Core facilities (CFs) provide a centralised access to costly equipment, scientific expertise, experimental design, day-to-day technical support and training of users. CFs have a tremendous impact on research outputs, skills and educational agendas, increasing the competencies of staff, researchers and students. However, the rapid development of new technologies and methodologies for the life sciences requires fast adaptation and development of existing core facilities and their technical and scientific staff. Given the scarcity of well-defined CF career paths, CF staff positions are typically filled by people having followed either academic or technical tracks. Each academic institution follows different policies and often fails to adequately recognize the merits of CF personnel and to support their training efficiently. Thus, the Core Technologies for Life Science association (CTLS), through the Training working group, has conducted an anonymous online survey to assess the training needs of CF personnel, as well as to identify common characteristics and challenges in this relatively new and dynamic career type. 275 individuals, including core managers and directors, technicians, technologists and administrators, participated in the survey. The survey was divided into 2 sections; the first, applied to all respondents, and the second, specifically targeted core management issues. Training needs in technological areas, financial and soft skills, management and administrative issues were surveyed as well. The lack of clarity and consistency regarding established career paths for CF professionals was evident from the second part of the survey, highlighting geographical or cultural differences. Gender balance was achieved and the distribution was always taken into account. The results of this survey highlight a need to develop better training resources for CF staff, to improve their recognition within academic institutions, and to establish a recognized career pathway.

KEY WORD: Core Facilities · Career development · Staff · Education · Skills

INTRODUCTION

A significant proportion of the high-impact research in life-sciences that is being carried out in universities and research institutes involves centralised core facilities (CFs). 1 CFs are key participants in modern research, an integral structural part of the scientific community, acting as catalysts for the construction and advancement of an efficient research and innovation environment. They make it possible for researchers to gain access to specialized and unique technologies, state-of-the-art equipment, valuable materials, data management and, most importantly, they are the go-to place for expertise and competence. 2 Thus, the increased complexity and sophistication of research instrumentation and methodologies, in particular with scientific equipment placed in core facilities, has demanded the progressive incorporation in the operational and management schemes of CFs of well-trained scientific and technical staff. In consequence, the intrinsic scientific and technical interest of implementing cutting-edge methodologies, and the establishment of new and complex frontier equipment has attracted new generations of top professionals to CFs, who understand that these goals are of comparable interest to those found in more traditional research environments.

Staff in core facilities are experts in their field of technology. They often train users in the operation of highly specialized instrumentation, give scientific advice on the choice of the best method, sample preparation, implementation of the experiment, processing and analysis of the data. They are responsible for repairs and maintenance, watch for emerging technologies, train students and/or other professionals, while often publishing their own methods and
contributing to team science in the process. The emergence of core facilities is a reflection of the dependence of science upon technology, the development toward more complex and more expensive instrumentation, and the trend toward collaborative team science. 3, 4

Frequently, CFs operate largely as non-profit businesses in the research ecosystem with the ability to recover costs through “recharge” mechanisms. Thus, in addition to technical and scientific skills, expertise in customer service, quality assurance, project management, and even business administration, are also essential. Developing and managing a budget, dealing with difficult customers and marketing are all important parts of operating a CF. Equally significant is remaining constantly at the cutting edge of technology and methodologies, by networking with instrument vendors and assay system developers in order to contribute to the advancement of research.

Although, those who work in CFs are well aware of the need for properly organizing access, training, maintenance of the equipment and good service practices, there is not always a system in place for the development of the scientific and technical skills required for the progression of the personnel involved in providing the best possible access to cutting-edge services. It is notably becoming increasingly evident that these key technological professionals feel in many cases that their important contributions are not sufficiently recognized.

Especially in Europe, certificates and academic curricula designed to train expert technologists working in CFs, such as the “University Diploma for European Core Facility Management - Université de Paris,” are rare exceptions, probably because of the lack of institutional support. 5 To overcome this issue, the European Commission Horizon 2020 has funded several initiatives focused on the training of operators and managers of research infrastructures in the life sciences, such as the ARISE “Career Accelerator for Research Infrastructure Scientists” program, RITrain with the “Executive Master in Management of Research Infrastructures,” and the InnoCore “Core Technologies for Education and Innovation in Life Sciences” project.

In recent years, best practices for CFs in certain fields were published which also addressed recommendations on the training needs and continuing education of CF managers and staff. 6-9 Despite these and other initiatives, such as the “UK Technician Commitment” (www.technicians.org.uk/technician-commitment), that aims to ensure the career development and sustainability of technicians working in higher education and research across all disciplines, much more is needed to ensure recognition and professionalization of CF staff.

Traditional research positions for professors, staff scientists, or doctoral students have been clearly established within a longstanding academic hierarchy within universities and research institutes. Therefore, their role within an institution, duties, responsibilities, and their degree of independence is well defined and known within the research community worldwide. Core Facilities are a rather young phenomenon in the research landscape, and therefore both the implementation of these units within their institution as well as the job definitions for CF heads and staff positions have (not yet) been well specified, and differ significantly from one institution to another.

Some institutions have begun to develop core facility specific job families, which can be technical and/or managerial. The Association of Biomolecular Resource Facilities (ABRF) has published a list of US Institutions that have introduced career tracks specific for core facility personnel (https://abrf.org/committee/career-development-committee). Development of new job families requires significant collaboration among administrative and academic stakeholders, including Human Resources Departments. Increasing the visibility of reference examples is critical for further growth in this important area, because without proper criteria for assessment there can be no effective career advancement. 10

Core Technologies for Life Sciences (CTLS) is an international non-profit association based in Europe that brings together scientists, and technical and administrative staff working in or in close association with shared resource laboratories, such as CFs, technological platforms or research infrastructures (https://www.ctls-org.eu/). CTLS has identified that an important challenge in the proper organization of CFs in the future must be to clearly define a career path for these top professionals. Accordingly, the CTLS Training Working Group (WG) was established in 2016 to identify and compile information about the training needs of the CF staff community, and to promote career paths accordingly. Hence, the WG carried out a survey with the dual goal of assessing the current career status of CF heads and identifying the training needs to support CF staff, whatever their role.

To the knowledge of the authors, so far no survey results on this topic have been published across technological areas on an international scale. Through this short summary, we present the main findings of this survey and key conclusions to show how CTLS aims to endorse and support the needs of the core facility community, in order to promote career development for its members and identify best practice across institutions.

MATERIALS AND METHODS

An anonymous survey was created in SurveyMonkey (https://www.surveymonkey.com/). The link to the survey was sent via email on the 12th of June 2018 to all CTLS
members. This email was forwarded on by recipients, and the link to access the survey was also circulated to the German BioImaging mailing list, and to the members of the Association of Biomolecular Resource Facilities (ABRF). The survey closed on the 31st of July 2018.

The survey consisted of 19 questions (see Supplementary information) which were structured as follows:

- 6 mandatory general questions to provide information on the respondent (all multiple choice).
- 6 questions about the training needs (5 multiple choice, 1 open-ended), not mandatory.
- 3 questions about available training offerings (1 multiple choice, 2 open-ended), not mandatory.
- 4 questions accessible only to Core Facility Heads and Administrators regarding their career path (all multiple choice), not mandatory.

RESULTS

Respondent demographics

The total number of respondents to the survey was 275. The non-mandatory questions had a response rate of 40% for the training needs and offerings questions, 97% for the Core Heads and Administrators only section.

Among the 275 respondents, 131 were female (47.6%), 134 were male (48.7%), showing an excellent overall gender balance. Ten respondents (4%) preferred not to answer the gender question.

The respondents were from 14 different countries worldwide, representative of 5 different continents (Fig. 1): 64 were from the UK (23.3%), 62 were from the US (22.6%), 46 from Germany (16.8%), 26 from France (9.5%), 14 from Belgium (5%), 13 from Italy (4.7%) 9 from Sweden (3.3%), 6 from Spain and Switzerland (2.2% each), 5 from Ireland (1.8%), 4 from Austria (1.5%), 2 from Australia, Czech Republic, Denmark, Georgia and Portugal (0.7% each), while there was 1 respondent from the following countries: Albania, Barbados, Canada, Japan, Luxembourg, Malaysia, Netherlands, New Zealand, Poland and Singapore (0.4% each).

The type of organization that respondents work in are: 139 in a University (49%), 131 in a Research Institute (46%), 4 in a hospital, 1 in a company (Fig. 2). Nine didn’t identify with these classifications and selected “other.”

We found a significant difference in the type of organization based upon the different geographical areas. In particular, in Europe 66% of the responses came from Research Institute staff and 33% from Universities, while the proportion of core facilities in Universities among respondents was much higher (85%) in the USA.

It may be that research institutes independent from universities are rarer in the USA, compared to Europe. As we do not currently have data that specifically supports this hypothesis, broader differences between research institutions in Europe and the USA could be the topic of further investigation. Alternative explanations could include potential misunderstanding of nomenclature, as some may focus upon whether their institution engages in undergraduate education as the primary distinguishing factor, although in many cases research institutes can be semi-autonomous, but still affiliated with a university system.

All 275 respondents provided their area of specialization (Fig. 3). The highest number worked in Microscopy and Imaging facilities (22.6%), followed by, Flow cytometry (16%), Proteomics and metabolomics (12%), Genomics and transcriptomics (9.5%), while other areas included Bioinformatics (6%), Biophysics and structural biology.
10.6% were involved in managerial tasks, with no specialization in any scientific area.

Concerning their role within the core facility, more than half of the respondents were Facility Heads/managers (62%), 17% were Staff scientists, 13% were Technical Staff, 5% Administrative/Managerial, 3.6% were infrastructure coordinators, while 2.9% were deputy heads of facilities (Fig. 4). In terms of academic qualification, more than 80% of the Facility Heads/managers held a PhD, compared to 74% of the Staff Scientists and <40% of the technical staff.

From the open-ended fields associated with this question, a variety of terms were suggested, such as platform manager, lab engineer, Unit head, Director of Collaborations, Experimental officer, supervisory staff, and the original “one man show,” which fits well with small-size core facilities. Such heterogeneity is a clear indicator of the need for a consistent nomenclature that would help in defining the different roles within a core facility and facilitating the harmonization procedure in the career progression of CF professionals. However, it should be clear that based upon the modes of survey dissemination, the CTLS stakeholder population, and the rest of questions/answers, it seems safe to assume that all respondents represent individuals who directly contribute to the core facility programs at their institutions as the primary role, rather than general roles in their institutional administration.

Training needs

The second part of the survey aimed at assessing the training needs perceived by the CF professionals, in terms of management, soft skills and technical needs. The question regarding areas of technical/scientific expertise to be improved was only answered by 42 out of 275 respondents and the details of the answers are beyond the scope of this work. Briefly, there appears to be a need for improved understanding of programming languages, statistical analysis, metabolomics and omics technologies, with individual mention to detailed specifics such as tissue recognition and dissection, optics, structural biology, image analysis, flow cytometry, and cryo Electron Microscopy skills.

To the multiple choice question: What management skills would you like to improve on? 240 answered and only 7 respondents (4%) did not need to improve management skills.

The same type of question was asked for the “soft skills” and the answers from 254 responders were collected: 52% said that they would value training on conflict management, 50% on negotiation, 44% on team management, 36% on time management, 35% on engaging with users, 34% on presentation and communication, 27% on team building and 17% on recruitment. Additional suggestions were marketing and quality management systems.

No significant differences in the training needs were evident between the Core Heads and those in a non-managerial role, except for a higher proportion of the latter voting for training in user engagement, consistent with a role as the daily interface between the users and the Facility. Interestingly, the response rate to all the questions about training needs was significantly higher for females than for males, as shown in Figs. 5 and 6, while there was an equal distribution in the respondents to the survey in general. No significant differences in the management and soft skills training needs emerged from the analysis per area of expertise, meaning that the list of proposed topics is transdisciplinary and quite representative.

The respondents were also asked if they had identified any courses to address these needs. Overall, the percentage of respondents that hadn’t identified any course to address...
their needs was very high (80%), highlighting that these kinds of training are missing altogether or that the communication about them is lacking.

In order to assess the most favored training format, a multiple choice question was asked and scored 253 responses (Fig. 7). According to the overall results, mentoring was the preferred training format (39%), together with E-Learning/hands-on in virtual training platform (38%), followed by Networking sessions with peers from other Core Facilities and Short, intensive sessions off site (3 days or less) (36% each), Short, intensive sessions on site (3 days or less) (32%), short visits to sites with expertise in a specific area (shadowing) (29%), Online tutorials and prerecorded videos and Lecture series over longer time periods (online or in person) (25%), and Webinars (17%).

Core Heads preferred mentoring and virtual training platforms, followed by networking sessions with peers and short visits with shadowing sessions. Only 14% of Core Heads wanted on site training, while Staff scientists and Technical staff would select this type of training in 68 and 62% of cases, respectively. Indeed, core facilities managers often need to gain specific managerial competencies at a stage in their careers when they are already relatively senior and cannot commit a significant amount of time to training, but these data suggest that they prefer off-site training rather than in-house, probably recognizing the importance of networking and of keeping some undisturbed time to benefit from the training sessions.

Nevertheless, the outbreak of COVID-19 and the necessary national measures taken to tackle the spread of the virus may cause significant disruption to the provision of training and mobility opportunities for learners across the world. Because the duration of such measures has been extensive, and is likely to continue in several countries for an indefinite time, there is an urgent need to adapt and apply innovative methods to design and deliver efficient online courses and training.

Core facility head survey results
The third part of the questionnaire was restricted to the 178 responders who identified as Core Facility Heads/Managers, Deputy Core Facility Heads or Administrative roles. Importantly, as over 7-times as many respondents identified as Core Facility Heads/Managers or Deputy Managers, relative to other administrative positions, to simplify, we will refer to them all from now on as Core Heads. For each question in this section we have assessed the gender balance. 98 were male (55%), 75 were female (42%) and 5 did not...
The respondents in the Core Head Section were from 14 different countries: USA (22M, 23F, 2 no gender), France (10M, 6F), UK (23M, 12F), Germany (23M, 12F), Italy (3M, 9F) Switzerland (2M, 2F), Austria (4M, 0F), Belgium (3M, 2F) and others. The majority of Core Heads were located in a University or Research Institute setting. Only 2 were from hospitals and 1 from industry. In Universities, 53% were male and 47% female, while in Research Institutes 60% were male, 37% female and 3% didn’t specify.

Although the majority of CF Heads hold a PhD degree on average, as presented in Fig. 8, a difference can be seen between countries, in particular between the countries with an Anglo-American educational system (UK, USA, Canada, New Zealand, Ireland, and Australia) and other European countries. Overall, across the different geographical regions, a considerable fraction (18.7%) of CF Heads hold a MSc or BS (31 out of 165). Indeed, the survey shows that 100% of CF heads in Germany hold a PhD, even if this is not a mandatory title in every academic institution, but a strong recommendation, probably associated with a more formally hierarchical system.

Compared to the more defined academic track, the lack of a well-defined career path for the scientific and technical facility staff often generates confusion, resulting in CF professionals not always being adequately recognized by the scientific community. In order to assess the most plausible socio-economic status of Core Heads, who are generally considered to be the leader of a single core facility and can be variously referred to as “Director” or “Manager” depending upon certain variable definitions, they were asked what their core facility position equated to in the academic career progression of their institution/university. Most core facility heads identified as early career investigators or Junior Group leaders (26M, 24F) or Principal Investigators (PIs)/senior Group leaders (36M, 20F), while postdoctoral level (14M, 13F) was selected by a minority of Core Heads. Importantly, PI generally designates independence, while Junior Group Leaders or postdoctoral researchers are usually members of a larger research team that reports to a common PI. 1F and 7M identified that their CF Management/Head role was considered as that of a Technician. 2M and 0F described their role as “Director” (Fig. 9).

The USA is the only country in which gender balance is achieved in all the positions, including the PI (54% of women). In all the other locations the number of women with a “PI equivalent” designation is significantly lower than their male counterpart (14–24%).

The survey next asked if the CF Heads had a permanent work contract. Of the 165 that answered 68.5% had open ended contracts, while 31.5% had fixed term contracts. Within the “fixed term” answers, the majority were on 5 y contracts. Core Facility heads in Europe benefit from
permanent contracts in the vast majority of cases (80%), while the situation is different in the USA where the percentage falls down to 39%. (Fig. 10) However, further speaking to the need for better understanding of fundamental institutional differences, this could also stem from general differences in definitions and structures in the USA vs. Europe academic systems, as generally speaking the only personnel in USA universities with “permanent” jobs are tenured faculty members.

A further question was asked to provide a snapshot of the steps that immediately precede the career progression to a top CF position. According to the results, Core Heads had a variety of different jobs prior to their current position, with the majority (34%) of Core Heads having come from a postdoctoral environment or a core facility staff setting (24%) (Fig. 11).

Lastly, CF Heads were asked to indicate why they chose to become a CF Head. The most popular reasons for leading a Core Facility are reported in the word cloud in Fig. 12. Five options were already proposed: 1) I am a technology-oriented person, 2) I like to be involved in different-projects, 3) I wished a more stable job position, 4) I wanted a better worklife-balance, 5) By coincidence. Several interesting answers were suggested by the respondents, using the “Other” option, such as service attitude, interest in management, interaction with people, prevalence of collaboration vs competition, strong connection to research without bearing the PI’s pressure and responsibility.

DISCUSSION

The lack of clarity around established career paths for CFs professionals at many research institutions, compared to academic faculty positions, is a flaw in todays academic life sciences. Creation of a CF staff scientist or team scientist track as an attractive and viable research career choice in academia - one with stability, professional recognition and status as well as opportunities for progressive advancement - would provide a career path for individuals who are interested in the technological and methodological aspects of research, but not in academic faculty positions. Some institutions worldwide have succeeded in introducing new job families for CF staff: whether this is the result of a joint effort of all the stakeholders (i.e., Rectors/Vice-Chancellors, Human Resources Departments, single Departments and various committees representing academic and CF staff) or a top-down process, would be worth further investigations.

CTLS, together with other associations and alliances of CFs such as ABRF, German Bioimaging, Core 4 Life, and Alliance 4 Life, are actively working to shed light on the career path of staff working in CFs, and to provide opportunities of professional training. Notably, CTLS has been promoting, supporting or organizing EU-based conferences, symposiums, workshops, training schools and courses that cover the breadth of interests of the CF staff community, where the sessions dedicated to CF staff career development have always been among the most attended and have triggered vivid discussion, demonstrating the urgent quest of the participants for possible solutions and successful examples to get inspiration from.
The absence of a clear career track goes hand in hand with the lack of dedicated training programs for career development, which would provide not only the necessary scientific and technical skills, but also transversal “soft” competencies such as human resource, quality, and financial management. Moreover, many institutions do not adequately recognize these training needs and do not routinely allocate the necessary resources to allow the continuing professional development of CF operators and managers.

The CTLS Training Working Group performed this survey to obtain information regarding the training needs of core facility scientists, and identify variations among different career stages and institution locations and types. Several key takeaways from this survey revealed commonalities across the different respondent groups.

SUPPLEMENTARY INFORMATION

The survey summary data generated by SurveyMonkey are reported. These data include only the summary of data generated by multiple-choice questions. The open-ended questions are not included in the data summary because they generated individual responses.

SURVEY QUESTIONS

Sent through SurveyMonkey.

General questions:
- What is your field of activity?
- What is your Gender?
- In what country do you work?
- In which type of organization do you work?
- What is the highest qualification you hold?
- What is your role within your Institution and Core Facility / Infrastructure / Shared Resource Lab?

Training needs:
- What management skills would you like to improve on? (Tick all that apply).
- What soft skills would you like to improve on? (Tick all that apply).
- What areas of technical / scientific expertise would you like to improve on? (Please specify or leave blank if there are none).
- Have you identified any courses to address these needs?
- Can you recommend any courses that you have attended that have had an impact on your activity?

Training offer:
- What kind of training (in English) does your organization offer to external people?
  - For each course offered, please specify:- Course title-
  - Duration of course-
  - Frequency of course held-
  - Fees payable (Yes/No)- Course contact (Email).
- Would your Core Facility / Infrastructure be willing to offer places to external people as part of a shadowing or staff exchange program?
Career path of Core Facility Heads/Managers

- How is your position ranked within your organization (i.e., equivalent level of responsibility)?
- What position did you hold previous to your current job?
- Why did you choose to become a CF Head/Manager or Infrastructure Coordinator? (Tick all that apply).
- Do you have a permanent work contract?

Training needs per field.

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