

Chapter 5

Skills Required for Managing Research Equipment



Skilled instrument staff ranging from scientists, operators, technicians and engineers can enhance safety, productivity and extend the lifespan of equipment, as well as its components in addition to generating new knowledge and innovation. Skilled staff remains a critical and scarce resource in many countries including South Africa. For instance, discussions across the globe on this subject have revealed that instrumentation staff are not only a scarce skill, but are the hardest positions to fill in any research institution. Considering the scarcity of skillful staff, it becomes increasingly difficult to attract and retain such experts.

5.1 Staff Scientists

Staff scientists are usually responsible for managing labs, facilities (e.g. radio telescope), or specific equipment (e.g. microscopes.) with the intent to acquire new knowledge through research. These experts tend to be academically qualified, typically with a doctoral qualification and tend to be employed on academic grades, such as associate or full professors. In general, staff scientist lead research programmes and investigations, generate data, interpret the data and publish manuscripts. Additionally, staff scientists (i) train students; (ii) pursue grant applications; (iii) generate publications; (iv) develop new innovations, techniques, systems and methodological protocols; and (v) operate and maintain the research equipment.

5.2 Operators

In addition to the staff scientist, an operator plays a key role in managing the research equipment. One of the key roles of an operator is that of training and advising post-graduate students, researchers, postdoctoral fellows and other users on how to utilise

the equipment independently in order to answer their specific research questions. Operators usually have a masters and/or doctoral qualification and are normally employed on technical grades as they are able to design and execute methodological protocols using either conventional or advanced techniques or both that best align to the research focus of the user. In addition, the operator's role is to (i) define and optimise the research methodology required to undertake a specific research investigation; (ii) train students, staff and users on how to independently utilise the equipment to generate quality data; and (iii) aid in the analysis and interpretation of the data. The operator may seldom choose to publish manuscripts as a lead author where he/she has undertaken independent research projects. Oftentimes, the operator is a co-author where he/she has made significant contributions towards answering specific research questions posed by staff scientists, other researchers or users through the generation of reliable, innovative and publishable results.

5.3 Technicians

Technicians are responsible for the day-today maintenance, operation and management of the equipment by allocating access-time to various users. They also ensure that the equipment is duly calibrated and configured for usage by each user and that adequate consumables, chemicals and materials are in place for the user to utilise the equipment optimally given the limited access time granted to each user. They also monitor the operational status of the equipment (such as functional, partially functional or non-functional) and performance of systems in consultation with engineers and operators. Technicians may be employed to (i) manage, operate and maintain feeder equipment; (ii) prepare samples for analysis; (iii) report malfunctions; (iv) undertake routine sample analysis; (v) manage the stock of consumables and other materials required for the operating the facility's equipment; and (vi) manage access to the equipment including following up on payment of charge-out rates from users.

5.4 Engineers

The role of engineers is mainly to conduct maintenance, testing and upgrade advanced equipment or control systems, usually in consultation with the operator. Engineers within research institutions may be employed in a highly specialised capacity to (i) diagnose and troubleshoot malfunctions; (ii) replace components and/or parts; (iii) test components and/or parts; (iv) undertake routine maintenance; (v) undertake minor software and other technical upgrades; and (vi) manage and maintain the operations relating to the equipment, including consumables. Sophisticated equipment must have dedicated engineers assigned to ensure optimal functionality at any stage of the equipment lifespan. Most of these engineering-related activities tend to be conducted within the framework of a maintenance plan with the supplier.

5.5 Data Specialists

A data specialist is a fundamental team member in any infrastructure facility. A data specialist can be a technician or possibly an operator or junior staff scientist that possesses strong analytical and problem solving skills. Data specialists have the necessary understanding, competency, expertise and skills required to navigate the cyber-sector. The basis of having such a team member on hand is for the data specialist to assess the value of data, manage that data, make the data discoverable and preserve and store the data so that it can be made useable. In essence, the duty of the data specialist is to (i) analyse and verify data; (ii) design databases or software programmes as part of the data mapping process; (iii) generate reports; and (iv) provide technical support and assistance. A summary of some of the data specialist skills are summarised in Table 5.1.

Each of the critical skills defined and described in this section for instrument staff requires an element of auxiliary discipline-specific training. This is hands-on or practical training for a period spanning 12–18 months and can be considered as an internship-type training intervention that may or may not form part of a curriculum for obtaining a formal degree or qualification. Either way, it becomes a compulsory requirement for an individual seeking to pursue a career path as a staff scientist, operator, technician, engineer or data specialist. Furthermore an auxiliary discipline-specific training programme may not strictly adhere to a strict curriculum format. Rather it provides the individual with the necessary hands on training to develop their skills set further such that they are able to operate at a highly skilled level either as a staff scientist, operator, technician, engineer or data specialist. Essential to the success of any auxiliary training programme is the appointment of a suitably qualified senior experienced staff member as a mentor to the assigned student. An example of auxiliary training in marine studies, includes (i) diving courses; (ii) skipper training or training on how to steer or sail a boat or ship; (iii) training in the use

Table 5.1 Some of the required skills set of a data specialist

<p>People who are experts and</p> <ul style="list-style-type: none"> • Operate at a competent level close to the data, and have knowledge of programming and writing codes • Might have a technical background which includes formal computer training or programming and statistical analysis • These experts can be either permanent or contracted specialists
<p>People who explore data through statistical and analytical methods</p> <ul style="list-style-type: none"> • They know how to assess the data with a view to, for instance, address curiosity-driven issues • They can build models using data and they are able to code and develop programmes
<p>People who manage, curate, and preserve data</p> <ul style="list-style-type: none"> • They are information specialists, archivists, librarians and compliance officers • If data has value, experts are needed to manage it, make it discoverable, preserve it and make sure it remains usable • They plan, implement and manage the sourcing, use and maintenance of data assets in line with governance policies, processes and procedures

of mechanical equipment and navigational software, amongst others. The proposed structure of an auxiliary training programme, therefore, ought to focus on the following critical areas of development, with a specific focus on discipline specific research equipment training and management:

- Theoretical training (30%) comprising:
 - Lectures.
 - Assignments that focus on case studies.
- Practical workplace training (70%) comprising:
 - Assignments that focus on practical or hands-on field work.
 - Discipline-specific accreditation courses.
 - Workplace or field work activities.
 - Other relevant training.

A summary of the skills set required for sustainably managing research equipment is presented in Table 5.2.

5.6 Succession Planning

Succession planning is commonly referred to as talent management and development and is the deliberate and systematic effort made by the leadership of organisations to recruit, develop and retain individuals with a range of competencies and skills (Seniwoliba, 2015).

Succession planning is critical for the sustainable management of RI. It is essential that emerging researchers and students are trained and skilled by the current generation of operators, technicians and engineers. The appointment of untrained and unskilled staff can often lead to an increase in costs related to equipment damage, downtime and safety hazards. The downstream implications impact on the quality and quantity of research outputs. Retaining and attracting skilled operators, technicians and engineers is a huge priority for any research laboratory and is also deemed as the hardest positions to fill given the skilled labour shortage globally as described earlier in this section.

Succession planning is an essential process that addresses the depleting size of the talent pool and an aging workforce. Considering the aging workforce of skills RI expertise in South Africa, succession planning should be priority for immediate, medium-term and long-term replacement workforce. Facilities need to plan and take firm steps for identifying and training the successor(s) of the aging workforce who face retirement in a minimum period of five years.

Interventions in this area of skills is paramount and must be driven by both the basic education sector in partnership with research intensive institutions. An outline of a structured intervention programme to aid succession planning is presented below:

Table 5.2 Summary of the skills set required to sustainably manage a research equipment facility

	Staff scientist	Operator	Technician	Engineer	Data specialist
Qualifications	Ph.D.	M.Sc. (preferably a Ph.D.)	M.Sc. or honours	B.Sc. in engineering	B.Sc. in ICT and computational statistics (preferably Hons)
Experience	A track record in undertaking independent research and publishing in high-impact journals	A track record in designing and executing methodological protocols using conventional or advanced techniques	A track record in managing, operating and maintaining research equipment	A track record of (i) designing; (ii) testing; (iii) constructing manufacturing; (v) installing; (vi) operating; (vii) maintaining equipment; and (viii) diagnosing and troubleshooting malfunctions on the equipment. Partnering with suppliers is an important activity in this regard	A track record in data manipulation and analysis by selecting the best tools to interrogate data so as to recognise trends that deliver insights to research questions
Auxiliary training	Essential				

- Level 1 intervention at the school level must focus on:
 - Solid foundation at the school level in mathematics, science and physical sciences.
 - Inclusion of an artistic or creative element into the schooling curriculum to support the innovation required in these disciplines.
- Level 2 intervention at the tertiary level must include:
 - Accredited auxiliary training programme courses or internships as an integral part of the curriculum for awarding a degree.
- Level 3 intervention at the workplace must focus on:
 - Appointing mentors and/or coaches to aid the young incumbent along a career path trajectory towards being a skilled staff scientist, operator, technician, engineer or data specialist. The young incumbent is therefore trained to succeed or replace the current staff scientist, operator, technician, engineer or data specialist, at the time of the current employee's retirement.
 - Providing project management training which is critical at the level 3 intervention, for training the incumbent to be assume a management role. Training therefore, must be linked to ensuring the sustainability of a facility and must also extend to include: (i) budgeting and financial management, (ii) planning and forecasting for RI management, maintenance, upgrades or shut down, (iii) building and growing capacity for optimally managing RIs, and (iv) strengthening communication skills such that, the incumbent is able to negotiate price and terms related to maintenance contracts with suppliers.

5.7 Summary

In this chapter, attention is drawn to the essential role of having appropriately skilled and qualified staff trained to optimally and sustainably manage research equipment. This chapter defines the skills and qualifications required to build the human capital development pipeline which specifically addresses staff scientists, operators, technicians, engineers and data specialists. Fundamental to the provisions of this chapter is the development of a robust succession plan to ensure that the critical scarce skills are attracted, trained and retained in the science system.

Reference

Seniwoliba, A. J. (2015). Succession planning: Preparing the next generation workforce for the university for development studies. *Research Journal of Educational Studies and Review*, 1(1), 1–10.

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