PUBLISHERS

Non Solus (Latin for "not alone") reads the banner of a woodprint adopted as a logo in 1620 by the House of Elsevier, a family of Dutch booksellers. The print shows a sturdy elm tree that supports a growing vine, which wraps around the trunk and entangles the branches (Figure 1A). The vine bears fruit, which a solemn scholar harvests with ease. In 1880, an unrelated publishing company adopted the venerable Elsevier name and logo, which according to its website: "...represents, in classical symbolism, the symbiotic relationship between publisher and scholar. The addition of the Non Solus inscription reinforces the message that publishers, like the elm

tree, are needed to provide sturdy support for scholars, just as surely as scholars, the vine, are needed to produce fruit. Publishers and scholars cannot do it alone...." (Library Connect, 2015).

Today, this 400-year-old logo no longer reflects reality. As scholars, we now *could* take over the means of fruit production—in fact, we already do most of it. Like our intellectual ancestors hundreds of years ago, we still conceive and execute the research, and we write the manuscripts. But now, with the advent of electronic word and image processing, we also create our own graphics, proofread our own text, and in some cases typeset it. More significantly, the Internet enables us to instantly disseminate our work around the world. Publishers provide a measure of quality control by orchestrating the peer review process, but here again it is scholars who do the actual work of reviewing papers. It is thus surprising that despite the diminished (and arguably dispensable) role of the publishing industry, our community remains slavishly committed to centuries-old traditions that, we will argue, are illogical and in many cases exploitative and harmful to our community.

Of course, Elsevier is only one of several large for-profit publishers that subscribe to an ingenious business plan. In an insightful satire, Scott Aaronson describes a fictitious computer game company built on principles similar to those of the for-profit publishing industry, exploiting its patrons to contribute their products and labor

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Abbreviations used: ASCB, American Society for Cell Biology; CNRS, Centre national de la recherche scientifique; CV, curriculum vitae; EFF, Electronic Frontier Foundation; EMBO, European Molecular Biology Organization; FASTR, Fair Access to Science and Technology Research; HHMI, Howard Hughes Medical Institute; MBoC, *Molecular Biology of the Cell*; NIH, National Institutes of Health; RELX, corporate group previously known as Reed Elsevier; UC, University of California.

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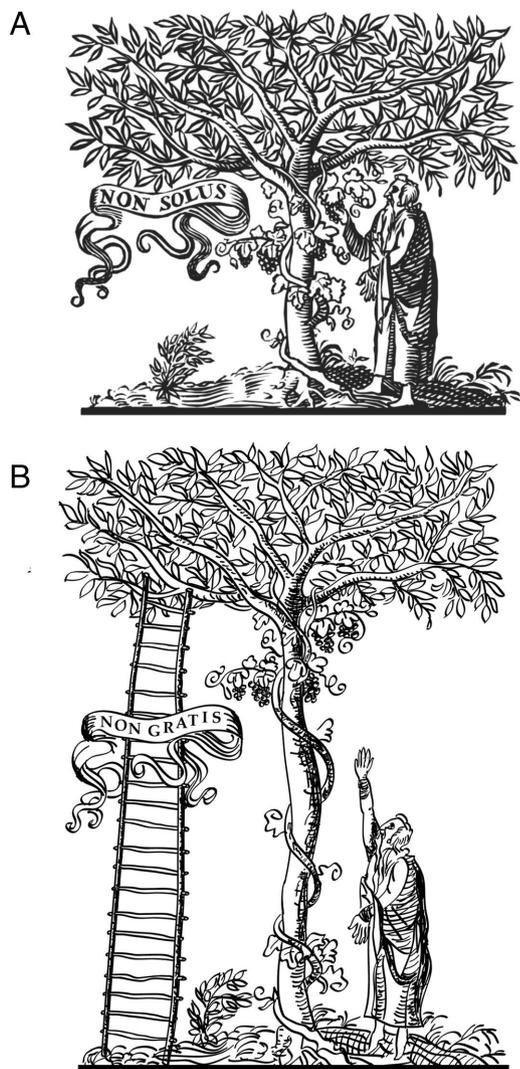


FIGURE 1: (A) The trademark and logo of Elsevier (A.D. 1620). (B) The authors' satirical view of the Elsevier logo four centuries later: The tree has grown (A.D. 2019).

for free (Aaronson, 2007). In Aaronson's scenario, developers donate their games to the company because they need its "seal of approval." Experts test and debug the games for free when told that it's their "professional duty" to do so. So, for only a trivial investment in the products, the company can charge customers high rates for the games it now owns. Aaronson concludes: "On reflection, perhaps no game developer would be gullible enough to fall for my scheme. I need a community that has a higher tolerance for the ridiculous—a community that, even after my operation is unmasked, will study it and hold meetings, but not 'rush to judgment' by dissociating itself from me. But who on Earth could possibly be so paralyzed by indecision, so averse to change, so immune to common sense? I've got it: academics!"

The situation is amplified by the fact that publishers have created de facto monopolies. In this industry, normal market forces that control pricing through competition are entirely absent. Every paper we publish is a singular product, and every academic library is obliged to provide access to it. Otherwise, we, the scholars, cannot perform our jobs. Because of this mandate, publishers can increase prices virtually at will (at least until library budgets are

exhausted), which is strongly supported by data that show the increase in subscription cost far outpaces other market indicators (Crawford, 2014). The only control in place is depressingly reminiscent of a parasite–host relationship: To ensure its own survival, the parasite must not kill the host. Why having a monopoly on the product combined with a captive market for it does not violate antitrust law is unclear to us.

To compound the issue, we blithely accept most publishers' demand to sign over copyright of our work, allowing them to control access to it and maximize their profits. If we imagine an updated logo reflecting the current business practices of for-profit publishers, it might look something like Figure 1B. The elm tree has grown, as the for-profit publishing houses now have grown into gigantic multinational conglomerates. The fruit of knowledge now hangs out of reach, even when we are stretched on our tippy toes. For access we need to use the ladder that is gated and festooned with the banner whose motto has morphed into *Non Gratis* ("not for free"). The role of the tree has changed from disseminating knowledge to controlling access. And yet, we happily keep nourishing the tree. Just as Scott Aaronson (2007) describes, we work for them for free in producing the work, reviewing it, and serving on their editorial boards.

WHAT PUBLISHING REALLY COSTS US

The profits of major commercial publishers are astonishing. As a whole, the industry made more than \$10 billion in 2015, with profits for the largest players, such as Elsevier, Springer, Taylor & Francis, and Wiley, exceeding 30% (Murphy, 2016). Elsevier alone, a publicly held company and the world's largest for-profit academic publisher, revealed revenues in its 2018 Annual Report of \$3.2 billion for its science/technology/medical branches with an operating profit of \$1.2 billion (RELX, 2018). This profit margin of almost 38% increases to more than 40% when we look at the journals division by itself, which posted earnings of \$1.75 billion and estimated profits of \$737 million. In other words, every time we pay a \$3000 article processing charge, only \$1800 supports the publishing process, while the remaining \$1200 goes directly to Elsevier shareholders.

Putting these numbers into perspective reveals the magnitude of the problem: the annual *profit* Elsevier makes selling access to scientific journals exceeds 90% of the entire annual budget of the Howard Hughes Medical Institute (HHMI), the major philanthropic funding agency for biomedical research in the United States, which funds more than 300 investigators in more than 60 research institutions. The National Center for Scientific Research (CNRS), the major funding agency in France, spends 30 M€ /year on journal subscriptions (~20% of its entire annual budget allocated for consumables and small equipment) (CNRS, 2016). This money is effectively a surcharge, or tax, on scientific research imposed not by a government but by a for-profit industry. Imagine how much research could be carried out using these resources if they were channeled back into our academic enterprise.

By comparison, the profits generated by university presses and society journals are modest, and they often support valuable initiatives that enrich our community. These include the prestigious European Molecular Biology Organization (EMBO) Fellowships that would not exist without revenue from EMBO journals; the impactful American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellowships funded by income from *Science* magazine; and the various activities of the American Society for Cell Biology (ASCB) supported by the journal *Molecular Biology of the Cell* (MBoC). These enterprises add to the larger good of our community values, and they deserve our support and volunteered labor.

Most of us pay publication charges from grants funded by taxpayer money. After this, our libraries, also funded (directly or indirectly) by taxpayers, pay a second time to gain access to this published work. The open-access models adopted by for-profit publishers do not lessen the impact of this double-tap on our scarce resources. Elsevier's *Cell Reports* charges \$5000 to publish an article. Thus, while foregoing the library subscription income, the shareholders' profits are well preserved in the aggregate of their portfolio. But at least open access enables us to evaluate the price tag up front. Scientists can decide on a case-by-case basis whether any particular journal is worth that much money, and publishers cannot lock away our papers in their archives, holding them ransom and charging our community over and over for access. A telling example of how value-for-money can be provided by stand-alone, not-for-profit journals is the *Proceedings of the National Academy of Sciences (PNAS)*. This venerable venue has been breaking even for more than 100 years and currently charges the University of California (UC) system \$25,000/year for access to its content. Based on UC library usage statistics, each paper downloaded from the PNAS costs the system \$0.04. Elsevier, on the other hand, charges the UC system a whopping \$11,000,000/year for access to its collection of journals, a figure which works out to more than \$1.04/download (Schekman, 2019). This clear-cut example illustrates what it really costs to run a fine, high-profile journal. Nobody would object if a commercial publisher, needing to sustain a profitable business, charged a bit more, but 26 times more seems extortionate.

WHY DO WE RESIST CHANGE?

All the issues mentioned above have been raised ad nauseum. They have caused flurries of outrage across a range of academic communities, yet the issues persist in the face of boycotts and editorial board resignations (Kingsley and Harnad, 2015). Why do we not only tolerate an antiquated and patently exploitative publishing system but also actively support and promote it? Why is our community so resistant to seeing through these issues and effecting meaningful change? There are a number of reasons that contribute to the unfortunate status quo.

First and foremost, we as a community have fallen into the lazy and lamentable habit of using journal titles as yardsticks to measure our accomplishments. We pretend that this is a rational strategy by pointing to metrics such as the journal impact factor, widely viewed as a false metric tailor-made to be gamed by high-profile journals (San Francisco Declaration on Research Assessment; <https://sfdora.org/read/>). Although impact factors are now widely assumed to dictate the careers of many young scientists, in reality, the importance of publishing in high-profile journals arises largely from an antiquated notion within the scientific community. There is no intrinsic value to publishing our work in such journals; there is only the value that we, collectively, decide to place on it. As long as the "gold-stars" associated with authoring papers in, for example, *Cell* and *Nature*, are perceived as significant drivers in hiring, promotion, and funding decisions, Elsevier, Springer, et al. will remain untouchable forces. In his wonderful children's book *The Sneetches*, Dr. Seuss powerfully illustrates the impact of the gold stars in an imaginary society. The Sneetches that inhabit this society come in two castes: some have gold stars affixed to their bellies and some do not. The Sneetch society is stratified by this attribute:

When the Star-Belly children went out to play ball
Could a Plain Belly get in the game...? Not at all

You only could play if your bellies had stars,
And the Plain-Belly children had none upon thars.

Geisel, 1961

As the story goes, a lot of money is made by those who offer to print stars onto the bellies of those lacking them, which as status symbols are just as meaningless as papers in high-impact-factor journals on our CVs as indicators of signature contributions. We desperately need to eradicate the misleading metric of the journal impact factor, and a movement to do this is well underway. Alternative, article-based (i.e., not journal-based) metrics are an improvement and are gaining acceptance, although even this is not enough (Hutchins et al., 2016; Santangelo, 2017). One of us (P.W.) served on a grant evaluation panel for the European Research Council (Hyman et al., 2016). In our panel it is the stated and adhered to policy that we would not consider where a paper is published. Rather, in our evaluations we assessed its real impact in a field. Change of this sort and defiance of the status quo is badly needed in all committees and panels that make decisions that impact the future of our next generation of scientists, even if it entails a bit more work. Believe us, it is far more informative (and fun) to read and evaluate a candidate's contributions than to trust blindly the decision of a *Cell* or *Nature* editor. Even if the highest-profile journals may not be the biggest money-makers for the publishers, their business practices of bundling subscriptions and creating ever-expanding suites of high-profile spin-off journals rely on them as profitable hooks for maintaining market share.

Second, the beneficiary of the current system is a multibillion dollar industry whose influence is so strong that most institutions funding our research are unwilling or unable to counter it decisively. The research community itself may lack the courage to stop publishing in for-profit journals, but public funding sources like the National Institutes of Health (NIH) and major philanthropic funders such as the HHMI could make this change overnight by demanding that the work they fund be made freely available upon publication. An ideal strategy would be one that reduces the exploitative behavior of for-profit publishers without subjecting nonprofit publishers to friendly fire. Indeed, a major movement in this direction emerged last year with Plan S (Box 1), developed by cOAlition S (Science Europe, 2019) and adopted by major funding agencies around the world such as the Wellcome Trust, the CNRS, the Max-Planck-Institutes, and the Gates Foundation (Wikipedia, 2019b). In light of these developments, we fail to understand why other funding institutions continue to compromise with for-profit publishers, allowing them to retain exclusive rights to charge for access to the work that they fund. HHMI, for example, "strongly encourages" but does not demand immediate open access (HHMI Policies SC320 Public Access to Publications, 2017), and efforts to change NIH policies (the FASTR Bill) (Wikipedia, 2019a) have stalled in the U.S. Congress (Harmon, 2018). With so many accessible publishing options available, is there a compelling reason to compromise on this issue? Akin to those politicians who deploy demagogic talents to convince national electorates to vote against their own interests, for-profit publishers bring enormous resources to bear and "convince" policy makers, funding agencies, and researchers that their services are invaluable, and that their practices and profit margins are fair and justified.

Third, the publishing landscape is complex. It is imperative for us to adhere to our academic mission of making sure that scientific contributions are properly reviewed and refined so that our published work represents reliable, true advances of knowledge to the best of our ability to judge. For that, we have accepted a communal

BOX 1: The 10 Principles of Plan S.

1. authors should retain copyright on their publications, which must be published under an open license such as Creative Commons;
2. the members of the coalition should establish robust criteria and requirements for compliant open access journals and platforms;
3. they should also provide incentives for the creation of compliant open access journals and platforms if they do not yet exist;
4. publication fees should be covered by the funders or universities, not individual researchers;
5. such publication fees should be standardized and capped;
6. universities, research organizations, and libraries should align their policies and strategies;
7. for books and monographs, the timeline may be extended beyond 2020;
8. open archives and repositories are acknowledged for their importance;
9. hybrid open-access journals are not compliant with the key principle;
10. members of the coalition should monitor and sanction non-compliance.

Plan S states that by 2020, research funded by public grants must be published in open access journals or platforms.

responsibility, reflected in the many altruistic ways we volunteer our time and effort. These are powerful traditions that we deeply value. It is not always easy to see clearly when these values are being abused. Perhaps it is this intrinsic conflict in our own ethical principles that enables for-profit publishing companies to continue to flourish with a business model that exploits and manipulates our community values for financial gain, though occasionally, the true picture emerges crystal clear for all to see: Elsevier repeatedly engaged in litigation to protect its interests and, in an amusing move bordering on the ridiculous, patented their "Online peer review and method," leading the Electronic Frontier Foundation (EFF) to award Elsevier their August 2016 Stupid Patent of the Month Award (Nazer and Harmon, 2016).

Fourth, the editors who work for journals run by for-profit publishers are not our enemies. These editors, many of them talented scientists trained in our own labs, learned to recognize good science, to identify faulty logic, and to distinguish significant discoveries from incremental advances. We value them as colleagues and, for the most part, they do their best to handle submissions fairly while upholding the prestige of their respective journals. Yet, some have become corrupted by their masters and act more as powerbrokers (judged by their efforts to maximize the journals' impact factors) than as scientists and mentors practicing the art of rational, evidence-based decision-making.

This list describes a few of the many reasons why we put up with unnecessary and exploitative practices of for-profit scientific publishers. Perhaps evolutionary genetics provides a relevant lesson: Traits that are harmful to an entire population can persist for long periods of time when they provide individuals in that population with a survival advantage. And young researchers, who believe that they *must* publish their work in glossy magazines to be successful,

grow up to be established investigators who hold the next generation to the same, increasingly corrosive standard. So, how do we change the system?

HOW CAN WE EFFECT CHANGE?

Obviously, we cannot expect publishers themselves to initiate significant change. The executives of for-profit publishing companies argue that they cannot suddenly abandon their fiduciary responsibilities to shareholders and begin plowing profits back into the research community. This argument, however, is fundamentally flawed. By acting in good faith to advance the interests of both the company and the public (Stout, 2015), directors of for-profit publishing companies could certainly moderate their greed and help fix the system. Indeed a few publishers are becoming more sensitive to the needs of the community (see the example of Wiley below), while others such as Elsevier adamantly adhere to a profit-first principle. For them, the evolution from symbiont to parasite appears complete and irreversible.

What is left is for universities, funding agencies, and (most importantly) the research community to wake up. As with climate change, it may require drastic consequences to galvanize us into action. In the United States, state and national contributions to public universities have been declining since the early 1990s (Bourne and Vermillion, 2016), while the money that universities spend on subscriptions to academic journals has risen far faster than other market indicators (Crawford, 2014). Something has to give. A wake-up call for the UC system came in 2003, when Elsevier, in an attempt to squeeze higher online subscription rates out of the UC system, cut off electronic access to its journals. This was the first time that we (and our students and postdocs) *literally* could not read our own papers! After the threat of a large-scale boycott, Elsevier eventually struck an undisclosed compromise (probably saving the UC system millions).

Unfortunately, the 2003 deal between UC and Elsevier produced no lasting change but likely provided a template for dealing with subsequent university revolts. Four years ago, for example, a threatened boycott by Dutch universities of Elsevier journals was averted without Elsevier making major concessions (Grove, 2015). This deal is now again under renegotiation. Similarly, Finnish universities and institutions threatened to boycott Elsevier and then agreed to a deal that promises little, if any, substantive change in the publishing landscape (Elsevier Connect, 2018; National Library of Finland, 2018). It appears that many institutions in Europe continue upholding the status quo perhaps waiting until Plan S kicks in in 2021.

But as history repeats itself, we (try to) learn from mistakes of the past. Earlier this year, as the 2014 contract between UC and Elsevier came up for renewal, negotiations broke down once again. Elsevier rejected a UC proposal that would have provided a gradual transition to open access while capping Elsevier's revenue at roughly their current levels. With no subscription contract, scholars at all of UCs 10 campuses again will no longer have library access to Elsevier publications published from 2019 and onward. (Continued access to older, archived contents was contractually guaranteed in past agreements.) Perhaps not coincidentally, Elsevier's stock dropped 4.6% of its value on the day negotiations with UC broke down. Similarly, large consortia of German, Swedish, and Hungarian universities and research institutions have canceled their subscriptions to Elsevier journals.

Even as Elsevier remains intractable, however, there is evidence that other publishers are getting the message. Wiley, for example, recently struck a deal with the German consortium of research

organizations, agreeing to pursue a path to universal open access set by the academic community (Kwan, 2019). This path, incidentally, closely resembles the one that Elsevier has been steadfast rejecting.

Yet what remains puzzling is the lack of more widespread anger in our communities regarding the degree of exploitation and abuse by for-profit publishing enterprises that we not only tolerate but also accept and support. How can our colleagues be, as Scott Aaronson points out, "... so paralyzed by indecision, so averse to change, so immune to common sense" (Aaronson, 2007)? There remain a few thousand of our colleagues at UC who have not signed-on to the Elsevier boycott, upholding in their passivity the status quo even when faced with the tangible consequence that their community has now been deprived of access. What can/should we do as individuals to accelerate change? One obvious action that would help weaken the grip of the for-profit publishing industry on our community would be, whenever reasonably possible, to decline to provide our free labor. One of us (P.W.) for example, with very few exceptions that can be counted on one hand, has not published in or reviewed for any Elsevier journal for the past 16 years. Another tangible action is to reward with special recognition those young scientists who have chosen to publish their work in open-access venues and hence identified themselves as adventurous pioneers, that is, the kind of colleagues who one would like to recruit and promote at forward-looking institutions.

Starting small with individual actions helps with another malady in our profession: the constant struggle to maintain a good life-work balance. Imagine, for example, what you could do with 4 hours in your day. You could either review a paper and put money into the pockets of canny investors or spend some quality time with your family, go for a walk, or perform some unpaid community service that actually makes the world a better place. If you really want to review that paper, there is another strategy that could turn the ethical dilemma into a win-win situation (see Box 2).

One symptom of scholars' frustrations with restricted access to journals is the emergence and widespread use of illegal download sites that provide free access to millions of copyrighted publications (Bohannon, 2016). Just as Napster and Bit Torrent servers forced a reorganization of the music industry—which in contrast to the for-profit publishing industry can legitimately claim to defend royalties paid to artists—sites such as Sci-Hub and LibGen pose a significant challenge to the status quo, as evidenced by Elsevier's near constant litigation. The original motivation for creating Sci-Hub and other illegal download sites was to provide access to scientific literature for scholars in the developing world. Current data,

however, reveal that the per capita usage of these sites is comparable in affluent countries, indicating the magnitude of worldwide demand for access to the literature. The phenomenon of content "leakage," be it through pirate sites or scholarly peer-to-peer collaboration networks such as ResearchGate, nowadays provides widely used alternatives to access publications otherwise locked away behind pay walls and increasingly empowers libraries at the negotiation table.

The authors of this article are old enough to remember the end of the Cold War. One of us (P.W.) grew up in postwar West Berlin, embracing the antiauthoritarian culture of the era; the other (D.M.) studied for a time at the University of Leningrad in the days leading up to Perestroika and the collapse of Soviet communism. So, with the reader's indulgence, we adapt the call of a past U.S. president:

COLLEAGUES, TEAR DOWN THAT TREE!

And if we scientists fail to tear it down in one blow, then let us at least open our eyes and continue to chop away at it. The end goal seems obvious: The knowledge that we produce in our publicly funded works belongs to humankind and must not be locked up—newly submitted papers should be open access and older ones open archive. Our real challenge is to break the paths that get us there. And major change *can* happen, even if it seems impossible to imagine now. The Berlin Wall no longer stands, and we are certain that—if we put our hearts into it, embrace healthy values, and eradicate bad ones—scientists, learned societies, and scientific journals can invent new, powerfully symbiotic relationships.

EPILOGUE

Although formal negotiations broke down in December, 2018, Elsevier continued to provide the UC access to its subscription online content until July 10, 2019. On this date, Elsevier terminated access to new content in all of its journals as well as to older content in a subset of 580 journals. In response, over 30 UC faculty serving Elsevier editorial boards suspended their services (Grens, 2019; Sanders, 2019). Now scholars in the UC system must find alternative access to work that authors and volunteer peer reviewers previously entrusted this company to publish, that is, to make public. The wake-up call could not be louder; it is time to stop hitting the "snooze" button!

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BOX 2: Suggestion for a reply when asked to review for a for-profit journal.

Dear Editor,

Thank you for inviting me to review this work. I will be happy to do so, but please be advised that I charge \$400 per hour [optional: and I read rather slowly].

Please confirm that this arrangement is acceptable to you.

Sincerely yours, ...

Note that the suggested rate for professional advice is a bargain. It would be very hard to find a lawyer to work for this rate for a for-profit enterprise.

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