Integrating Tools From Business and Industry to Encourage Effective Academic Laboratory Management.

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Abstract

For those interested in the pursuit of knowledge there may be no more noble path than that of basic research. In most of the public-sector laboratories that take part in this basic research, a principal investigator hires a laboratory manager to help run the day to day operations of the lab. Yet despite having such a critical role in the laboratory, it is estimated that over half of incoming lab managers aren't equipped with any prior training in leadership or management. This lack of training and resources could have widespread effects on the academic research that is responsible for over 50% of the basic research done in the United States. Through a series of interviews, we determined that public-sector laboratory managers seemed to have the most trouble with time management, fostering consistency, and leadership skills. By speaking with private sector lab managers and surveying the skills and concepts utilized in the business world, we created a list of focus areas and implementation strategies that will help to encourage more efficient and effective laboratory management and prepare lab managers in the public sector for the leadership roles they fill.

Dedication

To my parents, who have always been there when I needed them, and who have spent my whole life making sure me and my brother and sister have had every opportunity to succeed. I am constantly reminded of how unfathomably lucky I am to have you in my life and I never would have been able to do this without you. Thank you.

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Chapter I.

Introduction

For those interested in the pursuit of knowledge there may be no more noble path than that of basic research. While applied research sciences attempt to take an interventionist approach, basic research is conducted for the purpose of creating and confirming theories that help explain everything from disease to evolution (National Science Foundation [NSF], 1953). At the forefront of basic research in the United States is the principal investigator. The National Institutes of Health [NIH] guidelines (n.d.) states that a principal investigator is "the individual(s) judged by the applicant organization to have the appropriate level of authority and responsibility to direct the project or program supported by the grant". In the United States alone there are approximately 21,500 investigators being funded by public tax dollars, mostly of whom are employed by academic institutions (Couzin-Frankel, 2014). Together these principal investigators receive over $26 billion per year from federally funded grant programs in support of their basic research (Rockey, 2014). Together they are a driving force in the quest to understand the world around us.

Public Sector Laboratories

While a scientific lab may come in many different sizes and forms, most academic laboratories contain the same basic elements. Since the purpose of an academic lab is to conduct research, a principal investigator will want to surround themselves with

those capable of carrying out the science they are interested in. For this task they typically hire post-doctoral employees. Post-doctoral employees are those who have already obtained their Ph.D. and are continuing their scientific training, usually in order to prepare for writing their own grants and starting their own labs (Bonetta, 2009). Next most academic labs will reach within the university and try to attract graduate students who share research interests with the principal investigator and will help to carry out this research under their guidance. Finally, a lab will contain a variety of support staff, including research technicians who help run experiments, administrative staff who help organize a principal investigators calendar or order lab supplies, and in some cases a lab manager who will help supervise the laboratory (Pain, 2012). In order for the lab to function efficiently all these groups of people must work together to produce the research directed by the principal investigator.

At the heart of this scientific process however lies one of the foundational problems with academic research in modern times: with so many PI's competing for such limited public funding, the stakes have never been higher to publish as many papers as possible (Rawat & Meena, 2014). In addition to this intense competition, the current political climate has only added to the stress and scarcity of public sector funding. During the sequestration of government programs that began in 2013, the NIH budget was cut by over $1.5 billion per year (NIH, 2013). That equals roughly 640 grants per year that were no longer available to principal investigators for whom the NIH is one of the primary sources for laboratory funding in the United States (NIH, 2013). This drop in available funding hit newer Principal Investigators even harder, as the startup grants they were competing for come with a lower chance of getting funded when compared to grants

submitted by their more experienced peers (Couzin-Frankel, 2014). While funding in recent years has stabilized slightly, it is still growing at a rate that struggles to keep up with inflation and is subject the whims of an increasingly divided legislature. All these factors together create an environment of great uncertainty and one in which it is critically important that a laboratory be as productive as possible.

In addition to competing for funds, most of these principal investigators are also competing for something just as valuable that is becoming just as rare: a tenured faculty position. As figure 1 shows, less than 25% of faculty were tenured or on the tenure-track, with more and more professors competing for part-time faculty jobs that come with lower pay and less job security (Weissman, 2013). As a result, instead of being more involved in the research operations of the laboratory, a principal investigator often spends much of their time writing grants, giving talks, and trying to publish papers in order to increase their chances of obtaining continued funding or a tenured position. Since they are so busy, it is often the case that principal investigators do not have the time to engage in any extracurricular training related to management skills or leadership (Eberle, 2016). In fact, recent studies have shown that as many as 86% of incoming principal investigators have not had adequate management training before assuming their roles at the head of a laboratory (Filipp, 2009). Thus, it is more important than ever that a laboratory has someone that has the skills to take charge of the day-to-day management of the laboratory. In most research labs, this person is the laboratory manager.

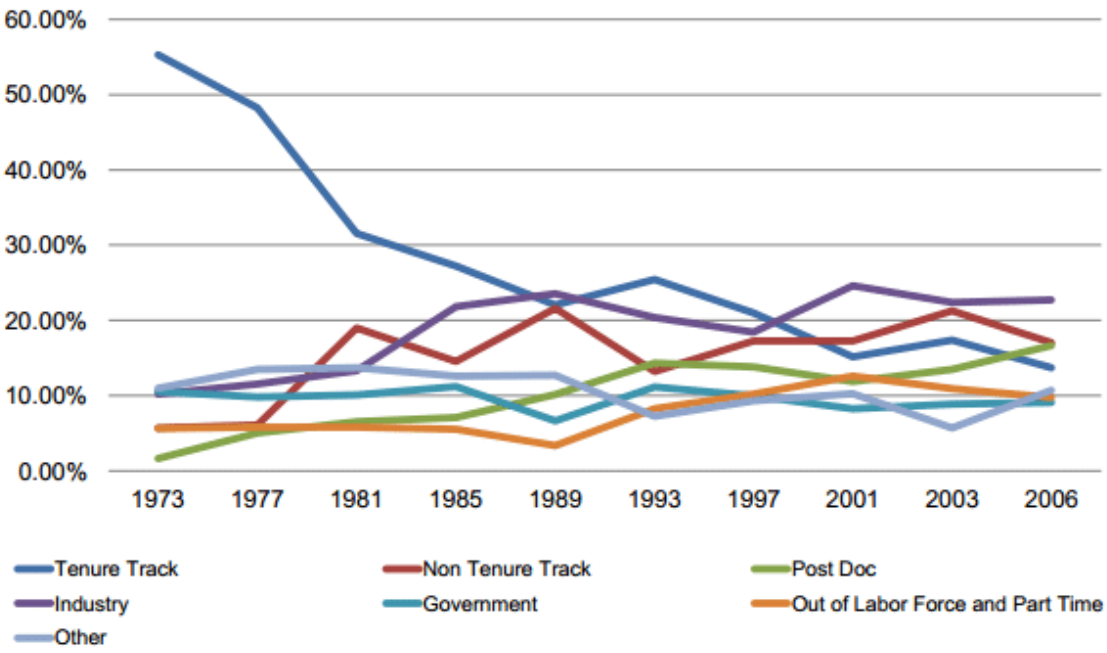

Figure 1. Decline of tenure track positions in the United States.

A graph showing the sectors and positions PhD graduates move to after successful completion of their doctoral degrees, and the sharp decline in those able to secure tenure track positions between 1973 and 2006. (Weissman, 2013)

The Role of a Laboratory Manager

The laboratory manager position itself is a highly variable one. Just as each lab is unique, each laboratory manager position can take on many forms depending on what the individual lab needs. This means that while some lab managers have total control over the day-to-day operations of the lab, others split their time between administrative work and assisting with experimental work (Shen, 2014). Most laboratory managers will be in charge of administrative tasks for the lab, such as training new employees, ordering and keeping inventory, and scheduling meetings for the lab and the principal investigators. Some may also take on tasks focused on the financial side of the lab: creating monthly spending budgets and helping to process payments to internal and external sources. Put

another way, the laboratory manager is the liaison between the principal investigator and the rest of the lab and often acts as the point person for all day-to-day operations within the laboratory. Yet despite having such a critical role in the laboratory, it is estimated that over 50% of incoming lab managers received no training at all on how to be successful in their new positions (Ackerman 2016). Further still, it is estimated that over 50% also have no more than a Bachelor's degree, with a majority of those having a degree in a science field related to the type of research their lab is performing (Ackerman 2016).

The truth is that most laboratory managers and technicians, who are often serve as as de-facto laboratory manager, are hired straight out of college (Ledford, 2011). Part of the reason for this certainly stems from the fact that they can be hired cheaply. The median starting salary for a laboratory technician is only 42,520, which falls well short of the salary for other entry level jobs in related science fields (Bureau of Labor Statistics [BLS], 2017). Part of this is certainly due to the non-profit nature of the universities that employ these technicians and laboratory mangers but can also be a result of limited available funding or the Principal Investigator's imperative to put as much of their money as possible towards the research side of the lab (Recchia, 1999). For most laboratory managers and technicians, a job working in a lab is often a stepping stone to further their career goals. Many laboratory workers hope their time in a laboratory will help bolster their resumes and publication records for application to graduate school, medical school, or veterinary school (Ledford, 2011). While laboratory managers tend to stay in their roles slightly longer than technicians, recent surveys have shown as many as 25% of laboratory managers have been in their position for less than two years (Ahlberg, 2017). This number is only higher for technicians and research assistants, who are almost always

taking on their roles with an eye towards further education. These factors, combined with a lack of proper management and leadership training given to the principal investigators, suggests that there might be a staggering lack of these skills in academic laboratories. There is a lack of data on academic laboratory manager qualifications for these positions, but one could presume that part of the reason for such a deficit in training is due to academic laboratories seeking candidates who graduated with scientific backgrounds, over more management focused backgrounds.

Private-Sector Laboratories

Running in parallel to the network of academic research laboratories there exists an entire industry of private sector research laboratories. Some of these laboratories such as Pfizer and Genzyme are involved with the research and development of drug-based therapies. Some labs exist within private hospitals, such as McLean Hospital, where they allow doctors to carry out their own research on-site. Others still, such as Charles River Laboratories, are laboratories that exist to support the academic and private-sector spheres through biomedical services such as animal breeding while still conducting their own self-guided research. Together these research and development companies make up for approximately 71% (or $322.5 billion annually) of all scientific research and development expenditures in the United States as of 2013, which shows a slow but steady increase from the 68% it was responsible for just four years prior, as is shown in table 1 (National Science Board [NSB], 2016). Despite being responsible for most of the research and development spending in the United States, the business sector was responsible for only 51% of the basic research carried out in the country, meaning the

productivity of basic research is generally even between the public and private sector (NSB, 2016).

Table 1. U.S. R&D expenditures by sector 2010-2013

Sector	2010	2011	2012	2013
	Current $millions			
All performing sectors	408,197	427,833	435,347	456,095
Business	278,977	294,092	302,251	322,528
Federal government	49,955	52,668	51,318	49,859
Federal intramural	31,970	34,950	34,017	33,026
FFRDCs	17,985	17,718	17,301	16,833
Nonfederal government	490	493	468	467
Universities and colleges	60,374	62,446	63,284	64,680
Other nonprofit organizations	18,401	18,134	18,026	18,561

Table 1 displays the total expenditure in research and development spending across all scientific fields from 2010-2013. (NSB, 2016)

It may then come as no surprise that along with their differentially sourced funding, private sector laboratories can often have a different structure when compared to public sector laboratories. Instead of a Principal Investigator heading the lab there is often a Project Director or Research Lead. While they share similar roles and require similar qualifications, the real difference between public and private sector laboratories becomes clear when we look at the laboratory manager. The job description for a private sector lab manager may look similar, but the necessary qualifications are often quite different. Many positions require training in a management or business-related field along with a science background, and many list experience leading teams or projects as a prerequisite. By hiring an employee with a business orientated background that already has a skillset in management and leadership, they ensure that the laboratory manager will be able to

overcome many of the common pitfalls of a research position and effectively lead their team to a successful outcome.

What Differs Between the Public and Private sectors?

While it may at first glance seem as if a laboratory manager may not need a comprehensive toolkit of business strategies, a closer examination shows many ways in which a management and business background would benefit the position. For example, a laboratory is often a highly dynamic workplace, with many different projects going on at the same time. Many business environments have adopted project management tools to help track the progress of various targets (Portny & Austin, 2002). Rough versions of these tools have begun to emerge with a focus on laboratories, such as LabGuru and Quartzy, however these have more of an experimental focus and less of a focus on the laboratories overall management. Another key area is that of leadership. While leadership skills may be able to obtained from previous employment, often there is no formal background or training required for these positions (Eberle, 2016). Leadership is a crucial skill for laboratory managers, who will be asked to enacting change, build trust, and managing projects that require the teamwork of the entire lab (Kotter, 1996; Kotter 2001). By putting all these skills together, a laboratory manager should be able to help their lab function more efficiently and become more productive.

With the amount of overlap that exists between the private sector and academic laboratory manager jobs it would seem there is a great deal of potential to equip the public sector with the tools from the private sector that they could use to thrive in their positions. With such a wealth of knowledge available, however, it is important to give focus to those which would be the most useful in the day-to-day life of a laboratory

manager. Through surveying the field for the tasks that laboratory managers find most time consuming and difficult, we should be able to prioritize both which private sector lessons would be the most helpful, but also which areas of their jobs laboratory managers should pay the most attention to as they grow in their positions.

Chapter II.

Research Methods

In order to determine which areas should be the focal points of our research, it was important to approach this problem in three distinct phases. Phase one consisted of interviews with members of the public sector scientific community. In order to gather a valuable cross-section of data, care was taken to approach laboratories of varying sizes, disciplines, and locations. In addition, interviews were not limited to lab managers, but extended to include research technicians, graduate students, post-doctoral associates and fellows, and principal investigators. This variation allowed us to capture different opinions on how a lab was run, what the most difficult parts of being a member of a lab were, and how those difficulties were handled. These interviews were conducted primarily in person but were conducted over telephone or Skype when necessary.

The interviews consisted primarily of three main segments. Segment one gathered basic information about the laboratory member, including the number of years they had worked in science, the number of years spent in the current lab, and the amount of training they had received in any management related fields. The second segment varied based on the role of the interviewee. For lab managers this segment focused on the parts of their jobs that they found to be the most challenging. For other associated lab members (graduate students, post-doctoral associates and fellows, and principal investigators), this segment focused on which parts of their lab manager's job they thought were the most important for making sure the lab runs smoothly and what challenges they thought their

lab manager faced in ensuring the lab's success. Finally, the focus was shifted to an analysis of why projects undertaken by the lab manager had succeeded or failed. In the interviews of lab managers this was a critical self-analysis of the techniques they employed and why they believed they did or didn't work. In the interviews with other members of the laboratories this was an evaluation of the lab manager's skills as a project and team leader and an assessment of the lab manager's management and leadership skills.

In order to gather the most useful data from these interviews, questions were presented as to elicit open ended responses. Instead of asking how a lab manager might handle a certain task or respond to a situation, they were asked what situations they had found to be the easiest and hardest to respond to. This form of questioning allowed us to gather unbiased insights into exactly what lab managers themselves found challenging about their positions and what lab members felt were the strengths and weaknesses of their laboratory managers. Since these interviews were not all conducted at the same time, care was taken to avoid adding questions to the later set of interviews that could bias the responses of the interviewees. Thus, in order to consolidate these answers, we made efforts to group responses into a broader set of categories after all interviews had been completed, the results of which would determine the focal points of the next phases of our research.

The second phase of the research consisted of interviews with members of private sector drug companies and industry based scientific laboratories. The same interview segments were used as above in order to keep the interviews consistent so that meaningful comparisons could be drawn. These interviews were used to determine the

differences in challenges between private labs and public labs and if there are more tools available to help those in private sector jobs succeed in managing labs. When possible, we also assessed the strategies that were used in the private sector and compared them to the ways that lab managers in the public sector dealt with the difficulties they encountered in their positions. We also reached out to managers at other companies that were not affiliated with science, in an effort to further find similarities both between the public and private sector on the whole, but also the types of strategies that were employed by both science based and non-science based private sector companies.

The third phase of our research consisted of an analysis of the problems and shortcomings that exist in the public sector and which tools from the private sector may be most helpful to laboratory mangers. By consolidating data gathered from the public-sector laboratory members into like groupings, we determined which problems were most likely to arise in a public-sector laboratory setting and how those issues affect the laboratory on a daily basis. After determining those issues, we turned to the problem-solving methods and tactics employed by the private sector, both in specific and broad terms to come up with a series of steps and potential implementations that can be used by public sector laboratory managers. These solutions pulled from both the interviews with private sector members, but also from a deep background of literature on management and leadership topics that public-sector lab managers may not have experience with.

Chapter III.

Results

In order to determine the areas of laboratory management where the most lessons could be learned from the private sector, we sat down and interviewed 13 public sector laboratory employees: seven laboratory managers, four laboratory technicians, and two post-doctoral associates. These interviews were supplemented by four interviews with members of private sector laboratories and scientific companies, three of whom were in management roles and all of whom shared in some administrative duties within their group. Finally, we interviewed two managers from outside the scientific community, in order to draw parallels between scientific and other fields. While some qualitative data was collected, an emphasis was placed on responses to the open-ended questions in order to let each interviewee openly discuss their own experiences and define what was most important to them in the position. The most weight was placed on answers to questions that directed interviewees talk about the challenges of their position and how they coped with these challenges.

Public Sector Findings

Since the laboratory managers were the focal point of this research, we will look at their responses first. The average interviewee had spent 5.8 years as a lab manager and 6.5 years in the field of science. Five of the seven had started as laboratory technicians or assistants only to either be asked to move into a laboratory manager role (in the case of

two interviewees) or actively sought out the promotion (in the case of the remaining three). For two of the interviewees their current laboratory management position was their first job in the science field, both of them moving from university straight into the position. All seven of the interviewees had an educational background in science, whether in the form of a bachelor's degree (six interviewees) or a master's degree (one interviewee).

When asked about what duties they are asked to perform, all seven of the public-sector laboratory managers mentioned being responsible for ordering for the lab, while many other responsibilities were shared by more than one of the interviewees (see Table 2). A common theme that arose when asked what the most important part of their job was revolved around helping the laboratory to run smoothly. For different laboratory managers this meant different things: one said that this meant making sure all the equipment was running smoothly, while another said it was about making sure safety protocols were followed so they didn't get fined by regulatory agencies. Despite the varying focuses most seemed to indicate that their job was to make sure that other members of the lab had what they needed, whether that came in the form of research tools or help with experiments.

Table 2. Common tasks between public sector laboratory managers

Laboratory Task	Number who perform task (n=7)
Ordering supplies	7
Administrative duties/Keeping PI's schedule	6
Updating/enforceing safety protocols	4
Assisting with animal experiments	3
Tracking lab finances	3
Animal colony management	2
Grant writing	2

Table 2 lists commons tasks that were cited by more than one laboratory manager and the number of laboratory managers who said those tasks were a part of their job.

When the questions turned to what parts of their job they found the most difficult, all but one mentioned the difficulty they had balancing the many tasks they were asked to perform. Many of the interviewees said it was hard to stay focused on one task because demands came from every member of the lab and it was difficult to balance those with their own duties. More than one interviewee mentioned that because they felt pulled in so many directions that they often had to work longer and later hours to accommodate all the tasks they had to get done. Yet another interviewee talked about how hard it was to get people to follow safety protocols. They mentioned that despite trying to make sure everybody knew the safety standards in place, members of the laboratory would still ignore their requests to follow the proper protocol. In a similar vein, another laboratory manager mentioned their frustration with the lack of an ability to keep areas of the laboratory clean, mentioning that despite a yearly spring cleaning the laboratory always reverted to a mess within a few weeks.

Private Sector Findings

With these interviews conducted we took their responses to members of the private sector to assess if there were similarities. The average private sector interviewee had spent 6.8 years in management roles and an average of 11 years working in science. While all of them had some science background, three of the four had taken management classes in college and two of them either had either an undergraduate or master's degree in management. Of the two interviewees who had held jobs outside the science field one had previously worked in marketing while the other had worked in a management-like role at a start-up. In contrast to the public-sector employees, members of private sector labs most often mentioned how much leadership was the most important part of their position. Most also considered this to be the most difficult part of their jobs. All four of these interviewees thought it was important to keep track of and properly manage their team. Two of the three private sector science managers talked about how staying organized was a crucial part of helping to keep projects on track and the lab running at full capacity.

These responses seemed to touch on similar issues when compared to the public-sector laboratory managers with the main exception that they had a much stronger focus on leadership. There was also a larger focus on big picture tasks, as opposed to the smaller day to day tasks that seemed to take up much more of a public-sector laboratory manager's time. While part of this may be a result of the positions themselves, all three of the private sector laboratory managers mentioned that they had been offered training course in management or leadership by their companies, while only one of the public-sector laboratory managers said similar training was available to them. Interviews with

the coworkers of the public-sector laboratory managers indicated that this lack of training was noticeable. Three of the six employees interviewed said they thought their laboratory manager could be more efficient and only one of the six rated their laboratory manager as a strong leader.

With such a difference between the public and private sector laboratory managers we then sought to determine what the most common areas may be between the positions and what lessons and skills the private sector seemed to have that the public sector did not. First, we wanted to focus in on time management due to the overwhelming concern that public-sector laboratory managers seemed to have with the work they had on a daily basis. Next, we turned to organization and consistency, since private sector employees seemed to indicate there was a much higher level of structure within their positions compared to their public-sector counterparts. Finally, we wanted to look at the most apparent different: the lack of leadership skills. While this wasn't a surprise given the lack of prior training and present training offered to those in the public sector, it was still a striking deficit and one that could be the most important to the improvement of the public-sector laboratory manager.

Chapter IV.

Discussion

In looking at the responses given and the research available in the field we have identified three skills and areas of focus that can be of the most help to laboratory managers in the public sector. For each of these skillsets we examine what makes them a problem, why this problem matters, and what can be done to become more effective at one's job with regards to those skills.

Skillset #1: Controlling a chaotic environment

With so much variability between lab management positions and within each position itself, there seemed to be great deal of concern with the level of chaos each laboratory manager was expected to control. Almost every laboratory manager brought up how they were expected to perform not only a wide-ranging set of tasks, but tasks that seemed to grow by the day, often leaving them with little time to take care of their own projects. Since a lab manager is often seen as the point person for issues in the lab, any problems that crop up during the day inevitably come back to them, from things like running out of supplies to broken equipment. This constant influx of new tasks creates presents an immediate problem for the lab manager and means their days are filled with interruption. Being faced with a constant stream of new tasks can mean that old tasks get lost in the shuffle, creating a feedback loop in which it becomes difficult to get new

projects off the ground since they are focusing so much of their time on catching up with old tasks.

This sentiment was not unique to the public sector. Our interviews with private sector laboratory workers also touched on how chaotic the position was on a day to day basis. However, it was not presented as one of their biggest concerns about their positions. In both the public and private sectors there was a focus on the number of tasks that were required by the job, though even the tasks varied in nature. While public sector laboratory managers focused more on the cascade of interruption tasks brought by other lab members, private sector managers lamented the number of meetings they felt took up their time. They also considered emails to be a more taxing part of the job, compared to only a one public sector laboratory manager who brought up email as something they thought was a hassle. Overall private sector managers seemed to view their jobs as just as busy as public-sector laboratory managers, but with a slightly lower degree of chaos.

That isn't to say that management positions in the sciences are alone in dealing with a chaotic work environment. Many employees in other sectors are finding it more and more difficult to meet the demands set by their companies and supervisors in this day and age (Gardner & Mortensen, 2017). And yet despite this, private sector laboratory managers seemed to be more in control than the public-sector counterparts. What is it that allows those in the private sector to experience seemingly the same workload but not as readily succumb to the chaos of their position? It stands to reason that adequate preparation to handle these problems would allow public sector laboratory managers to get a better handle on these types of work environments, but what skills specifically

would they need to focus on to best handle the chaos and variability that comes with the position?

Areas of Focus

When asked what skills and concepts the private sector managers used to combat the chaos and variability in their jobs they kept circling around two main ideas: time management and task prioritization. While most often these concepts were presented separately, there is a strong relationship between both the management of one's time and the priority with which they approach their work. These skills are critical both when working within individual projects or when tackling a task as a part of a larger team (Gardner & Mortensen, 2017). While these concepts are both important, it is necessary to understand why each is also separately crucial to any successful project and position.

In today's interconnected world, where projects are expected to be delivered at a blistering pace, time management has never been a more critical skill to possess at all levels of a company, but especially for those in management positions (Bevins & Smet, 2013). Time is often referred to as the most valuable resource a person can have and thus it is extremely important that it is managed well (Clayton, 2015). Time management is especially crucial because of its close relationship with productivity: the better one can manage their time, the more work they can produce. In a business setting this may mean more reports or deliverables, but in a laboratory setting this may take the form of individual experiments, grant submissions, or even publication submissions. As we've explored how critical publications are to the success of a laboratory, an increase in productivity can mean the potential for more research, more submissions, and thus possibly more funding (Rawat & Meena, 2014).

The effects of poor time management are also well documented throughout the business world. Poor time management can lead to the failures of teams and their ability to deliver on projects, which in turn can lead to lower team morale and other counter-productive work behaviors (Bevins & Smet, 2013; Rotundo & Spector, 2011). In a laboratory setting this can mean delays in experiments and missed deadlines for paper and grant submissions, which affects both the production of the lab but also the success of its members. Small delays due to poor time management can also quickly accumulate to create larger problems. For example, if a laboratory member takes an extra day every time they are asked to perform a genotyping assay, this can add up to weeks of lost time over the course of a single year. While there is no way to eliminate errors or mistakes in processes likes genotyping that can delay results, the task not being completed promptly due to poor time management that is a situation that can be prevented by exercising more awareness and putting forth more of an effort to properly manage one's day.

With the amount of attention being given to time management in the business world, why is it still such a problem? If we simply taught everybody how to properly manage their time, wouldn't that allow for greater productivity and nearly no time lost to inefficiency? The answer is unfortunately more complicated than just administering a training course. Some studies have shown that proper training in techniques with time management will lead to greater productivity, while others have come to the conclusion that the effect of training employees good time management may be more a function of the individual than their trained or inherent skill set (Aeon & Aguinis, 2017). What is clear is that fewer than 10% or people are satisfied with their time management situation (Bevins & Smet, 2013). With so much inconclusive data we are left to search for another

piece of the puzzle that affects how someone manages their time, and one of these areas is task prioritization.

Task prioritization isn't a new concept, but in today's hyper-connected workplaces the ability to take in and organize a great deal of information into a hierarchy of importance is becoming and more and more necessary skill (Sargut & McGrath, 2011). Managers and employees are being asked to juggle multiple projects, multiple job roles, and a seemingly never-ending onslaught of emails in an attempt to be as productive as ever in a world that demands results instantly (Gardner & Mortensen, 2017). Without an ability to process and organize all of these inputs and determine which of their active tasks are the most important, an employee is subject to constant interruption by unrelated or smaller tasks that can slow them down. This in turn can lead to delays in delivery or worse a complete failure to reach a satisfactory endpoint of a project at all. With these ideas in mind we set out to find the best strategies for learning to cope with the constantly changing project environment that a lab manager faces by focusing on how to better manage one's time and putting the highest priority tasks first.

Setting Up Each Day for Success.

Since time management and task prioritization are so connected, we will treat them as one concept as we look for ways in which public sector laboratory managers can integrate them into their labs. There are a variety of ways to approach and improve one's time and priority management, ranging from the use of specialized tools to a classic pen and paper list. Not only is it important that one learns to manage their own time, but they must be able to teach and train those that work with them to apply the same principles otherwise problems can arise. Not properly teaching your coworkers to focus on their

own time management can mean any tasks you wish to delegate to them will have a much higher risk of failure, even if as the manager you are managing your time well. First however we must look to what one can do on an individual level to help manage and prioritize one's workflow.

One of the most common tools utilized in the private sector involves taking steps back to focus on the larger picture. Often as a manager, especially in a chaotic environment, we tend to focus too much on the day to day and less on the overall goals of a project (Bregman, 2013). This puts us into a situation where we spent more time "fire-fighting" smaller tasks and not spending enough energy on advancing our larger goals. (Bevins & Smet, 2013). While small and immediate tasks will always crop up and need to be handled, it is important to not let them take over a majority of the time that would be better spent on other areas of a project. In order to combat this "fire-fighting" mentality, there are many suggestions for how to stay focused on the larger picture. One of the most basic is to sit down every year (or every quarter) and list out five projects you'd like to complete. Bregman (2013) suggests that managers should spend 95% of their time focused on doing things that would help complete these five tasks within the timeframe as defined. For a laboratory manager these tasks could be completing a renewal for an animal protocol, finishing the writing of a grant application, or organizing a particularly messy area of the laboratory. Given the nature of a laboratory manager's position, however, it is almost certainly unrealistic for them to be able to devote 95% of their time to only these five tasks; That would leave only two hours every week to take care of the many other aspects of their jobs. While there is no perfect starting point for how much time a laboratory manager should spend on these five tasks, starting at 50%

and working up towards 75 or 80% of their time on these tasks could be a good way to begin to integrate this concept into their job. As well as taking the time to set up goals at the start of each year or quarter, time should also be taken at the end of each week to assess at how the lab manager spent their time in order to make sure they aren't letting this 50% drift downward as they become inundated with the "fire-fighting" tasks of the week.

In coordination with taking the time to set goals by looking at the bigger picture, it's important to manage the day-to-day tasks that come with the position of laboratory manager. Both in the science and business worlds, responding to email has become one of the largest drains on worker productivity. Recent surveys have shown that people on average spend 28% of their time at work managing or responding to their inboxes and that they check their email approximately seventy times every day (Argenti, 2017). That same study showed that people who spent less time on their email and who felt more in control of their inboxes were more productive and had a higher level of job satisfaction (Bevins & Smet, 2013). In a world so dependent on email, how does one eliminate the unnecessary clutter and spend more time on what matters? One idea borrows from the same concept used in our previous solution and suggests we list out three to five tasks we hope to accomplish each day (Blumenthal, 2017). These tasks can include day-to-day job responsibilities but should also reflect the five greater priorities that have been set for the laboratory. The main focus of every day should be placed on doing things to complete these three to five tasks, and only once those tasks are comfortably on track to be completed should one go about checking their email. Furthermore, Blumenthal suggests that even once we do start working on our inbox, we prioritize on the things that have a

deadline or an urgency, and we leave the rest for once our daily tasks are completed. By maintaining this focus on the priorities set for the laboratory and spending less time on "fire-fighting" tasks such as email, a lab manager puts themselves in a stronger position that is more likely to allow for the completion of the tasks they set out to accomplish. Another suggestion for staying on task comes involves trying to avoid interruptions altogether. Putting up an out of office email reply with contact information in case of an emergency can help you focus on just the present task without worrying about seeming like you are ignoring people's emails during the workday (Gardner & Mortensen, 2017). This can allow the laboratory manager to carry out their important tasks without the distraction of smaller less urgent tasks that are bound to come up during the day.

Task Prioritization: Determining What's Important.

With these two ideas in hand we can turn to tools that help us visualize our time management and further help us decide what is important and what isn't. One of the best tools for this is Covey Time Management Matrix, made famous in his book "7 Habits of Highly Effective People" (Covey, 1995). As figure 2 shows, Covey's matrix separates tasks by both their importance and their urgency. Quadrant I is for tasks that are both important and urgent, such as an impending deadline on one of the five important projects we have set for ourselves or an emergency within the laboratory. This emergency could be something drastic like a workplace injury or something critical to the laboratory's functioning, such as fixing a broken machine that everybody in the lab needs to conduct experiments. Quadrant II is reserved for tasks that are not urgent but are important, which includes things that can help us move our five tasks towards completion, but that don't necessarily have to be done right away. Quadrant III is for

tasks that are urgent but not important, such as much of our emails, which only appear to carry an urgency because of the constantly connected world we live in. Finally, there is quadrant IV, which we reserve for the tasks which are neither urgent, nor important.

	URGENT	NOT URGENT
IMPORTANT	***Quadrant I:*** Urgent & Important	***Quadrant II:*** Not Urgent & Important
NOT IMPORTANT	***Quadrant III:*** Urgent & Not Important	***Quadrant IV:*** Not Urgent & Not Important

Figure 2. Covey's Time Management Matrix.

The 2x2 grid conceptualized by Stephen Covey in his landmark 1995 book "The 7 habits of Highly Effective People" used to better help manage one's time. (Covey, 1995)

By positioning each of our tasks into one of these quadrants, we can help ourselves visually organize and prioritize the tasks we have to complete, giving more weight to those which are both urgent and important. More often than not, we spend a majority of our time in quadrants I and III without giving proper attention to the longer-term goals and tasks in quadrant II (Argenti, 2017). This again puts us in more of a fire-fighting mode, where we spend less time doing what's important and more time reacting to things that may be urgent to others, but not to the laboratory as a whole. While it is certainly important not to ignore these tasks, as many of them are in service to other

laboratory members, it is equally as important that they are placed in the proper context and that their urgency is not just a function of a person wanting something quickly just because. This phenomenon is often known as the "Hurry Up and Wait" problem, in which coworker may portray a task they need done as incredibly urgent, only for it to be of far less urgency than initially implied (Ashkenas, 2014). Part of why this is theorized to happen so often is due to the speed at work is done today. With email and a constant connection to the grid we as a society have become used to getting what we want as soon as we want it (Ashkenas, 2014). In a work environment however, this can cause many problems, most readily when other members of the lab see each of their requests as an definitive urgency, without taking into account the laboratory managers own priorities and those that may be more important to the lab as a whole. By using tools such as Covey's matrix, laboratory managers can work to prioritize both their internal and external tasks in such a manner that will be of the greatest benefit to the lab as a whole, while working to minimize distraction and manufactured urgency.

How to Communicate Your Time Management Strategy.

While utilizing these concepts and tools can be enormously beneficial to a laboratory, they don't come without their potential pitfalls. Perhaps the largest concern comes from getting your whole laboratory on the same page when it comes to your prioritization of tasks (Gardner & Mortensen, 2017). If everybody in the lab is basing their feelings off their own priority system, then telling somebody you'll get to their task later because it's not important or urgent can be isolating and make them feel as if their work isn't important to you, when in reality you are working to organize things for the benefit of the entire lab. For this reason, it is absolutely critical to manage expectations

within the lab, both with regard to your availability to work on their tasks but also as to how you go about the process of determining which tasks receive the highest priority (Gardner & Mortensen, 2017). Soliciting the laboratory's input on your five high level tasks can go a long way towards helping them understand where your priorities lie, as can keeping them updated on timelines regarding their own requested tasks (Gardner & Mortensen, 2017; Bevins & Smet, 2013). Honest communication is extremely important, whether it is being able to admit when things are running behind schedule, or in explaining respectfully that while something may be a priority to one person, that there are more urgent matters to attend to that affect the whole lab. Adding periodic updates and levels of transparency to these overarching projects can also aid in getting everybody on the same page when it comes to how you are spending your time (Bevins & Smet, 2013).

A final important concept to pay attention to when it comes to managing one's time is to not over-reach or over-commit one's self. Too often laboratory managers seem to take on more than they can complete in a reasonable time frame (Filipp, 2009). Part of this seems to stem from a lack of ability or willingness to delegate tasks out to other members of the laboratory. While the laboratory manager may feel they are helping by offering to take on so many tasks, if things aren't getting done when they're supposed to it can be doing more harm to the laboratory than good. In order to combat the potential for over-commitment it is suggested that a manager only take on 90% of their maximum workload, leaving the other 10% for daily urgencies that will arise (Filipp, 2009). If you begin the day operating at 100% it becomes almost impossible to take on any immediate tasks, without letting something else slip through the cracks. Over time these missed

tasks compound creating a backlog of tasks from which there is often no escaping without working overtime to correct the deficit (Veazie, 2018). Being able to continuously reflect on whether or not you're over-reaching and if tasks are slipping through the cracks is a good way to determine if you're taking on too much and if you need to delegate some of your tasks out to other laboratory members.

Skillset #2: Creating consistency in a dynamic environment

Another of the biggest problems a public-sector laboratory manager will have to face is one of consistency. While we have already looked at handling the chaotic nature of the position when it comes to daily tasks, we also must turn some attention to the general lack of consistency that can exist within a lab itself and how that affects those working in it. This lack of stability can take many forms, from consistency of personnel to reproducibility between the protocols and experiments carried out in a lab. As we've already discussed, the position itself also lends itself to a wide range of tasks, projects, and responsibilities, even within a single laboratory. On top of this variability laboratory managers are widely split with regards to how long they stay in their position. Recent surveys have found as many as 25% of laboratory managers have been in their position for less than 5 years, while almost 40% have been in their position for over 10 years (Ahlberg, 2017). However, regardless of whether they plan on staying in their position for two years or twenty, laboratory managers can go a long way towards establishing a more consistent workplace.

Part of the reason for a lack of consistency within a laboratory is the seemingly revolving door of technicians, graduate students, and post-doctoral associates that rotate in and out of the lab. Laboratories are relatively unique in their employment structure in

that most employees and students in the laboratory accept their positions with the express goal of leaving for another better position within a short period of time (Ledford, 2011). For example, technicians often use a position in a laboratory to bolster their resumes in order to apply to graduate school or medical school within a few years (Ledford, 2011). While graduate students almost always remain in one laboratory for the duration of their education, they will often be seeking employment as either post-doctoral associates in other laboratories or members of the private sector once they defend their PhD's. Finally, post-doctoral associates and fellows often stay in a laboratory for as little as three years and do so in order to try and publish a few more significant papers on their way to applying to a much-coveted faculty position (Bonetta, 2009). In fact, typically the only point of consistency in a laboratory structure is the principal investigator themselves. Assuming they were able to obtain tenure, a principal investigator will often stay in the same position until they decide to retire, which absent the forced retirement provisions of the past, is becoming later and later in their lives (Rockey, 2012). Compare this to the principal investigator's private sector equivalent, the CEO, who has the average tenure of just 9.7 years (Adams, 2018). On top of this, fewer and fewer aspiring principal investigators are being offered tenure at all, with some analyses showing as few as 20% of principal investigators being able to secure a tenured position at a research university (Bohannon, 2014). With so many potential principal investigators and so few positions available, it is all the more important that a laboratory be as efficient as possible to ensure its employee's future success.

Perhaps the most poignant way in which establishing consistency can be beneficial in a laboratory setting is highlighted by the recent crisis in the science

community regarding the reproducibility of experiments (Baker, 2016). A recent survey in Nature established that over 90% of scientists believe there is a problem reproducing data, whether that be from their own laboratories or the work of other's (Baker, 2016). In some fields as many as 40% of studies have been found to be unreproducible when experiments were re-run by other labs, and almost half of individual scientists across all scientific fields have at some point failed to reproduce their own work. While some of these failures to reproduce experiments are certainly caused by spontaneous errors such as a bad reagent or a difficult animal running a behavioral test, the consequences of publishing such results can be detrimental to the field (Henderson, 2007). In many cases it can take years before a result is re-run by other laboratories and proven to be problematic. This costs not only the time and resources of the scientific community, but especially in the biological fields can delay potential research on cures for diseases or even create unnecessary panic, such as we've seen with the anti-vaccination movement (Yi, Park, & Melton 2017; Eggertson, 2010). While there will never be a perfect system for eliminating errors that lead to a lack of reproducibility, being able to keep as many parts of the process as consistent as possible can help to reduce the number of issues along the way (Henderson, 2007).

Areas of Focus

Unfortunately, one major reason for the focus on consistency in the private sector is virtually impossible to effect on the same scale in the public sector: employee turnover. While the private sector wants to reduce turnover for a number of reasons both financial and cultural, public sector laboratories are going to experience regular turnover due to the goals and natures of their positions (Tulsi, 2013). While there may be some technicians

who are 'lifers', most will find themselves along with graduate students and post-doctoral associates in a short-term employment arrangement. While the turnover aspect may be negated by the nature of a public-sector laboratory, higher levels of consistency can still be helpful in reducing unnecessary turnover caused by low morale or a disorganized work environment (Flowers and Hughes, 1973). Most laboratories have a hefty number of on-boarding tasks for new employees, including addition to existing protocols and mandatory safety training, not to mention that every laboratory does things a little bit differently (Tulsi, 2013). Even if a new laboratory member is experienced in the field, it can take weeks or months for them to become versed in these new protocols and become fully integrated in the lab (Tulsi, 2013). If there is extra and unnecessary turnover in a lab that can mean an enormous amount of lost time due to consistently having to train new employees. Cutting down on the amount of time lost in these transitions can save a lab a huge amount of resources and allow it to be more productive.

Another area of focus that is typically brought up in the private sector is trying to keep consistency in the structure of the laboratory. In the private sector this takes the form of teams, whether that means one person is in charge of a project or a less hierarchical system where each person is held accountable equally (Fussel, 2015). It matters less which organizational structure is used and much more that all members of the team share the same vision and are on the same page. In a laboratory where most researchers act as their own individual teams, a focus on structure looks more at whether or not people are considered to be "in charge" of various aspects of the lab. Often in laboratories each person will have a highly specialized set of knowledge which may extend to a particular set of equipment or experiments that go on in the lab. When this

dynamic is present and that person leaves, this can create gaps in knowledge that make it more difficult to run the lab consistently (Tulsi, 2013). Even with there is overlap between a departing employee and a newly hired employee, this overlap is often only a matter of weeks. This is hardly enough time to ensure that a new employee is fully versed in the processes of the lab and this deficit in knowledge can lead to lots of wasted time trying to get a new employee up to speed (Tulsi, 2013). While it will rarely, if ever, be possible for a laboratory manager to create more overlap between employee appointments, they can work toward ensuring that important information is not lost in this transition by spreading out delegated tasks to make sure that no one person is the sole proprietor of a subset of knowledge.

In keeping with the theme of shared knowledge, there are few things a laboratory manager can do to help establish consistency more than working to keep protocols within the lab consistent. In addition to the many safety and animal related protocols that exist in each lab, each individual experiment will contain potentially dozens of smaller protocols that range from the mixing of a solution to a complicated animal surgery. Most of these protocols are passed down from lab member to lab member, and this decentralization leads to a higher probability that they will either be copied or followed incorrectly, or in the worst-case scenario lost altogether. Adding to this problem, a single lab may have multiple members running fairly simple procedures (such as PCR genotyping in a biology laboratory) in a variety of different ways while using different reagents. Not only does this variety increase the chances of producing an unreproducible result but having to purchase various reagents for each individual person can cost a lab much more money than if protocols were consistent and used the same reagents. Going one step further,

finding a way to centralize the lab's protocols can also make it easier to pass information down to new lab members. Instead of needing to learn each individual person's procedures they would only have to learn a single method that they obtain from a common place. This would also be incredible useful when it comes to safety and animal protocols, since these are constantly changing and being updated. Being able to make sure that everybody is seeing the most up to date version of a safety or animal protocol reduces the risk of adverse effects and benefits the welfare of both the researchers and the animals they use in experiments.

Finally, especially in a laboratory setting it can be extremely beneficial to keep the smaller things consistent. This can range from keeping items stocked in a constant location, to making sure there is readily available information on ordering, to creating weekly schedules for common tasks. By establishing consistent patterns across a variety of things within the lab, you can reduce the amount of time spent helping lab members find stocked items or determine how to properly dispose of hazardous waste. If this information is available, updated, and in a common area known to the lab it will mean fewer interruptions and more time to focus on your five larger picture or daily tasks.

Minimizing Unnecessary Turnover.

Although the laboratory manager may have limited sway in affecting employee retention, they can certainly take steps to help ensure that there is less unnecessary turnover within the lab. Most private sector research agrees that the three largest factors in employee retention are workplace culture/morale, feelings of engagement, and opportunities for growth (Seppala and Cameron, 2015). Recent surveys show that even in high turnover environments, such as that of a laboratory, high morale can lead to turnover

rates as much as 25% lower than work environments with low morale (see Figure 3). Incredibly, these same surveys showed that high morale can also drastic lower the number of safety incidents by as much as 48%, which is all the more important in laboratories where hazardous materials or equipment is used daily (Gallup, 2013). All of these statistics reinforce the need to make sure that employees are happy in their positions and that doing so will help to curb unnecessary turnover. The question then becomes how does a laboratory manager create a culture where it's fellow employees are engaged, happy, and productive?

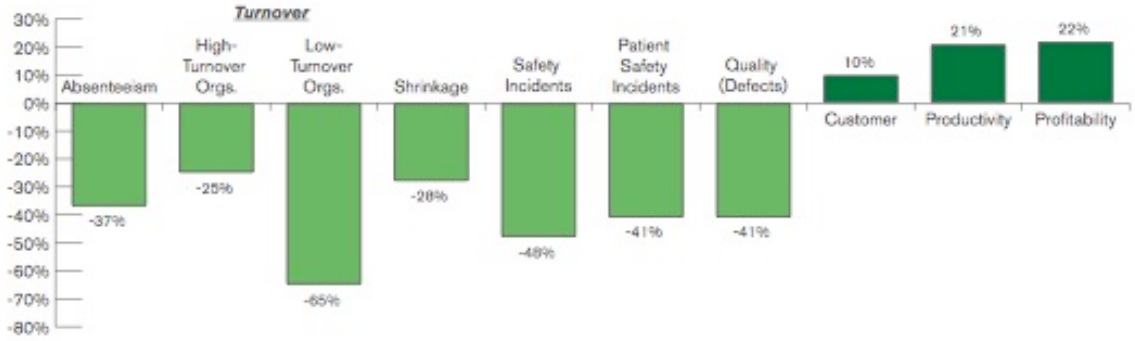

Figure 3. Differences between high and low engagement environments.

This chart illustrates the positive effects of workplaces that have high employee engagement vs those which lack that similar engagement. Notably a more engaged workforce can help decrease turnover, increase safety, and increase productivity. (Gallup, 2013)

Perhaps the number one way to affect morale is to foster a healthy and productive workplace culture. The concept of focusing on workplace culture is not new, but should not be over looked (Chamberlain, 2017). One of the main factors in whether employees perceive their environment as a positive relates to their engagement with their work

(Gallup, 2013). When employees feel more engaged with a company, or in this case the laboratory, they are more productive and happier overall. One of the clearest ways a laboratory manager can foster this engagement is by ensuring clear lines of communication throughout the lab (Zenger & Folkman, 2014). Many studies have shown employees who feel disorganized or that their direction is unclear often become dissatisfied (Chamberlain, 2017; Zenger & Folkman, 2014). These employees are more prone to entering into what Flowers and Hughes (1973) considered to be the "turn-over" zone, where employees suffer from an erosion of morale and if environmental factors don't force them to stay, will be looking to move on to other positions. If instead of disorganization there is a structure of clearly set goals that are communicated to the lab, employees will find themselves more engaged and more productive, which can benefit not only themselves but the lab as a whole (Seppala & Cameron, 2015).

Finding the Right Personnel for Your Lab.

Moving past factors like communication it is important that a laboratory contains the right mix of people that add positively to the existing lab culture. This means emphasizing the importance of smart hiring practices when it comes to searching for technicians, graduate students, and post-doctoral candidates. In the private sector, smart hiring often comes down to making sure that employee's goals align with that of the company (Trevor, 2018). Part of this alignment is already built into a laboratory, as technicians are often seeking positions looking to pursue degrees in higher education, and post-docs are hoping to leverage their positions into faculty or industry positions (Ledford, 2011). However, it is important to keep in mind the context of each individual laboratory when it comes to hiring your employees. For example, it is often suggested

that new labs look towards a career technician as opposed a younger technician who may be looking to move on in just a couple years (Ledford, 2011). Hiring a career focused technician can give a new lab a source of stability and lowers the likelihood that you will have to retrain someone in just a couple years while you're preparing to apply for tenure or still trying to get your lab off the ground (Recchea, 1999).

As important as it is to hire an employee whose goals align with that of the laboratory, is equally as important to avoid hires who would contribute negatively to the lab's culture. Avoiding employees who may display overconfident or narcissistic personality traits can be more important than trying to hire a one-in-a-million superstar (Trevor, 2018). While no formula is perfect for preventing such hires, laboratory managers should take part in the interview process and try to evaluate potential employee's culture fit in the lab. Structuring interviews to determine how a potential employer has reacted to situations for example is more useful than asking what they would do in a specific situation (Porath, 2016). Likewise assessing the way in which they speak about previous bosses and co-workers can be a good indication of the civility and integrity they will bring to the workplace (Porath, 2016). While often the principal investigator will have the final say in lab hires, they often solicit opinions from other lab members, who have taken part in the interview process, so it is important that the laboratory manager takes care to properly vet potential candidates.

Off-boarding Strategies to Prevent Knowledge Deficits.

Just as it is essential to work on finding the right employees, what to do when an employee is ready to leave is just as important. Especially in a lab environment where there is a lot of specialized knowledge, having a plan in place for when employees are

ready to leave the lab can ensure that information is not lost in the process. If a manager waits until just a few weeks before the employee leaves, there often isn't sufficient time to properly pass down all the information that the departing employee has amassed over their time in the lab. Luckily and most scenarios, there is a lengthy period of time between when a laboratory employee starts planning to move on and when they actually leave the lab. For technicians it may be when they begin to apply to graduate schools the winter before they hope to attend, while for post-docs it may begin when they start applying for faculty positions. It's at this time that the laboratory manager should attempt to begin the process of off-boarding, to allow as much time as possible to for a clean transition out of the lab (Knight, 2016).

One way to ease this transition is to sit down with the departing employee and try to take stock of what information will need to be passed down and organized for other lab members (Knight, 2016). Once this information is identified, you should work towards creating apprenticeships, or identifying other members of the lab who will work with the departing employee to take over the knowledge and responsibilities that they alone may have had (Macik, 2016). Choosing newer employees to fill these apprentice rolls can be beneficial as often there is a lower risk that they would also be leaving the lab in short order. Finally, if the employee will have a direct replacement, as is often the situation with technicians, starting the process of hiring early can be advantageous to the lab. This can allow for more overlap with the departing employee, which translates into more hands-on training and a lower risk of a large knowledge gap after the transition (Knight, 2016). More time will also allow for an exhaustive search for potential candidates, which can help to find someone that fits both the lab's strategic vision and culture (Mapes,

2015). Being aware of these off-boarding tasks and making sure to start them early can go a long way towards reducing the potential knowledge gap and adding some consistency and stability in the face of expected personnel turnover.

Centralizing Your Laboratory's Important Information.

Keeping with the concern of losing information, one thing that many laboratories lack is a centralized place to go for information regarding protocols, safety info, and other important lab documents. Not having a centralized protocol repository can not only lead to the potential loss of information when an employee leaves but can also mean that lab members are using outdated methods that may lead to failed or wasteful experiments (Ruble and Lom, 2008). If a laboratory doesn't have such a system for storing and sharing protocols, setting up such a system can seem like a daunting task, and maintaining it can seem nearly impossible. Luckily, a large number of tools exist to aid in the management of these types of files. First there are generic cloud storage companies such as Dropbox, OneDrive, and Google Drive, all of which allow online storage of documents and the ability for people to share files with other members of the lab (Macneil, 2010). There are also a number of tools that were created with laboratories in mind that allow for protocol and experiment management. Some websites such as "Protocol.io" allow not only for the uploading and sharing of protocols, but contain features that allow lab members to follow and check-off a protocol as they work through it during an experiment (see Figure 4). Others such as "Labguru" offer an all-in-one solution, with not only a repository for protocols and experimental data, but also an ordering system and modules to help track inventory and equipment usage (see Figure 5). Even with these options, some laboratories may prefer to utilize a more internal structure or file sharing solution, such as a private

intranet or network storage solution, which can keep potentially sensitive documents and protocols out of the cloud where they risk being lost or stolen.

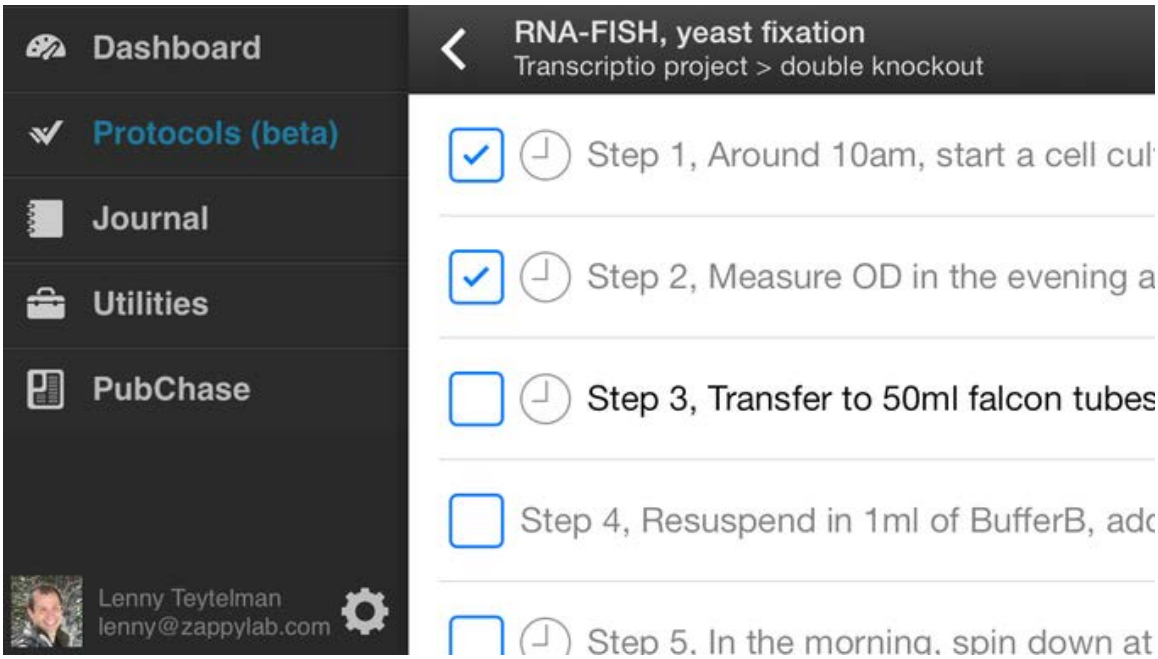

Figure 4. Protocol.io Checklist Interface

Protocol.io's checklist feature, which displays uploaded protocols on a mobile device allowing the user to check off the steps as they go. (protocols.io kickstarter, n.d.)

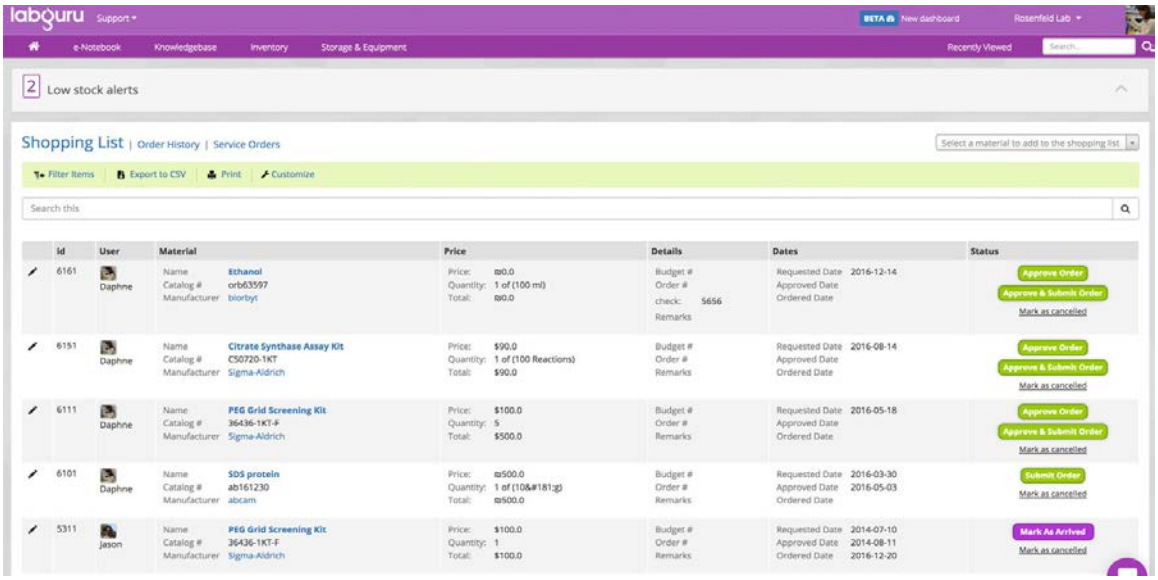

Figure 5. Labguru ‘Shopping List’ Interface

The ordering modules within labguru’s program allow for the requesting of supplies by active lab members, along with ordering approval tracking and submission by the lab manager (Labguru, n.d.)

Whichever way a lab chooses to keep its documents, it is important that they remain not only accessible to those within the lab but also are readily updated and organized. If you're starting from scratch it is important to set up rules or procedures for how to go about either adding a document to the library or editing an existing document. Maybe a protocol will have to be reviewed by multiple lab members before being accepted into the library or perhaps every so often a lab meeting can be called to discuss new additions and changes to protocols that the lab uses (Ruble and Lom, 2008). One of the biggest reasons information is lost during transitions is because of poor organization, so the end goal should be to make sure that there is a person or people in charge of making sure the collection stays regularly organized and updated (Macik, 2016). Laboratory managers can lessen this possibility by encouraging consistent

documentation, whether that be in lab member's personal laboratory notebooks or the central protocol repository (Macik, 2016). This will require accountability and consistency from all lab members, which may be difficult to maintain at times. It is in those situations that it is up to the laboratory manager to try and motivate those that fall behind on keeping their information updated (Knight, 2016). Reminding lab members about the collaborative nature of their work or helping them to teach new lab members so that the knowledge is retained can go a long way towards enabling consistent updating of common protocols.

Skillset #3: Leadership and Change

Last but certainly not least we turn our eyes towards the concept of leadership. Over the years there have been an enormous amount of resources leveled at determining what a strong leader can add to a company. Those who are perceived as strong leaders head companies with higher morale, more productivity, and higher employee engagement, while weaker leaders are often seen to have the reciprocal effect on their companies (Seppala & Cameron, 2015; Rotundo & Spector, 2011). Strong leaders are able to adapt quickly and implement changes to keep their team and company on track, whether challenges come from internal sources such as turnover or external sources such as new competition or a changing global landscape (Kotter, 1996). In recent years however there has been a growing discussion as to whether such leaders as necessary in non-profit and public-sector positions (Tierney, 2006). The argument points out that since non-profits aren't beholden to shareholders, that there is often not a need for as much change since adaptations to maintain growth aren’t a focal point for a non-profit (Simms, 2010).

The counter-argument however, is that public sector and non-profit positions may need that leadership more than ever. The public sector employs over 10 million people and has reaches into every area of people's lives, from health care to education to culture and the arts (Pallotta, 2016). The services that these companies provide are increasingly being seen as not only important to the people they serve, but also as a driver of the economy and the country's GDP (Berg, 2013). Instead of needing to appease shareholders by driving for growth and profits, strong leaders in non-profit and public-sector jobs can instead find ways to grow their companies to benefit more people, expand the services they provide, and in the case of public sector laboratories, speed the search for answers to help us understand the world around us. Nevertheless, there still remains a large deficit in public sector leadership positions when compared to the private sector (Tierney, 2006). Part of the problem seems to be a lack of upward mobility in the public sector, where only 30% of leadership positions are filled internally, compared to 60% in the private sector (Landles-Cobb, Kramer, & Milway, 2015). It is estimated that in 2016 alone there was a need for almost 80,000 new mangers, and that in the next decade there will be almost 300,000 upper management positions that will need to be filled in the public sector (see Figure 6).

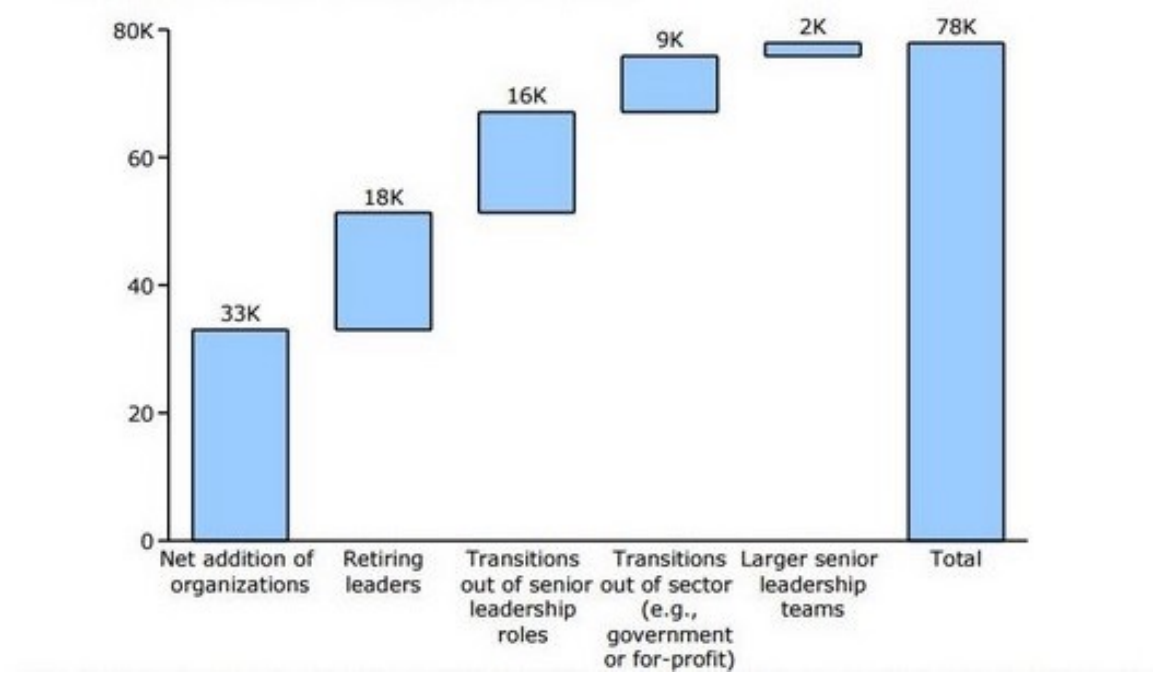

Figure 6. Estimated unfilled non-profit leadership positions in 2016

This chart shows the estimated number of leadership positions will need to be filled in the non-profit sector and the reasons why those positions will be open (Tierney, 2006)

Public sector laboratories are not spared from this leadership deficit. Since they often have people in high ranking positions who lack advanced or even introductory training in leadership, the absence of leadership can be a noticeable one. As has been discussed many principal investigators come into their CEO-like positions with no prior training in how to manage or lead a team, and those that do often only receive a lecture or two on the topic (Eberle, 2016). Similarly, many laboratory managers also do not have a background in management or any training in leadership, so they too may initially lack the skills necessary to be strong leaders (Filipp, 2016). Even if a principal investigator did wish to hire a laboratory manager with a strong leadership background, they may have to postpone hiring such a candidate in favor of technicians or post-docs who may be able to immediately contribute to the research aspects of the lab (Mapes, 2015). In the publish or

perish environment this is often the most prudent choice, especially for those principal investigators in tenure-track positions who will need to be as scientifically productive as possible in their first 5-7 years (Weissman, 2013). So, what then for the laboratory managers who have no management training and the technicians thrust into lab manager-like roles: What leadership skills do they need to focus on first?

Areas of Focus

For many years scholars have attempted to tease out why some leaders are successful while others led their teams into failure, even when they were of otherwise comparable skill and intelligence levels. In the late 1990's a psychologist named Daniel Goleman theorized that while successful business leaders varied in many regards, they all had one thing in common: high emotional intelligence. Later defined as "the ability to accurately perceive your own and others' emotions; to understand the signals that emotions send about relationships; and to manage your own and others' emotions", emotional intelligence became a sensation in the business world and is still considered to be one of the most important aspects of any business leader (Ovans, 2015). Goleman's work (1998) stated that emotional intelligence comes in five main forms: self-awareness, self-regulation, motivation, empathy, and social skills (see Table 3). Other business skills may be important, but it was the presence of a high emotional intelligence that presented the highest correlation with success as a leader. While there is some evidence to suggest that there is a genetic component to emotional intelligence, other studies show that we can grow our emotional intelligence through dedication and thoughtful reflection (Vernon, Petrides, Bratko, & Schermer, 2008; Chamorro-Premuzic, 2013). With that in

mind, it is crucial to make sure laboratory managers focus in on these aspects of their personalities and work to increase their emotional intelligence whenever possible.

Table 3. Defining the 5 factors of emotional intelligence

	Definition	Hallmarks
Self-Awareness	The ability to recognize and understand your moods, emotions, and drives, as well as their effect on others	Self-confidence Realistic self-assessment Self-deprecating sense of humor
Self-Regulation	The ability to control or redirect disruptive impulses and moods The propensity to suspend judgement to think before acting	Trustworthiness and integrity Comfort with ambiguity Openness to change
Motivation	A passion to work for reasons that go beyond money or status A propensity to pursue goals with energy and persistence	Strong drive to achieve Optimism, even in the face of failure Organizational commitment
Empathy	The ability to understand the emotional makeup of other people Skill in treating people according to their emotional reactions	Expertise in building and retaining talent Cross-cultural sensitivity Service to clients and customers
Social Skill	Proficiency in managing relationships and building networks An ability to find common ground and build rapport	Effectiveness in leading change Persuasiveness Expertise in building and leading teams

Table 3 lists the five factors that make up a person's emotional intelligence and gives both the definitions for each component as well as the hallmarks of a leader who possesses those traits. (Goleman, 1998)

When considering more foundational skills in management and leadership, every private sector manager we spoke with listed learning how to properly lead and motivate a

team. While at first this may seem like a more holistic goal, when broken down it contains two very specific components that are important for the management of any team, even in public sector laboratories: delegation and motivation (Zenger & Folkman, 2017). When teams fail it is often for one of three reasons: a lack of vision, a lack of teamwork, or a lack of motivation (Boss, 2015). By working to make sure your team establishes all three of these components you can set both yourself and your team up for increased success, which in the case of laboratories can mean more publications which lead to more funding (Pain, 2015; Pfirman, Balsam, Bell, & Culligan, 2007). Recent surveys show that inspiring others and motivating a team is considered one of the most important traits that a manager can bring to the table (see Figure 7).

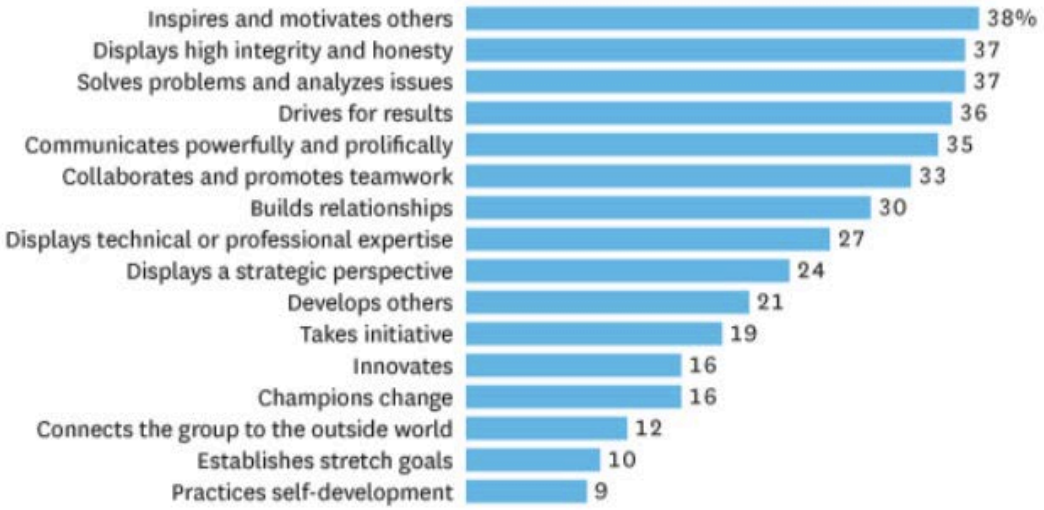

Figure 7. Which leadership skills are the most important

This chart shows which leadership skills are considered to be the most crucial to a management position as selected in a survey of over 300,000 members of the business community. (Zenger & Folkman, 2014)

Of all leadership skills one can develop though, one that will be called upon time and time again is the ability to lead and affect change. Managers and leaders rise to their positions because they are seen as employees who can call on their skills to create positive changes within a company (Hill, 2007). This same need extends to the laboratory, where a highly dynamic environment presents not only the frequent necessity for change, but also many opportunities to create a more efficient environment that can increase productivity. The problem, however, is that due in large part to their lack of training in such areas, many laboratory managers will try to create change that will either stall midway through the process or fail to be enacted altogether. That is because so many attempts lack the full vision and preparation that is necessary to enact lasting change (Kotter, 1995). Even in the business world there are numerous examples of how not properly preparing a team or company for change can lead to backlash or failure (Kotter, 1995). Taking steps to avoid this failure means understanding the work that has to be done before trying to enact the change, as well as the steps that must be taken during and after the change process begins to ensure its success.

Finally, it's important to focus on what happens when things don't go our way. Even for the best leaders, who prepare and plan and follow all the 'proper' steps, failure is an unavoidable part of the job. While some leaders may opt for paths that avoid failure at all costs, it is the truly great leaders that are willing to take risks and are willing to own their failures when things don't work out (Weiss, 2004). Too often leaders, especially those that are new to the role, pursue safe strategies or get cold feet the minute a problem arises with a project and opt to abandon it rather than see it through to the end (Kanter, 2011). The confident and courageous leader will instead encourage their team and look

for solutions, all while avoiding leading their team headlong into a sure disaster (Kanter, 2011). It is this courage to stick with one's convictions that is necessary to enact lasting positive change within a company. Lastly it is not only courage, but the resilience of the leader that will determine their success. The best leaders are those who display resilience in the face of failure, allowing themselves to digest criticism and self-reflect to determine what they can improve on next time, all without letting a failure deter them from making bold decisions in the future (Coutu, 2002).

Letting Emotional Intelligence Guide Leadership.

While there have been mixed results shown on whether or not someone can acquire emotional intelligence versus whether it's an innate quality, there are still many steps one day take to try and improve their awareness of the pillars that make up emotional intelligence. Leaders must first make sure they are practicing self-awareness by assessing how they are performing and how their actions are affecting other members of the team (Goleman, 1998). For leaders who may be new to this process it can help to get your team involved in the process. Sit down regularly with members of your team and get their opinions on how you are performing and how your work could improve (Porath, 2015). Take that information and try and detect patterns in your behavior. Does your team find you are most productive after a weekend away? Maybe when deadlines pile up you let things fall behind and would benefit from more delegation. Whatever the pattern it's important that you spend time and reflect on how it affects both you and your team in order to make improvements that can help your lab thrive (Chamorro-Premuzic, 2015).

Next, it's important to practice and gain experience with self-regulation, which in a management position usually centers around thinking before acting. As a laboratory

manager it's easy to end up in a reactionary role, where every problem needs an immediate solution, but there is often a place for slowing down and examining the options before acting. One way to do this is to involve the other members of the lab in the process by letting them take the lead in a project meeting, even if you have to make the final decision (Prime & Salab, 2014). This can have the added benefit of building trust with your lab in addition to aiding in your self-regulation. You should also self-reflect on how you regulate your moods in an effort to see if your reactions are appropriate for most work situations (Goleman, 1998). This is another place where soliciting feedback from your coworkers can help in your assessment of how your moods affect your team.

The next rung on the emotional intelligence ladder involves motivation, not only of other lab members, but also motivating yourself. While we already know that motivating your team is one of the most important skills a leader can bring to the table, if that sense of motivation doesn't extend to a leader's work it can have a negative effect on the team as a whole (Zenger & Folkman, 2017). It is therefore crucial to build a positive laboratory environment as a foundation for motivating your employees. Going a step further involves finding out what motivates your employees individually. Since no two employees will be the same it will be important to know what each of them desires from their job to make sure their goals align with yours, which will help them feel supported (Flowers & Hughes, 1973). Staying resilient can also play a big role in helping to maintain motivation within your laboratory during hard times (Coutu, 2002). Negative experiences are common in laboratories, whether in the form of a failed experiment or a rejected grant application, but helping to stay positive in these times of stress can go a long way towards eliciting that same attitudes from your lab-mates.

The fourth component of emotional intelligence moves away from management-oriented skills and into building relationships with your laboratory team (Goleman, 1998). Empathy can go a long way towards helping to build these relationships and making employees feel cared about (McKee, 2016). There are many ways to foster a sense of empathy within a laboratory, but much of it can be built upon the management skills we've already discussed. One of the most crucial ways to engage in this process is by listening to what your lab members have to say (Seppala & Cameron, 2015). Whether soliciting their critique of how things are going or perhaps more importantly simply asking how they are doing, both with work and in their personal lives, just the process of engaging with them can go a long way towards building a trusting relationship (Seppala & Cameron, 2015). By building these connections, you can contribute positively both to workplace morale and more importantly individual employee's quality of life outside of work (Riordan, 2013).

The fifth and final part of emotional intelligence involves social skills. Broadly defined as one's ability to build connections with others, a leader with good social skills will have a much easier time of getting his or her team to head in the direction they want them to go (Goleman, 1998). Having good social skills encompasses a wide range of behaviors, but there are some that should be present in all interactions. Firstly, always showing respect to your employees can go a long way towards gaining their trust and respect (Porath, 2015). Small things like smiling, engaging in small talk, and asking how your fellow lab members are doing can go a long way towards making them feel like a valued part of the workplace community (Giles, 2016). Acting with integrity is also an important social skill as perceived by co-workers (Groysberg, 2014). Lastly, staying

humble can go a long way towards earning your lab member's respect (Giles, 2016). Being able to admit when you make a mistake or don't have an answer can allow you to use those situations as teachable opportunities (Prime & Salab, 2014). By focusing on all of these components, even those who may not start out with a high level of emotional intelligence can set themselves up as better leaders both in and out of the laboratory.

Leading Your Laboratory Through Change.

While all of these skills and concepts may be important individually, they all are used to help a manager lead his team, and there is no more difficult task a manager must face than leading his team through change. Many managers may be able to prioritize their time or act with empathy, but without an ability to continuously guide their lab through the constant stream of changes that will be necessary in such a dynamic environment, they will never truly become strong leaders (Kotter, 2001). When it comes to leading change there may be no greater expert than John Kotter, who's eight step processes for successfully leading change is one of the most impactful business articles of all time (see Figure 8). Kotter (1990) spends a lot of his focus on how to avoid the common reasons that change fails by looking at each step of the change process in order determine why even great managers can fail to lead effective change. These eight steps can more broadly be broken down into three main phases of the process: Creating change, enabling change, and sustaining change (Kotter, 1990).

Figure 8. Kotter's eight steps for leading change

This graphic shows Kotter's eight steps for successful change and breaks them up into the three major steps in the process. (Richman 2015)

The first steps towards enacting any lasting change are always going to involve creating the right environment for the change to happen. Too often leaders will speed past this phase, whether because of fear of lost profits of a desire to appear more productive (Kotter, 1995). By not giving the proper attention to the environment surrounding the change however, they often are setting themselves up for failure. First, it's important to establish a sense of urgency surrounding the change. In a laboratory setting perhaps this is an impending change to existing safety protocols or a grant expiring that will affect how spending takes place. No matter the reason it is important to communicate that this change is one that has a set time frame. Even if the reasons for the change lack such a defined urgency, finding a way to create a sense of urgency will better your chances for success. If other lab members sense that this change doesn't really need to take place in

the moment, they may become complacent and be less likely to engage in the change process with you. During this phase it is also important to form a powerful guiding coalition (Kotter, 1995). In a lab setting this means enlisting senior lab members or members of the lab who have expressed a desire for the change to take place. Having them on your side and making them vocal advocates for the change can be a powerful force that will help drive the process forward if it begins to stall. The final stage of creating change is making sure you have a detailed and coherent vision of how the change will take place (Kotter, 1995). So often change stalls because managers try and enact it before they know exactly how they will go about doing so. Sitting down with the lab members you've enlisted to help and coming up with a detailed plan for how you will roll out the change it crucial to this process. Being prepared to communicate this vision clearly to the rest of the lab will go a long way towards ensuring that you have the right environment to start the process of change.

The next phase of the change process involves finding ways to successfully begin and enable the change you hope will take place (Kotter, 1995). Once you've finalized your vision, the next step is communicating that vision clearly to the rest of the lab. This is where you can lean on the members of your guiding coalition to lead by example and help you change the behaviors that will be necessary to enable a successful change. It is important to emphasize that this is a collective process and that without everybody's efforts success will be difficult to achieve (Ready, 2016). Next, you'll want to empower other members of the lab to act on your vision by working to remove barriers to the success of the change. This could mean removing old reagents from the lab if you're trying to encourage the use of new one’s or creating a reward system for people who

follow a new safety protocol. Making sure that you engage the other members of the lab in the process can ensure that they are invested in the change themselves. The last part of this phase involves setting up short term victories to make sure that you team stays motivated (Kotter, 1995). Planning for these milestones is an important thing to consider when creating the vision for your change, but once you enact the change you must remember to acknowledge these milestones as important accomplishments as you work through the process. For example, if you're hoping to change the inventory organization of your lab, this could mean splitting things up into rooms or types of materials, anything that allow you to work one step at a time towards the final goal. Setting these intermediate goals allows the team to the observe concrete results and will motivate them to continue to move things forward.

Lastly, you will want to use the momentum from the change you've enacted to both sustain the changes you've made and to start building up an environment for future changes (Kotter, 1995). Having successfully led your lab through a change event, you should gain increased credibility with the lab as a whole, which you can use to continue creating positive change. Soliciting the rest of the lab for change ideas at this stage will allow them to take the positive feelings produced by the outcome of the last change and motivate them to come up with new things that can be improved (Kotter, 1995). If you've finished organizing the lab's inventory, maybe now would be a good time to work towards cleaning out old materials from the lab or maybe starting to consolidate what you do have into a more efficient ordering process. No matter the change you move to next it will be important to institutionalize your approach (Kotter, 1995). If you have the ability you can try and give more responsibility to a technician who played a crucial role in the

process, or maybe let another researcher take a managing role in the next push for change so they can gain experience leading the process. By allowing others to take on lead roles you can not only allow yourself more time to focus on other tasks, but you show that you're interested in helping them develop as managers and leaders themselves, which will greatly benefit them in their next positions (Flowers & Hughes, 1973).

Finally, it's important to discuss what happens when despite your best efforts, your attempt at leading change falls short. In such moments it is important to engage in productive self-reflection to try and figure out at what part in the process your change stalled (Prime & Salab, 2014). Sometimes it is because there was a stubborn resistance to the change. This can be common in laboratories, since often things have been done in a certain way for many years. In these cases, consider whether or not you feel like you educated the lab enough about why and how the change needed to take place or maybe you didn't fully engage and enlist enough people to make sure the change was successful (Kotter & Schlesinger, 2008). Other times failure can be caused by a lack of trust in your own ability to commit to the change. Sometimes this is the result of a new manager trying to enact a sweeping change or an old manager who has a history of not fully committing themselves to the change process. In these cases, it can be helpful to focus on the smaller victories of the change, or to redesign the stages of the change so that they seem less drastic (Kotter & Schlesinger, 2008). Breaking down a large process into smaller bits allows for more milestones to be observed and thus more chances for trust to develop between a laboratory manager and his fellow lab mates. No matter what reason for the failure is, it is important to remain resilient and not give up trying to enact change altogether (Coutu, 2002). Showing that you are unafraid of failure and willing to learn

from your mistakes can also go a long way towards building up the capital necessary to try again to enact changes down the road (Poraith, 2015).

Closing Thoughts

By integrating these skills into their positions, public sector laboratory managers who may not possess the background or formal training of their private sector counterparts, will set themselves up to not only more efficient and productive lab managers, but also stronger leaders both in and out of the workplace. While there is an endless set of skills beyond these that can set a laboratory manager up for success, arming themselves with the skills to tackle the job's most difficult aspects can no doubt only improve their chances for success not only in their current position, but in any position they wish to take on afterwards. While it is possible there will always exist a leadership deficit in the public sector, utilizing tools such as those above can help to close this gap and ensure a strong and productive scientific public sector for the generations to come.

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