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Editorial

The End of Exploring

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■ **APRIL IS THE** cruelest month, according to the modernist poet T. S. Eliot [1], drawing attention to the difficulty of renewal after winter, and how hope can be more unbearable than despair. Within academia, and perhaps especially in science, technology, engineering maths, and medicine (STEMM) subjects, there is a “Red Queen” problem: the need to keep running just to stay still [2]. This produces a continual

requirement not just to keep up, but to stay ahead; and staying ahead may necessitate the re-invention of the self, and revitalization of a research program, as the scientific and technological tectonic plates shift, realign, and indeed emerge. Against this backdrop, starting and sustaining a career in academia is not necessarily a straightforward undertaking. The aim of this article is to offer early-career (maybe even early midcareer) researchers some advice or heuristics derived from some [loses count] years in academic research which might help with this process. Finally,

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it puts this reinvention process in the broader context of the university's "fifth wave" [3], for you who would turn the wheel and look windward.

Turn the wheel

Just as in *As You Like It*, where Shakespeare defined the "Seven Stages of Man" in terms of playing seven different parts,¹ so from one way of looking at it, there are seven parts to an academic's role (man or woman). There are also seven "pillars" of professional practice, seven "do's," and seven "don'ts." Each set of seven will be considered in turn.

The seven² parts of an academic role are: 1) research output (i.e., papers); 2) research input (i.e., grants); 3) teaching; 4) administration; 5) professional activities (conference and workshop organization, reviewing, etc.); 6) external work (start-up, consultancy, expert witness, etc.); and 7) somewhere in the far distance, "a life." There are seven days in a week, so it might be reasonable to allocate one day per week for each activity *in toto*. However, tempting for the orderly academic mind that might be, of course, it does not work out like that: in the best spirit of the games *NetHack* or *Gloomhaven*,³ you have to kill what is in front of you first (or, as a description of how things tend to be rather than how they should be, which of several late things is going to be the least late). In other words, it is necessary to concentrate on the part that demands the most immediate attention, while over time giving equal attention to all the parts—without spreading yourself too thin, prioritizing your own values over someone else's threats, and being mindful of the allostatic load [4] that comes from too much context-switching. Managing those competing contradictions is all part of the job.

Moreover, six of these parts are work-related, and one is not. There are five days in a working week, allegedly, so that is not going to fit as per the pigeon-hole principle. However, they still have to be shoehorned in there, to maintain some mythical "work-life balance"; although part of the hegemonic cultural enforcement is the requirement to demonstrate unwavering commitment to science and to do otherwise—for example, in the pursuit of equality

¹And one man in his time plays many parts, His acts being seven ages". William Shakespeare, *As You Like It*, Act II, Scene VII.

²Standard meaning of "seven."

³The computer games that effectively bookended my academic career, although rather than "game," it would be more accurate to describe *Gloomhaven* more as "a way of life."

and representation for women or under-represented minorities—is sometimes disparaged as a dilution of that commitment [5]. This commitment can be relentlessly exploited, both in the form of zero-hours and short-term contracts in the scramble for appointment; but even in permanent positions as well, by the fact that for many people there is both a pleasure and a meaning to be found in research that takes it beyond a certain type of job⁴ [6].

Nevertheless, circumstances (usually at the start of an academic session) will arise when, or deadlines will demand that, evenings and weekends will need to be worked; in any case, conferences will need to be attended (notwithstanding pandemics, exploitative airfares, and outrageous registration fees). A keen sense of proportion and judgment is required to get the priorities right, but most importantly, for those with whom you share your life, when you are there, be there.

The seven⁵ pillars of professional academic practice are: 1) a "scientific parish"; 2) a plane ticket; 3) a project; 4) a program; 5) a professor; and 6) a plan. A scientific parish is meant to identify a group of researchers who are all broadly interested in the same research questions as yourself; moreover, they will welcome you and be pleased to see you at meetings of that parish, they will recognize you for your contributions to that parish, and—much as labeling and pigeon-holing might be disliked—you will be known externally for your contributions to the parish. This might seem contradictory to one Mamdani⁶ Maxim "I prefer to work where others are not"—what he actually meant was "I prefer to work where others will be," given his predisposition for pioneering new fields of research. It is consistent with starting a new field, establishing a reputation for work in that field, and moving on to a new field when the rich seam of early research results has been extensively mined and all that is left is incremental development.

The plane ticket (perhaps, it should be a train ticket, otherwise apologies to future generations for the climate) is the wherewithal to meet with your parish. Even if you do not have a paper in the conference,

⁴As one esteemed professor remarked to c1996-Jeremy: "I enjoy my job so much, and then they pay me for it." I was not for allowing that one: I still had a mortgage to pay and, rather more importantly, two children to feed. And eventually, a cat, who would make himself a legend in my lecture time.

⁵Mathematician's "seven": in this context, "seven" means "six."

⁶Ebrahim (Abe) Mamdani, 1942–2010. Inventor of Mamdani-type Fuzzy Inference, founder of the Intelligent Systems and Networks Group in the Department of Electrical and Electronic Engineering at Imperial College London, and above all a wise, generous, and wonderful human being.

it is important to go, be seen, and help out—there are always jobs that need to be done (and critical mass to be reached). Getting a project—however hard this might be, and it is increasingly competitive⁷—is a critical pillar for two reasons: first, it provides a budget to support the purchase of that plane ticket; and second, and perhaps more importantly, it provides a certain degree of independence. It is harder for others to have influence over your research direction, and (as above) *your time*, if you have a project (or projects) that are effectively paying your own salary with overheads and contributing to the department's independence to make its own budgeting decisions.

A project is, or should be, the means to an end for advancing your research program. Make sure that you fully understand what scientific questions you are trying to answer, what axioms or assumptions you have made, what you might be trying to optimize, and what are the potential implications of your work, i.e., why it is *relevant*. This should mean that you are always properly prepared for the elevator pitch in response to “what are you working on?” or the need to introduce yourself at a meeting (but note that trying to assess the societal implications of your work is a different undertaking altogether from trying to quantify, somewhat pointlessly, its potential impact [8]). Getting a project is often made easier by the judicious choice of a professor: we would all like to pretend that science is entirely egalitarian, when, in fact, it can be ruthlessly elitist. The judicious choice means choosing someone who is interested in and cares about advancing the careers of his or her protégés, and will support and share grant applications: another Mamdani Maxim was “I want to be a professor in a group of professors.” Unfortunately, not all professors see it that way.⁸

Finally, not so much a pillar but more of a supporting wall, a plan is needed to underpin all the other pillars. But note this is just a plan to determine how time will be allocated: it is not a rigid step-by-step guide to prizes, promotions, and that well-deserved Nobel Prize, Turing Award, and Fields Medal. In research, you have to take victory as you find it, not necessarily as you want it.

⁷For example, a reported success rate for the EU Horizon 2020 research program was about 12%, and for EU Horizon Europe, close to 16% [7]. UKRI award rate for 2022–2023 is in the region of 27%; it is supposed that other national programs have similar rates. The pertinent unasked question though—is whether there is enough money in all the possible research funding sources for every U.K. academic to meet their somewhat arbitrary grant income targets set for them by people not necessarily under the same performance pressure.

⁸To be more mathematically, scientifically, and psychologically precise, the empirical evidence suggests that there is at least one person suffering from the Dark Triad [9].

Therefore, “victory” does not just depend on you, it depends on other people and circumstances. Which offers insight into the seven⁹ “do’s” of academic practice. These are: 1) first, do something, that other people value (there has to be a “product,” with which you are associated); and 2) second, do something, that other people value. Admittedly, this second “do” might seem identical to the first, but it is so important it is worth mentioning twice—you have to be known *for* something, as well as known *as* something, i.e., a certain type of scientist or engineer laboring in the identified parish. It is, again, a matter of *relevance*. The only problem is that the correlation between some product and it being valued by and relevant to other people appears to be almost completely random.¹⁰ However, perhaps a useful guideline is *defamiliarization*: presenting a common or perhaps already analyzed problem of concern to your scientific parish in such a new, unfamiliar, or strange way that they gain (i.e., you contribute) an entirely fresh perspective and enable them to see their scientific concerns in a different, and constructively beneficial, way [10].

The other six “do’s” are: 3) do apply the Crick “gossip test” and 4) the Watson “boredom principle,” i.e., work on things that are of such interest that you prefer to gossip about them over others, and conversely, do not work on things that are not of interest, or rather worse, actually boring. Then, 5) what you do work on, do well, or as well as possible, i.e., do not practice strategic incompetence as a way of satisfying the Watson boredom principle. Next, 6) do act like $X + 1$, i.e., if you are at level X and want promotion to level $X + 1$, act like an $X + 1$ by taking the responsibilities associated with the role without presuming the privileges associated with the role. In acting thus, 7) demonstrate thought leadership as well as organizational leadership; and practice good citizenship—despite the misconception and misapplication of meritocracy [5], contribution to collective action is still appreciated by the scientific parish [11]. Finally, 8) learn when to “let things go”: starting a new initiative can be hard, but terminating an old initiative can be harder. Sometimes scientific parishes and institutions exist to perpetuate the problem they were intended to solve, and sometimes

⁹Computer scientist’s “seven”: start counting from zero.

¹⁰Based on a statistical sample of one, so not exactly reliable; and the “one” is me, so whatever the square root of reliable is. There might also be some confirmation bias going on here.

scientific problems have a half-life (the time it takes for the Crick test to return half the interest). Thus, an academic career in STEM almost inevitably requires some self-reinvention.¹¹

The seven¹² “don’ts” of academic practice are: 1) don’t whinge,¹³ and remember, sometimes if you want to change a system then you have to be seen to win in that system first; 2) don’t compare, especially using metrics, and especially not to your peers, because purely quantitative metrics can overlook qualitative values; 3) don’t censor yourself, a typical manifestation of imposter syndrome is to think “if I did it, then it must be trivial”—let the peer-review process determine if it is trivial or not; 4) don’t say “yes” to every invitation or change research direction for the sake of curriculum vitae (CV) fodder (ambulance chasing is never a good look); and 5) don’t ever take it personally, or “away with you.” An academic career for most people inevitably and invariably involves more than the occasional rejection: you just have to keep telling yourself the old adage that “success builds CVs, failure builds character.” All the same, the mistake would be to not keep trying.

Finally, 6) don’t wait for things to happen. Science is partially about people making discoveries, but generally, people making discoveries are not themselves discovered. Therefore, it is necessary to leave your comfort zone, confront your imposter syndrome, and go to a place wherein it seems you are the only person not talking to someone, and yet somehow everyone is still looking at you (and judging). The feeling never goes away, but, like Sisyphus, you have to faintly smile as you put your shoulder to the boulder and start pushing uphill, again [12].

Look to windward

The previous section is based on a talk that has been presented at various symposia for PhD students, postdocs, and early-career researchers, the last time in 2019. However, the world has changed much, especially (“unprecedentedly” apparently) in the last four years during and after the COVID-19 pandemic. Social and organizational systems can be

¹¹I once shared an office with an esteemed visiting professor from Poland, so I asked him the obvious question “What are you working on?” He answered: “Łukasiewicz Logic, with equality.” Oh good, I thought, not too specialized; I hope he likes football or the long winter afternoons will hardly fly by. “But,” he went on, “I am thinking of changing research direction!” Oh, I said, to what? “Łukasiewicz Logic,” he said, “without equality.”

¹²Physicists “seven”: seven $\pm e$ (experimental error).

¹³This article is not whinging, it is constructive reflection contributing to continuous self-improvement.

quasistable, in that they can go through periods of stability and instability, and in that context, it is still unclear whatever (hopefully) stable system—is produced by this quite radical resetting of any number of social, cultural, political, and economic control variables. We are trying to rebuild the plane while it is flying, as the saying goes, and the experience of living through a period of disruptive change brings about a kind of duality: between the organizational and administrative of the one hand, and the individual and productive on the other.

Perhaps, the most profound change that has accelerated in recent years is that we are now living in a *time of data*. This can be beneficial from a managerial or administrative perspective, as insights into organizational health and key performance indicators are important tools for shaping and refining high-level policy decisions. Of course, excellent administrators use this information with care: they are aware of Goodhart’s Law (that any metric used as a target ceases to carry any meaning) and avoid what has been called “the tyranny of metrics” [13]. They are also well aware that “league tables” of university rankings should be approached with some caution.

There is a phrase in football (soccer): “the table doesn’t lie.” But the phrase expresses a myth: league tables can, if not outright “lie,” at least mislead [14]. The position in a league may be *n*th, giving the basis for being, or rather claiming to be, the *n*th-best team, but the *probability* of being in the *n*th position is something entirely different. There is actually a fairly normal distribution of where a team is likely to finish in a league; and so in theory, if a single season could be played many times over, the central limit theorem would perform its usual revelation. Instead, a team gets one go each season. Similarly, in academia, the “league tables” of universities, which are not based on pairwise comparison but some mutable criteria, exhibit the same probabilistic variation: a university ranked *n*th should really be ranked ($n \pm x$)th to allow for that variation. Consequently, the best administrators know that changes in rank from one year to the next should be treated like Kipling’s twin imposters: a rise in one year is not necessarily a cause for rejoicing; a fall in another year is not necessarily a cause for despair. Either way, the key requirement is a reflective search for continuous self-improvement.

It is also important to distinguish between metrics at an organizational level and a personal, individual level—remember: don’t compare (and don’t set

these metrics as a target for yourself¹⁴). Therefore, it is important to remember that some metrics, for example, the *h*-index, are relative rather than absolute: an *h*-index in the hundreds might look impressive against one in the tens, but that might just reflect the relative activity in the first area compared to the other. The appropriate approach is to look at the normal range for a field, remembering that some outliers are meaningless (an unexpectedly high *h*-index could have indications: age, network centrality (i.e., popularity), or even manipulation); it is only an unexpectedly low index that would be a possible reason for concern. Ultimately, in any case, like Asimov's psychohistory and subatomic particles, most of these indices only work well when the targets don't know they are being observed or measured by them.

The second change is that we live in a *time of choice*. Some might argue that it is a world of excessive choice (and psychological experiments show that people offered a smaller range, for example, a selection from a box of chocolates, can be both more efficient and less regretful about their selection). Nevertheless, the world is as it is: but this means that organizations have a "Red Queen" problem too, and they too have to continually adapt just to keep up. This means that the organization's personnel have to adapt, and academics can let us be honest, on occasion be a fairly conservative (with a small "c") bunch.

In many ways, this presents a classic Ostrom/Ober problem. In Ostrom's theory of self-governing institutions [15], the seventh principle is "minimal recognition of the right to self-organize"; while in Ober's theory of Basic Democracy [16], the *zone of dignity* defines an optimal zone of control between an external authority and self-governance as between too tight control (infantilization) and too lax control (disorder). There is, therefore, a perhaps uncomfortable pressure on (external) administrators to propose necessary change, and a corresponding discomfort on (internal) personnel to bring about that change.

Again, the most adaptable administrators recognize this duality. For example, a centrally decided policy to introduce a workload allocation model to bring about equal participation¹⁵ in teaching and (local) administration, in reasonable pursuit of both

¹⁴I once saw a résumé that stated that the author's ambition was to have a paper cited 100 or more times. This is simply the wrong way around: the ambition should be to write a paper that is so good or influential scientifically that it gets cited. Besides, citation count depends, to some extent, on the size of the scientific parish: it is a relative, not an absolute measure.

¹⁵Itself a provision of Ober's thought experiment *Demopolis* [16].

fairness and productivity, should also give license to implement the model at a departmental level (i.e., respecting the right to self-organize), because of the risks of and potential problems with altering incentive structures, losing institutional memory and undermining preexisting, and long-standing social contracts. However, individual academics need to appreciate the context for such models, and not get hung up on fixed boundaries in return. It is essential not to forsake the idea that in an academic department, people are still voluntarily cooperating because they see what needs to be done and will do it for the benefit of the collective enterprise [17], even if that means going the proverbial "extra mile." Socially constructed conceptual resources, in the form of contributive justice, can still persist [11].

A secondary consequence of choice is that an academic department becomes less like a department store and more like a shopping mall: this involves a tradeoff between convenience (everything in one place, uniformity of style, consistency, etc.) and independence. It invokes the same duality: the best administrators create, provide, and improve the infrastructure and environment that make the mall attractive, recognizing that it is codependent on the productive units that mostly pay for it. While this may feel like the teaching and research elements of a university's mission are being franchised out to the professors who still care about such things, at the same time it also offers greater opportunities for individual ownership of a research program—but recall, it is still essential to be known for something and to have a "product" to put in the storefront window.

Yet another change is that we live in a *time of attention deficit*: attention can be seen as a common-pool resource, and it is a scarce resource—there is not enough for everyone that wants it, or at least not enough in a world where everyone is in pursuit of relevance. A by-product of globalization and speed of innovation is that universities are also required to be engines of growth [18]: hence, the need (as alluded to above) to be increasingly agile, and associated with business parks, innovation, and start-up incubators, and the need to be seen to be at the forefront of advances in science, technology, and engineering. Again, the most insightful administrators find effective channels for academics to feed their work into these arenas, without losing sight of the need for universities to retain their traditional societal roles as gatekeepers of knowledge

and evidence-based speakers of truth to (political) power—there is a reason why the oldest universities were generally founded at a distance from seats of power with a monopoly on coercive control.

By the same token, individual academics have to recognize that the ivory tower, dreaming spires, and glittering prizes are perhaps relics of a bygone age of academia. It is still valid to have some serious misgivings about the organizational demand for impact [8], partly because of the necessity of maintaining some high-risk long-term science in the research portfolio whose “return on investment” is unquantifiable and unknowable. However, this does not let the individual academic off the hook for *relevance*, and the academic’s inner voice needs to constantly be self-asking “what is your research for?”¹⁶ It is like those medieval maps, where the bits that had not been explored were marked “here be dragons.” In research, you have to have at least some idea of what particular dragon in what unvisited part of the map you are off to slay; and some idea of why it is so important, and to whom, that these particular dragons are in fact slain.¹⁷ A reliable tool or method for whatever slaying does get done tends to be helpful.

This notion of relevance is significant to students too. It is perhaps an unfortunate side effect that some students who, narrowly perceive the university only as a “business” providing a “service” in training to be “industry ready,” perceive themselves as consumers and “investors” in themselves [19]. Alongside an encroaching commodification and corporatization of the sector [20], this can fundamentally reduce the educative and collaborative academic–student relationship from a qualitative one to a transactional, instrumental, and credentialist one [8]. However, tenured academics at least should never forget that the relationship with their PhD students is a collaborative partnership with proto-colleagues against the science (slash dragons, windmills, etc.), even if the PhD students do not always yet see it that way. Sometimes, you just have to develop broad shoulders and learn how to shrug them.

Finally, beware of moral injury. Moral injury is caused by the perceived transgression of someone’s own conscience, ethics, or professional code

¹⁶Although if anyone asks, a perfectly legitimate response is to toss them overboard into the freezing waters of Lake Ontario.

¹⁷Hopefully, no dragons will actually be slain in the course of your research. Indeed, you probably will not find any dragons at all. But with a good research program and a bit of dodgy cartography, you will be able to say that there really are lots more even bigger and better dragons, just over there, that would really benefit from a good bit of slaying.

of conduct. An academic position is one of considerable power, but with considerable power comes considerable responsibility. Sometimes, that responsibility will be to different stakeholders at the same time and might even be in conflict: you might need to take some action in solidarity with one group who is suffering harm, but this could cause harm to a second group. On the other hand, inaction causes no harm to the second group, but the first continues to suffer. However, it is not part of your job description to solve problems that have vexed the finest minds in moral philosophy for millennia.¹⁸ Make a decision, pick a direction, and so long as you do a right thing, do not regret the decision that you have made or the direction you took, and seek the positive in wherever you end up. Even if it is the same place for 40 years.

So, IN CONCLUSION, if I knew what made for a successful academic career, I would have bottled and sold it a long time ago. There probably is no silver bullet, and with the organizational/individual duality, it is probably impossible to solve all of the problems or optimize all of the criteria, at all of the different levels, for all of the different people, all at the same time. In such cases, focus on those arenas that you can affect and inspire. The colleagues you work with, the group you work in, your department, and certainly your scientific parish, are all essentially collective action situations: so, seek to contribute to them (rather than appropriating from them) in a way that exemplars like Elinor Ostrom and Abe Mamdani showed us how. In general, and in the end, the happiest people are those that help others. In which case: look windward and do the right thing, or at least a proper thing. And be kind. ■

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¹⁸I have been advised to remove the metaphor used here. Email me if you want to know what it is going to be.

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