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Replaying the Tape of Academia: Fourteen Alternative Practices for the Physical Sciences

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Key Points:

- Modern academic practices reflect elements of both contingency and determinism
- Consideration of alternative practices can guide within-system change and large-scale restructuring

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Abstract The evolution of modern academic practices, analogous to the evolution of biological systems, reflects the influence of both contingency and determinism. From a theoretical perspective, how then could academic practices differ from those that were inherited? Would any alternative outcomes be more just, equitable, diverse, or inclusive? Here we present 14 alternative academic practices that might be attained upon replaying the tape of academia and evaluate their benefits and drawbacks. Oriented primarily around the physical sciences within the United States, these alternative practices reconsider common activities within the broad categories of the graduate student experience, faculty careers, evaluation methods, peer review and publication, and conference norms. Consideration of these alternative practices can guide within-system change and large-scale restructuring of academia to address the myriad challenges facing researchers and students. Conversely, alternative practices may introduce new issues or exacerbate existing problems. These alternative practices are meant to be imaginative, not prescriptive, and we hope their underlying ideas spur reflection and conversation on the existing practices embedded within academic culture. Readers are encouraged to complete a brief survey regarding their impressions of the alternative practices, available at the following link: rebrand.ly/AlternativePractices2024.

Plain Language Summary The practices of modern academia have been both intentionally developed and passively inherited through time. By presenting 14 alternative ways that academia could operate, this work encourages discussion regarding how current practices came to be and how they might be altered to encourage more productive and welcoming environments for teaching, learning, and research.

1. Introduction

The evolutionary biologist Stephen Jay Gould famously wrote "Replay the tape a million times… and I doubt that anything like *Homo sapiens* would ever evolve again" (Gould, 1989). Gould was referring to the long-debated predictability of evolution — the relative power of determinism versus contingency in shaping biological outcomes (Blount et al., 2018). Deterministic forces would imply repeatability with re-plays of history, while contingent effects would give more power to chance events that generate structures inherited through time. In drawing a parallel between evolutionary and academic structures, this framework inspires an interesting question: if the tape of academia were to be replayed, which modern practices would be recreated, and which would be different? For example, the practice of wearing brightly colored doctoral robes at graduation may reflect contingency as a chance tradition carried forward across academic generations. In contrast, in designing a doctoral degree, marking the end of the program with an evaluated written document may be a deterministic outcome. As commonly discussed in organizational theory (Stinchcombe, 1965), many practices within academia could reflect conditions from early in the development of university systems that have since been inherited through time without intentional modification (Kevles, 1977; Wang, 1995). Here we explore this framework by presenting 14 alternative practices that could arise upon replaying the tape of academia. Although there is no guarantee that replaying the tape would result in more equitable academic structures, by considering alternative practices we begin to evaluate why current academic structures exist, who they might be benefiting, and how they might be modified to ensure efficient, open, and inclusive science.

The 14 alternative academic practices cover five categories spanning academic activities: the graduate student experience, faculty careers, evaluation methods, peer review and publication, and conferences norms (Figure 1). We intend for each idea to be considered independently because some contain contradictory elements. These alternative practices are meant to be imaginative, not prescriptive. Several of the ideas we entertain are polarizing

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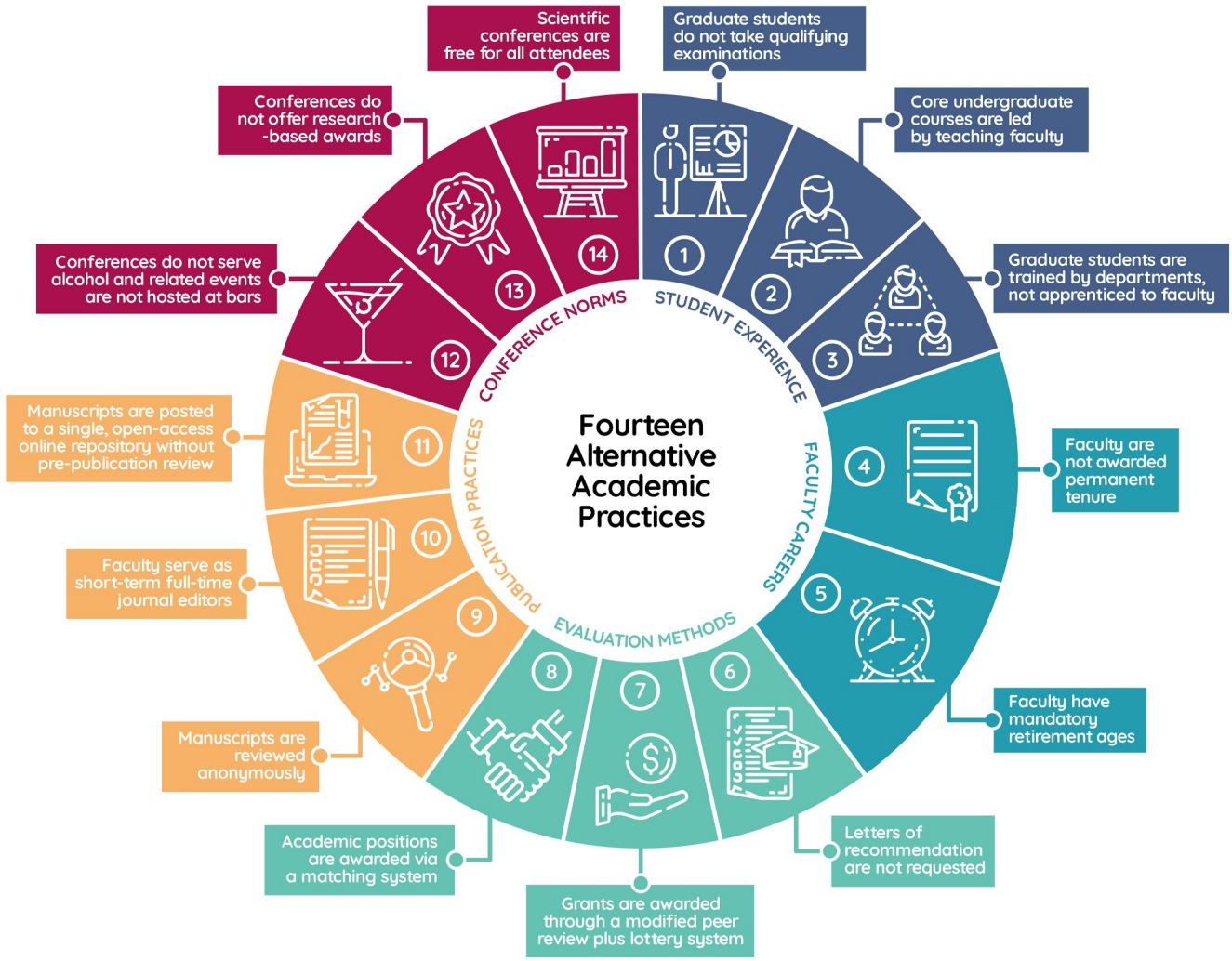

Figure 1. Fourteen alternative academic practices organized by category: the graduate student experience (navy), faculty careers (teal), evaluation methods (green), peer review and publication (yellow), and conference norms (red). With each category, practices are arranged by the perceived difficulty of implementation. Icons were designed by Hamel Khaled and were downloaded from the Noun Project. Readers are encouraged to complete a brief survey regarding their impressions of these alternative practices. The survey is available at the following link: rebrand.ly/AlternativePractices2024.

or present moral dilemmas, while others would require fundamental upheavals to the ways that scientific research is funded or conducted in the United States. Indeed, the authors of this work are not in mutual agreement regarding whether certain practices are preferable to current systems. Each alternative practice involves trade-offs among power, productivity, and inclusivity, while carrying the potential for unforeseen outcomes. Although no alternative practice will solve all issues for all people, some alternative practices can likely improve academic culture for both students and faculty. While the practices apply most directly to the physical sciences as pursued within the United States, many of the ideas are broadly applicable across academia.

We hope the 14 alternative practices are a launching point in group discussions, journal clubs, faculty meetings, or other gathering spaces for questioning which modern practices are serving researchers well and which are merely inherited traditions. That is, in evaluating the alternative ways that academia could function, we aim to inspire debate on whether modern academic practices are contingent or deterministic. A brief survey accompanies this article that seeks to capture reader impressions of the alternative practices and to solicit additional practices; this survey will close approximately 18 months after publication of this manuscript and aggregated results will be presented in a follow-up report. The survey is available at the following link: rebrand.ly/AlternativePractices2024.

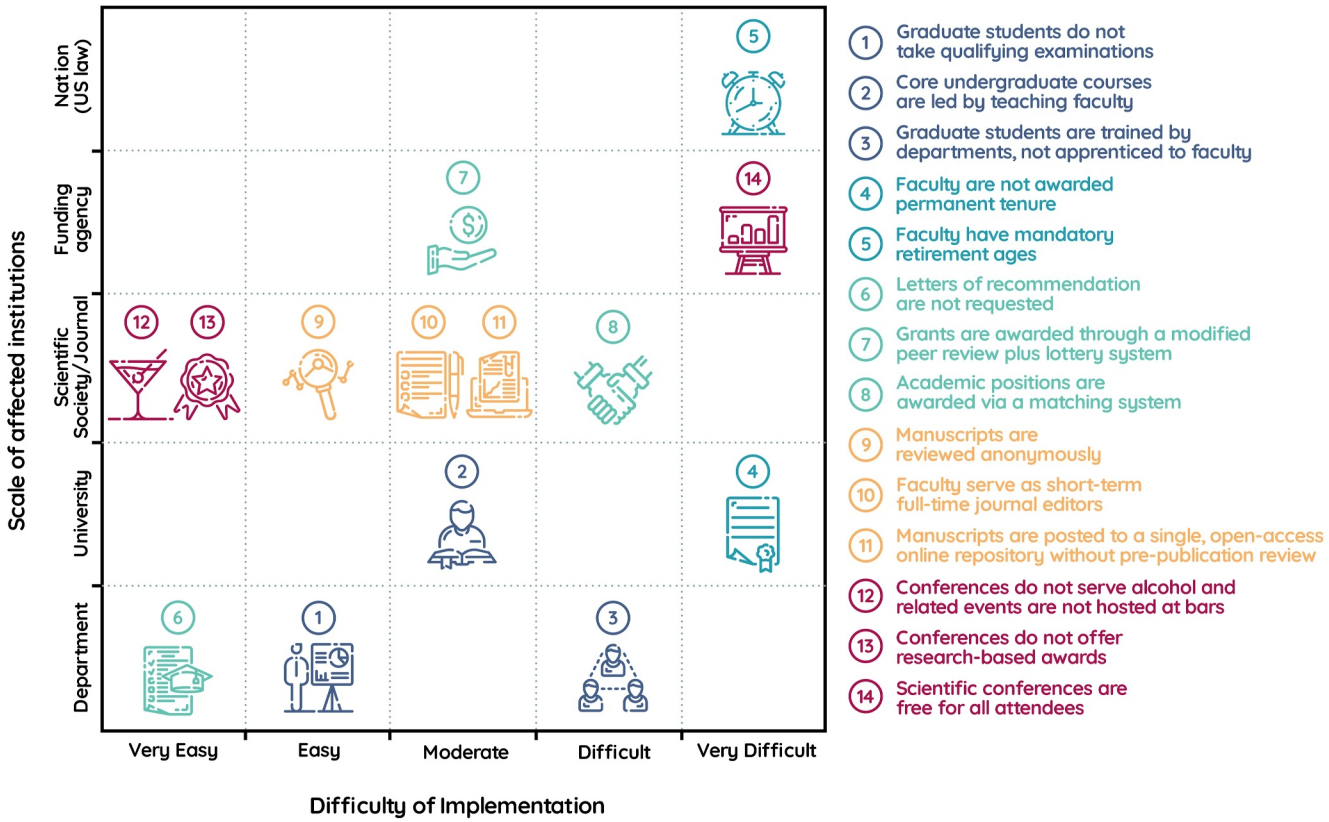

Figure 2. Qualitative plotting of the scale of affected institutions against the perceived difficultly of implementation for the 14 alternative academic practices. This figure demonstrates that both simple and complex changes can occur across individual departments, universities, academic societies, and government agencies. Readers are encouraged to complete a brief survey regarding their impressions of these alternative practices. The survey is available at the following link: rebrand.ly/AlternativePractices2024.

2. Methods

This article began with an interactive poster at the 2022 Fall Meeting of the American Geophysical Union (AGU). The poster had approximately 25 alternative practices listed with space provided for attendees to mark their agreement or disagreement using supplied sharpies. Additional space was also provided for new ideas to be added by conference participants. This format encouraged sustained discussion among researchers who visited the poster and, in addition to marking the poster with their votes, participants extensively annotated the poster with text and follow-up questions. Following the conference, the authors of this work reached the 14 practices presented here by identifying the alternative practices that had received widespread engagement during the conference and by grouping related themes. For example, we combined an alternative practice that had nearly universal agreement ("all articles are published open access") with a practice having nearly universal disagreement ("there is no peer review of articles") and an in-person discussion of a perceived hierarchy of peer-reviewed journals to reach alternative practice #11 ("Manuscripts are posted to a single, open-access online repository without pre-publication review"). Alternative practice #5, regarding mandatory faculty retirement, was suggested by a conference attendee. The 14 alternative practices were ultimately chosen to encompass a range of academic experiences and, within each of the five categories, the practices are ordered by increasing perceived difficulty of implementation (Figure 2).

3. Alternative Practices

3.1. Alternative Practices for the Graduate Student Experience

3.1.1. #1: Graduate Students Do Not Take Qualifying Examinations

Qualifying examinations (also known as comprehensive exams, oral exams, or preliminary exams) have existed in the United States since the 1930s and became popular in the 1960s during a tripling of the PhD student

population (Cassuto, 2015a; Estrem & Lucas, 2003). Often a combination of written and oral questioning, these exams act as a formal but porous barrier between the coursework and research stages of a doctoral program. At their best, qualifying examinations offer graduate students the opportunity to reflect on earned knowledge, demonstrate the capacity to conduct research, and develop coherent plans for the future, and they may be important for helping faculty identify the students most suited to writing a dissertation. In contrast, the experience of students taking the exams can be characterized by a sense of outdated ritual or anxiety (Lopez, 2022). In a survey of physics PhD students at Columbia University, 40% of respondents cited stress and/or sought counseling related to exams (Santiago & Nguyen, 2020). Another serious consequence of exams is bias against marginalized identities (McLaughlin et al., 2023; Posselt & Liera, 2022). Although exams are sometimes said to exist for "quality control" purposes (Guloy et al., 2020), there is realistically little expectation that all researchers passing exams have attained the same baseline level of knowledge or competence given that the style and content of qualifying exams differ among university departments, sub-disciplines within a given department, and even among students within the same sub-discipline. In contrast to educating students as part of a coherent academic program, these exams may benefit faculty who can use examinations to remove students from advanced degree programs when they may otherwise have limited ability to oust degree-seekers. If the tape of academia were replayed and a clear mechanism for employment termination evolved in place of qualifying exams, universities would potentially have more flexibility to dismiss graduate students but would need to clarify student employment status and expectations for progress within degree programs. Important reforms are already underway; for example, some institutions are assessing dissertation skills through grant writing and minimizing stress by eliminating the oral question-and-answer component of the qualifying exam (Posselt & Liera, 2022).

3.1.2. #2: Core Undergraduate Courses Are Led by Teaching Faculty

An instructional niche for pedagogical experts was previously supported during a period of abundant academic funding and employment opportunities (Cassuto, 2015b). In the modern world, however, faculty members are commonly tasked with both leading research groups and teaching courses. Although incentivizing research can negatively impact teaching (Bak & Kim, 2015; Hacker & Dreifus, 2010), outcomes for the two activities are not clearly negatively correlated (Figlio & Schapiro, 2017; Hattie & Marsh, 1996). Overall, teaching and research may or may not be mutually beneficial (Prince et al., 2007; Ryan, 2016). In either case, an alternative practice that could improve the educational experience of students and partially alleviate the teaching burden on research-oriented faculty would be to separate the research and undergraduate educational aspects of university functions and hire distinct faculty for each. Such a separation could potentially improve the quality of undergraduate instruction by allowing degree-granting institutions to hire and retain pedagogical professionals with training in data-driven inclusive teaching practices (Figlio et al., 2015). In turn, such a change might grant research-oriented faculty the freedom to focus on research and mentorship. Among other universities, Worcester Polytechnic Institute and the University of California system have adopted similar models by supporting a growing cohort of tenure-track teaching faculty across their campuses (Dedman, 2021; Flaherty, 2021; Harlow et al., 2020; Xu & Solanki, 2020). Indeed, research from UC Irvine found that large introductory classes taught by such pedagogical experts included more best practices for student learning, such as formative assessment and active learning (Vu, 2017). An additional benefit of expanding teaching faculty positions might be recruitment of a more diverse workforce; a study of the UC system teaching faculty found that approximately one quarter of the population were first generation college students and approximately half were female (Harlow et al., 2020).

3.1.3. #3: Graduate Students Are Trained by Departments, Not Apprenticed to Faculty

Formal academic advising has existed at least since Johns Hopkins University formed a faculty system to oversee undergraduate education in the 1870s (Gordon, 2004; Rudolph, 1962). Since then, PhD advising in the physical sciences has largely evolved into the model of an apprenticeship, where a fledgling scientist is affiliated with an established researcher who provides financial and intellectual support. This solo supervision structure can create stark power dynamics between supervisors and apprentices, typically to the detriment of the student (Friedensen et al., 2023). Even for students on fellowships who are ostensibly financially independent, a faculty advisor is required to certify progress reports to external agencies. Furthermore, the current structure offers little ability for apprentices to demand accountability under ineffective or harmful mentorship, especially as university administrators have few options for disciplinary action upon tenured faculty members unless an unambiguous violation

of university policy occurs. On the faculty side, while the apprenticeship model generates an expectation of mentorship, tenure-track researchers can receive very little training or support for this aspect of their positions.

As an alternative practice, graduate student training in the physical sciences could have developed to promote a horizontal mentorship structure in which departments act as a collaborative team that balances power across all members (Robertson, 2019). This alternative practice is similar to how advising in the humanities and humanistic social sciences did develop; without the grant system that directly couples student employment to faculty research projects, advising in these fields tends to be more department-led than in the bench sciences (Cassuto & Weisbuch, 2021). Under this alternative framework, graduate students in the sciences could be financially supported by departments and pursue their intellectual passions without reliance on a specific faculty member. Students may benefit from the reduced power asymmetry and faculty may benefit from access to a broader set of trainees. By conducting research with multiple advisors, students might also have richer experiences or form stronger interdisciplinary collaborations. Finally, a broad advising structure would allow students to seek out different mentors for academic, career, and interpersonal advice, lessening the burden for a single faculty member to act as an all-encompassing advisor. This alternative practice also has several potential drawbacks. Foremost, without a defined mentor, students could potentially find themselves without any academic guidance. Depending on the topic of study, many departments may also not have more than one faculty member capable of providing meaningful research assistance. Moreover, under a distributed mentorship model, a student may spend more time engaged in activities that are not directly relevant to their dissertation work. Lastly, a shared advising structure could impose an unequal service burden across faculty members that penalizes the best mentors.

3.2. Alternative Practices for Faculty Careers

3.2.1. #4: Faculty Are Not Awarded Permanent Tenure

The modern academic tenure system developed throughout the first half of the twentieth century to enable researchers to pursue risky, potentially controversial projects without fear of political or religious retaliation and to be protected in their speech within and outside of the classroom (Metzger, 1990; Seligman et al., 1915; Wilson, 2016). By allowing scholars to pursue challenging projects over long timescales, including research efforts that may not succeed, tenure encourages exploration and innovation. While the tenure system at American universities has arguably met many of these lofty aspirations, effectively permanent contracts have also generated negative consequences. Examples of such consequences include a hindered ability for universities to pivot quickly toward emerging areas of research (Wetherbe, 2013), a lack of long-term accountability for faculty behavior, and a loss of young academics to careers outside of academia due to an increasing abundance of senior researchers. Along a different evolutionary trajectory, the academic practice of tenure might never have developed. In this case, university faculty might have the same employment structures as the general population and be subject to the changing demands of the academic marketplace. Although this alternative practice would alleviate certain problems with the existing system, it might also prevent researchers from investing their time in novel and difficult research areas that may benefit society. An intermediate practice that balances these considerations may be to grant faculty fixed-length employment contracts spanning several years to decades (Clement, 2022; Nietzel, 2020). In addition to preserving the ability of researchers to ask big questions, such contracts would potentially allow scholars to move more freely between universities, private industry, and government agencies. Furthermore, long-term contracts could alleviate some of the stress currently felt by pre-tenure faculty by encouraging levels of academic productivity that are sustainable long-term (Jaremka et al., 2020; Lashuel, 2020).

3.2.2. #5: Faculty Have Mandatory Retirement Ages

Mandatory faculty retirement ages of 65 or 70 were common among American universities prior to the 1980s and 1990s when mandatory retirement was prohibited through amendments to the Age Discrimination in Employment Act. Much of the opposition to removal of mandatory retirement originated within the academy itself based around arguments that uncapping could lead to negative impacts on institutional health (Hammond & Morgan, 1991). Indeed, the number of age 70 faculty still teaching two years later, at age 72, increased dramatically following policy implementation at a large swath of four-year institutions (Ashenfelter & Card, 2002). Recent examinations have likewise found a ballooning number of faculty aged 70 and over (Ho et al., 2021; Kaskie, 2017; Weinberg & Scott, 2013). A model has suggested that removal of the mandatory retirement age may have

decreased yearly faculty openings by ~20% over two decades in the absence of faculty expansion (Larson & Gomez Diaz, 2012) even as the yearly number of doctorates earned at American universities increased by 35% from 2002 to 2014 and outpaced faculty growth (National Center for Education Statistics, 2023; National Center for Science and Engineering Statistics, 2022). Were the tape of academia to be replayed, mandatory retirement might remain legal in a manner consistent with the less stringent policies elsewhere around the world (Lahey, 2010). A major shortcoming of this alternative practice is that mandatory retirement is broadly viewed as discriminatory, and forced retirement is extremely uncommon in non-academic professions. Furthermore, required retirement at a specific age could create undesirable situations involving the loss of historic institutional knowledge, shorter professorial careers for individuals who become faculty at older ages, and loss of the research contributions that may have been made by faculty in later years.

3.3. Alternative Practices for Evaluation Methods

3.3.1. #6: Letters of Recommendation Are Not Requested

Letters of recommendation are meant to provide a qualitative metric for distinguishing among candidates for review or promotion and can be traced back at least thousands of years to the Ancient Roman and Greek civilizations (Cooney, 2023; Cotton, 1985). Given their important function within modern academia, it is problematic that studies have repeatedly found that bias is prevalent in such evaluation methods. Letters of recommendation have received scrutiny for perpetuating the illusion of meritocracy in academia, reflecting biases against women and people of color (Dutt et al., 2016; Madera et al., 2009; Schmader et al., 2007; Trix & Psenka, 2003). There are also commonly conflicts of interest surrounding letters of recommendation, such as when students write their own letters or when advisors write letters to seek student fellowship funding that will help further their own research programs. Furthermore, linguistic and cultural differences between the United States and other countries create inconsistent norms (Precht, 1998). If the tape were replayed, letters of recommendation may have not evolved from ancient times to the selection tool used today in the physical sciences. Indeed, many grants and some postdoctoral applications already operate without letters of recommendation, including certain fellowships from the National Science Foundation (NSF). Without official letters of recommendation it is possible that unofficial faculty endorsements or institutional prestige could take on increasingly outsized roles during selection.

3.3.2. #7: Grants Are Awarded Through a Modified Peer Review Plus Lottery System

Writing, submitting, and reviewing grants consumes substantial time and resources for students, faculty, and administrators. To some extent, this outlay of effort could be viewed as a necessary means of engendering continued federal support for the research enterprise that may be preferable to the less stable, predominantly corporate mechanisms of financial support that have existed at some universities in the past (Kaiser, 2011). However, if the success rate of funding applications is low, modeling has suggested that the value of funded research can be roughly equal to the value lost by applying for funding (Gross & Bergstrom, 2019). Furthermore, bias appears to be deeply embedded in the grant review process, including against women (Morgan et al., 2018), minority populations (Hoppe et al., 2019; Taffe & Gilpin, 2021), small universities (Murray et al., 2016) and the inclusion of novel ideas (Ayoubi et al., 2021). Although there seems to be generally broad support for the idea of awarding funding to the "best" proposals, it is difficult to agree which proposals are best.

An alternative practice that may bypass some of these challenges is instead to fund research via a system of modified peer review and lottery (Fang & Casadevall, 2016). Within such a system, grant proposals could be ranked as adequate or inadequate, with detailed feedback and critiques offered for both. This initial review could potentially be conducted blind. Proposals deemed meritorious would then be entered into a lottery and a fraction of those proposals, determined by available resources, randomly selected for funding. Proposals that were not selected would be entered into the next drawing. To prevent the accumulation of proposals, older applications might be weighted differently than newer proposals and eventually be removed from consideration. To ensure funding for early career scientists, new researchers could have improved odds in the general lottery or compete in separate lotteries with more generous odds (Fang & Casadevall, 2016). In addition to saving time, a binary review and lottery system could minimize negative impacts from biases. A modified system was also recently proposed where lotteries act as tie breakers (Nature, 2022), which seems to be more palatable to those that have previously participated in grant lottery systems (Liu et al., 2020). This alternative practice of grant funding via lotteries has

precedent in government agencies outside of the United States, including The Health Research Council of New Zealand and the Swiss National Science Foundation (Adam, 2019; Chawla, 2021).

3.3.3. #8: Academic Positions Are Awarded via a Matching Program

Applications to graduate school, postdoctoral fellowships, and faculty positions in the United States follow a similar pattern in which applicants submit materials, undergo interviews, are potentially accepted to multiple programs, and accept one offer. Problems with this system readily emerge, though, because applicants and programs each have incomplete information regarding the preferences of the other. As a result, a subset of candidates can receive many offers at the expense of other applicants and some positions go unfulfilled; this system wastes time, resources, and opportunity. An alternative practice is inspired by the United States medical community, which recognized and addressed a similar challenge in the 1940s and 1950s by requiring that students gain entry to residency through participating in what is now known as the National Resident Matching Program (Mullin, 1950; Williams, 1995). During this process, each applicant applies to medical programs and undergoes interviews. Following those interviews, candidates submit a ranked list of the programs they would like to enter and each program submits a ranked list of candidates they would like to accept. Decisions are binding, so each applicant must be willing to attend all of the programs on their list. A modified deferred acceptance algorithm then calculates the combination of student-program pairings in which matches between applicants and programs are optimized (Gale & Shapley, 1962; Maaz, 2020; Roth & Peranson, 1999). In turn, a second round of matching is subsequently completed to connect any unmatched candidates with remaining vacancies. There is no guarantee that all applicants will ultimately be matched nor that all programs will fill their available spaces. Slight changes to the matching program enable pairs of people, such as couples, to express preferences that allow them to apply for positions together (Kojima et al., 2013). While not without faults, such as limiting the ability of candidates to negotiate (McCarthy, 2002; Williams, 1995) and requiring a substantial administrative burden (Pereira et al., 2019), each year this matching program succeeds in efficiently allocating a very large group of accomplished scholars with competing interests among a variety of programs with unique specialties and applicant preferences.

Had academia developed following the path of medicine, applications for graduate school, postdoctoral fellowships, and/or faculty positions might be processed and evaluated through a similar matching system. Problems of specificity, such as an applicant desiring to work with a particular faculty member or in a specific disciplinary area, are only variants of the existing model; for example, prospective students might apply to individual faculty members rather than university-level departments. Moreover, the existence of early decision applications for undergraduate study establishes precedent for binding applications to academic institutions. For faculty searches, the ability to account for paired preferences among applicants would go a long way toward addressing the two-body problem (Wolf-Wendel et al., 2004). One challenge with this alternative practice is that generating realistic ranked-choice lists would require that departments know the resources that could be offered for graduate student stipend and faculty startup during interviews. That is, while programs could differ in their offerings to individual candidates, they would need to know those offerings prior to matching.

3.4. Alternative Practices for Peer Review and Publication

3.4.1. #9: Manuscripts Are Reviewed Anonymously

Modern peer review became common during the mid-twentieth century amid increased competition for publication, ongoing article specialization, and the development of mass printing technology (Spier, 2002). Peer review in the physical sciences is commonly conducted single-blind, where reviewers know the identities of an article's authors but those authors do not know the identities of the reviewers. Had academia evolved along a different path, standard practice could instead be double-blind review, in which neither reviewers nor authors are aware of one another's identities. This alternative practice, which is common in some humanities and social science fields, also already has some precedent in the sciences: for example, *Nature Geoscience* and *Nature Climate Change* offer double-blind reviewing. Given the documented roles of status bias, racism, and sexism in single-blind peer review (Huber et al., 2022; Smith et al., 2023; Strauss et al., 2023; Wennerås & Wold, 1997), double-blind review may result in a more equitable process (Budden et al., 2008). Furthermore, despite concerns that article content, style, or references might indicate authorship during double-blind review, a study with medical journals found that only ∼30% of reviewers were able to correctly guess the identities of anonymous

authors (Justice et al., 1998), although this figure will certainly vary widely by field. Even when implemented successfully, however, double-blind reviewing does not always result in improved publication outcomes and the preparation of suitably anonymized manuscripts can be time-consuming for scientists and journals (Cox & Montgomerie, 2019; Van Rooyen et al., 1998).

3.4.2. #10: Faculty Serve as Short-Term Full-Time Journal Editors

Faculty members often serve as the editors of journals publishing peer-reviewed literature and have largely dominated these editorial roles since the rise of salaried professional academics in the nineteenth and twentieth centuries (Fyfe & Gielas, 2020). Because the editorial role entails evaluating manuscripts for publication and synthesizing peer reviews, editors exert substantial power over which articles are accepted and how those manuscripts must be modified prior to publication (Resnik & Elmore, 2016). Faculty members are well-suited to this role in that they are generally aware of emerging disciplinary trends and are trained to evaluate the quality of analyses. Conversely, faculty members can easily be biased either through personal investment in topics or through their prior interactions with the authors whose work they are evaluating. Faculty members are also already burdened with many other responsibilities, so adding editorial demands to teaching and mentoring may reduce quality for all activities and could hurt both students and journals. If professional editors without competing priorities were appointed in place of faculty members, manuscripts submitted to peer-reviewed journals could potentially receive faster and fairer editorial evaluations. As seen in existing journals with professional editorial staff, however, removing practicing scientists from decision-making can incentivize publication of novel claims at the expense of the robust development of existing ideas (Schekman, 2013). Were the tape of academia to be replayed, the journal system might instead complement a core contingent of professional editors and science journalists with faculty members who serve 1–2 years full-time appointments. This idea is conceptually similar to the existing program of NSF rotators. While serving as editors, faculty may receive financial compensation from the journal, their university, or both. Although such an approach may improve the publication process, it could also disservice students who are working with the faculty members that leave to become editors. That said, the sabbatical system has already established as common practice that faculty will occasionally take term-length breaks from their typical teaching and mentoring roles.

3.4.3. #11: Manuscripts Are Posted to a Single, Open-Access Online Repository Without Pre-Publication Review

Printed and mailed journal publications were historically one of the primary ways in which researchers communicated and coordinated their research and thus served an essential role in the scientific enterprise prior to the proliferation of digital technology (Fyfe et al., 2015). In the modern world, however, it makes little sense to allow for-profit companies to charge researchers and the public for access to scientific outputs, produced and reviewed by scientists, that the public has already paid for indirectly through taxpayer-funded grants. The successes of arXiv in math and physics, biorXiv in biology, ChemRxiv in chemistry, and EarthArXiv in geosciences all suggest an alternative practice where open-access online platforms host manuscripts and associated metadata with essentially no pre-publication review (Ginsparg, 2011; Gowers, 2017). These systems can track article statistics and make recommendations, increasing paper visibility and lowering barriers to the dissemination of results. Furthermore, publishing research in one location, rather than across many journals, would help to address bias where researchers judge papers based on where they are published (McKiernan et al., 2019). A common and important criticism of preprint repositories is that they circumvent the peer review process. In practice though, the inconsistent nature of peer reviews (Peters & Ceci, 1982), the biases associated with review (Huber et al., 2022; Smith et al., 2023; Strauss et al., 2023; Wennerås & Wold, 1997), the long time required for review, and the existence of low-quality articles still published each year all indicate that the current system is not functioning efficiently (Heesen & Bright, 2021; Ritchie, 2020). That is, although responding to reviewers may improve article quality, the current process does not assure article credibility. Manuscripts posted to a centralized repository without standard peer review would still be subject to post-publication reviews through posted comments, community discussion, and follow-up research. In practice, this is similar to how reviewed articles are currently evaluated over the long-term in that it can take a community many years and new experiments to determine whether the ideas in any particular manuscript are valid. While concerns regarding the quality of preprint publications may be overstated, the hosting repositories do present pathways for the spread of misinformation. A middle-ground solution might be for submitted articles to be briefly evaluated by field-specific specialists; this

check should likely occur over a timescale of hours or days, rather than the months required for peer review, and focus on identification of methodological errors rather than specific or novel findings. Even within relatively traditional journals, such as those of the European Geosciences Union, a movement toward multi-stage open peer review is underway (Pöschl, 2012).

3.5. Alternative Practices for Conference Norms

3.5.1. #12: Conferences Do Not Serve Alcohol and Related Events Are Not Hosted at Bars

The presence of alcohol at conferences elicits strong responses tied to debates on the accessibility and inclusivity of scientific meetings, partially informed by the long-recognized potential harms of alcohol use in the workplace (Henderson et al., 1996). While imbibing can be an important component of celebrating and networking for some attendees, for others medical conditions or religious beliefs inhibit drinking and can prevent full participation in conference and conference-adjacent activities (Forrester, 2021; Pettit, 2019). Within geoscience, similar concerns are also present when considering the consumption of alcohol during fieldwork (Marin-Spiotta et al., 2023; Posselt, 2020). Diverging perspectives on the topic of alcohol at conferences were captured in a recent poll where, out of nearly 1,500 scientists, 26% advocated banning alcohol from conferences while 68% voted against a hypothetical ban (Forrester, 2022). If the tape of academia were to be replayed, alcohol may simply not be present at conferences. This is not hard to imagine given that a multitude of other academic spaces did evolve dry, such as laboratories, research vessels, and classrooms. Indeed, a transition toward sober geoscience conferences is seemingly already in progress. Beginning in 2020, the Geological Society of America mandated that alcohol could not be present during oral or poster presentations and limited each attendee to one free drink ticket per day for consumption within the exhibit hall. Likewise, AGU did not provide alcohol during the 2021 or 2022 Fall Meetings. If the role of alcohol at conferences were reduced or eliminated, new events oriented around food may accomplish some of the same community-building goals (Cohen, 2017).

3.5.2. #13: Conferences Do Not Offer Research-Based Awards

Conferences organized by professional scientific societies often include recognition of outstanding individual researchers through named lectures and awards. While the proliferation of topic-specific awards has potentially stimulated scientific growth (Jin et al., 2021), research has also documented gender and racial biases both in the recipients of such honors and in the descriptions of the honors themselves (Bazner et al., 2021; James et al., 2019; Lincoln et al., 2012). Even at relatively low levels of honor, such as invited speaking roles with standard presentation durations, gender-based discrepancies emerge (Ford et al., 2018). Given automatic internet monitoring of citations and related research metrics, the added benefit of awarding subjective honors to individual scientists who often win multiple accolades is questionable (Ma & Uzzi, 2018). That said, metrics such as citations often do not capture the overall impact of an individual's contribution through efforts like mentorship, outreach, and peer review (Davies et al., 2021; Moher et al., 2020; Nielsen & Andersen, 2021). As an alternative practice, conferences might not give awards or named lectures for research accomplishments and instead champion other means of recognition and evaluation. For example, conference accolades could focus on the achievements of society members in community efforts and thereby explicitly recognize the value of mentorship, outreach, and peer review to the research endeavor. Alternatively, named lectures could be re-envisioned as public talks that help disseminate scientific findings more widely.

3.5.3. #14: Scientific Conferences Are Free for All Attendees

Academic conferences have been critical for career advancement since their conception in the late eighteenth century, although they began as more formal political and diplomatic exercises before evolving into the modern specialized gatherings led by scientists (Bigg et al., 2023; Hauss, 2021). Despite their importance, modern conferences are relatively expensive (Hong, 2018; Kirchherr & Biswas, 2017), even when virtual (Cai et al., 2022), and government agencies such as the NSF and the National Institutes of Health (NIH) indirectly underwrite the costs of conferences by awarding grants to faculty that cover the fees associated with abstract submission, registration, travel, lodging, and society membership. In turn, faculty control which students access conferences and associated opportunities for exposure and networking. As an alternative practice, funding agencies like NSF and NIH could support meetings directly without passing money through principal investigators. Conferences could then still receive the same revenue as in the current system without requiring

registration fees and would partially wrest the gatekeeping role away from faculty. There is also likely a scenario where conference fees could be substantially lower without being free. Ideally this alternative practice would allow for effectively free virtual attendance (Cai et al., 2022), as well as more affordable and convenient conference access for members of the media and interested public. Such structural changes might also allow for more oversight and quality control of the conferences themselves by the funding agencies and may reduce the prevalence of predatory conferences (Pecorari, 2021).

4. Conclusions

Inspired by concepts of contingency and determinism, this article presented 14 alternative academic practices spanning the graduate student experience, faculty careers, evaluation metrics, peer review and publication, and conference norms. These are not an exhaustive list of the ways educational and research structures could change, nor are all of these ideas clearly preferable to existing systems. Universal agreement is not the goal of this work. Instead, in considering these alternative practices for how academia could operate, we hope that readers are inspired to critically evaluate the practices that are in place, why they have been carried forward through time, and whether they should continue into the future. Of the practices that characterize modern academia, which would develop again if the tape of academia were to be replayed?

5. Survey

Readers are encouraged to complete a brief (approximately 5–10 min) online survey regarding the alternative academic practices considered in this article. The survey was designed in collaboration with the Survey Lab at the University of Chicago and was deemed exempt by the University of Chicago Biological Sciences Division Institutional Review Board. The survey will close approximately 18 months after the publication of this manuscript, at which time the Survey Lab will provide the authors with de-identified results to be analyzed and reported in a follow-up publication. The survey is available at the following link: rebrand.ly/AlternativePractices2024.

Data Availability Statement

No data was generated for this article. Results from the survey associated with this manuscript will be presented in a follow-up report and, to the extent possible in accordance with IRB regulations, made publicly available.

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