on the process of research rather than on measuring outcomes and productivity. Although a range of users, from lab heads to graduate students, say that using Scrum has made them more efficient, the university has not yet found a reliable way to measure those efficiency levels. A possible metric, May says, comes from examination of how manuscripts are prepared and submitted. Anecdotal reports from researchers suggest that papers are being written and sent off to journals more quickly than before because deadlines are communicated better under the regular feedback of the sprint system. Priority-setting also encourages lab members to agree on draft sections rather than get stuck in endless cycles of revision. Another possible test of the benefits of the Scrum approach, May says, is to see whether lab members can increase the number of papers under review on which they are the first author.

One of the most striking benefits of using Scrum at the University of Oregon, DeStasio says, is how it has changed lab culture for the better. Previously, it was rare for members of the group to interact, partly because they worked across different rooms and offices. The regular all-hands meetings, although they are short, encourage and foster more interaction.

May says it's clear that many graduate students suffer when they do not work in a shared space, and that the collaborative nature of Scrum has helped to bring people together. Some of these obstacles break down along discipline lines, she adds. For example, May and her team realized that most biology principal investigators were frequently around the lab, but the offices of senior scientists in psychology were often on a different floor from the workspaces of the rest of their teams.

*"It's much more efficient to be able to have those quick and easy questions in real time."*

Berkman says that Scrum has changed that separation: he now has a standing desk in the same room as his graduate students, which features coffee-shop-style couches. "It just doesn't make sense for us to be in separate spaces," he says. The conventional style of training and mentorship is based on a centuries-old tradition of apprenticeship, he adds, and is not suited to modern science. Still, his embrace of at least one 'radical' Scrum principle sets him apart from his colleagues. "This system is being implemented in lots of labs across the university," he says, "and I'm the only faculty member I know who has moved his office into the lab." ■

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## COLUMN

# PhD project tips

**Angel Santiago-Lopez** shares six tips from the private sector on how to manage a PhD project.

In my experience, a PhD project sometimes feels like it demands more time than is possible — especially if you were hoping to maintain a healthy work–life balance. In my view, every graduate-school curriculum should carry a course on project management.

I am a PhD candidate in bioengineering at the Georgia Institute of Technology in Atlanta, and, during my studies, I have developed project-management skills that might help others pursuing a PhD. Here are six pieces of advice that helped me. The strategies below follow a common idea: define the undefined.

**Define your timeline.** Start the academic semester with the end in mind. What would you like to accomplish by then? Begin each academic term by defining major milestones associated with your research project (for example, completing the first draft of a review article) and your graduate programme (for example, conducting a PhD-proposal defence).

Break down what actions you need to take to achieve each goal. At this point, you can assess the time commitment required, as well as existing hard deadlines, then prioritize each action item to fit within the time available for the semester.

**Prepare to be 'punched in the mouth'.** US boxer Mike Tyson once said "everyone has a plan until they get punched in the mouth". Unforeseeable events (such as a broken pipe in your laboratory or a change in deadlines from your supervisor) will affect your timeline. It is important to keep in mind that the projected path for your semester will need continuous readjustment. To account for the dynamic nature of a research project, I perform a mid-semester revision to assess overall progress and decide which aspects to prioritize. It is good practice to build margins into your schedule: overestimate the time required to complete a specific task. Margins will serve as a protective cushion against unpredictable events that threaten to thwart your progress.

**Define your project scope.** Your project scope should start with a clear statement of overall goals, followed by a list of specific things that you expect to deliver in the course of your project. This part can be simplified as a 'master to-do list' that, once all checked off, will indicate project completion.

**Add value, not experiments.** What is absolutely needed to maximize the value (or impact) of your project? When creating your master to-do list, reflect on what would bring the most value to your project. Once these elements have been identified, devote all your efforts to completing them to the best of your ability. As graduate students, we are sensitive to the double-edged sword of academic freedom and scientific curiosity. You should let your curiosity take the driver's seat in some cases, but do not use scientific curiosity to justify fishing expeditions outside your project scope. As a graduate student, you have limited time and, often, limited resources.

**Define metrics of success.** Well-defined metrics of success lead to small victories. What does success look like for each item on your master to-do list? Having these metrics in place helps to address whether you are moving in the right direction. Ideally, reaching each metric should provide a glimpse of the final product of your research project. I consider reaching each metric a small victory, and each provides a boost of confidence to keep moving forward.

**Make progress by failing early.** Failure is inherent to the research process, and fear of failure can damage your productivity by inducing what is known as analysis paralysis — the inaction that comes from overthinking what needs to be done to achieve one's goals. In my experience, analysis paralysis is hard to overcome when there is a lot at stake. To avoid this, design experiments that address small portions of your overarching research question and give you space to fail early — if you're wrong about a key assumption in your project design, you'll want to know as soon as possible. An early failure is a successful failure because it allows you to recalibrate and quickly address the shortcomings of your project.

These project-management strategies can help to introduce a degree of control over the uncertainty of graduate school. Moreover, they are often used outside academia for their proven ability to increase the probability of success. If they work for the private sector, they will work for your research project. ■

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