Chameleons

D1.3 Gap Analysis

WP1 Determining the Gap

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1. Introduction

The overall objective of CHAMELONS is to develop new and innovative educational interventions to improve the learning experience offered by higher education with the intention of shaping more adaptable, entrepreneurial and employable graduates, ready to meet the challenges of the future. Work package 1 of CHAMELEONS sets out to determine the gap between what is needed in terms of intersectoral and interdisciplinary doctoral education; and what already exists. Deliverable 1.1 of this work package conducted a systematic literature review and two surveys of early career researchers and PhD module designers to identify what is needed. Deliverable 1.2 responded to the second element of the gap analysis – ascertaining what already exists across the CHAMELEONS consortium in terms of PhD modules that broaden student perspectives beyond academia. This deliverable, Deliverable 1.3 identifies the gap between what is needed and what exists based on employer interviews and questionnaires completed by early career researchers. It proposes two solutions to that gap:

1. A state of the art toolkit that pulls together existing modules to offer a complete menu of modules for PhD students that will prepare them for intersectoral and interdisciplinary working

2. A set of design considerations for the development of new PhD modules that seek to bridge disciplinary and sectoral divides.

2. Methodology

This report builds on the data gathering exercises detailed in CHAMELEONS deliverables 1.1 and 1.2 including:

1. a systematic review of publications that identify and discuss the educational requirements of PhD and Post-doctoral graduates with particular attention directed to skills required to enhance the possibilities of graduates gaining employment beyond the academic sector.
2. two surveys - of PhD and early postdoctoral students; and those involved in developing PhD modules - ascertaining their attitudes towards, and requirements from, courses/modules that offer and prepare them for cross-sectoral perspectives.
3. Consortium questionnaire: A survey of all members of the consortium to identify inter-sectorally designed and/or delivered courses/modules which are available to PhD/Postdoctoral students.

In addition, it adds a new dataset of PhD employer interviews.

Interviewees were initially gathered using connections from members of the consortium. Further interviewees were then identified via the snowballing sampling technique. All interviewees were contacted by email. Details of each interview and interviewee are displayed in the table below. Please note that location refers to where the interviewee was based, as all interviews took place virtually over Microsoft Teams in accordance with COVID-19 protocols.

Table 1 Details of the Interviewees.

Interviewee	Role and Sector	Location	Date and Time	Length
Interviewee A	Co-founder, Medical informatics company	Spain	6th November 2020 (5:15pm)	41 mins
Interviewee B	Medical Director, Pharmaceutical company	Spain	19th February 2021 (5pm)	54 mins
Interviewee C	Market research analyst, Health Research Clinic	Finland	24th March 2021 (11am)	37 mins
Interviewee D	Head of Education, Technology company	Ireland	6th April 2021 (11am)	39 mins
Interviewee E	HR director, Private clinic and hospital group	Portugal	7th April 2021 (12:30pm)	52 mins
Interviewee F	Co-founder, Sports wearables company	Ireland	3rd June 2021 (5:40pm)	53 mins
Interviewee G	Supervisor, Hospital-based research institute	Ireland	24th June 2021 (1pm)	39 mins
Interviewee H	Founder, Social media marketing company	Ireland	24th June 2021 (3pm)	34 mins
Interviewee I	Principal investigator, National software research centre	Ireland	25th June 2021 (10am)	45 mins
Interviewee J	Director, National data analytics research centre	Ireland	25th June 2021 (3pm)	30 mins
Interviewee K	Head of Innovation, Healthcare NGO	Portugal	28th June 2021 (12pm)	20 mins
Interviewee L	Career Guidance Officer, University	Ireland	28th June 2021 (2pm)	34 mins
Interviewee M	Independent contractor, National health organisation	Ireland	28th June 2021 (8:30pm)	18 mins

Interviews lasted between 18 minutes to just under an hour (see Table 1). Prior to interview, all interviewees were provided with an information sheet informing them of their rights to confidentiality and should they wish, the right to withdraw from the study at any time. Consent forms were also attached for signature.

The interviews took a semi-structured approach, with questions revolving around the interviewee's previous experience (or lack of) working with doctoral and post-doctoral students/graduates. Desirable skills or traits, hiring processes, existing or future projects or partnerships, and thoughts on the interdisciplinary and intersectoral nature of CHAMELEONS were also discussed. With each interview, themes began to emerge and so questions then evolved through an iterative process.

Interviews were audio recorded, transcribed and then analysed for emerging themes via the qualitative data analysis software NVivo. The codes created during the analysis form the basis of the findings presented here.

3. Findings: Employer Interviews

Findings from the interviews align with those identified in the systematic literature review and surveys and also bring new findings to the discussion.

3.1 Varying definitions of skill

An early finding from the interviews was just how differently skills were defined and interpreted by those in industry versus those identified in the academic literature. Academic literature had focused largely on the concept of 'soft' skills yet when asked about desirable skills in candidates, some of the employers began to discuss 'hard' skills. Examples included AI, software development and machine learning. Originally, the researcher thought of the 'hard' skills as a type of knowledge. This highlights potential disconnect between academia and practice.

Interviewee G argued that soft skills are actually inherent already, yet employers focus on hard skills more and so the development of soft skills receives less attention.

Skills will be discussed further in the next section.

3.2 Personality and values as a key hiring factor

One of the most unique findings from the interviews centred on personality – something that had not been mentioned at all within the academic literature. Personalities were mentioned numerous times as a key factor when hiring. Adaptability was often mentioned as one of the most desirable personality traits. It appears that fitting into an organisation on a personal level is just as, if not more important than, fitting in on a technical level. Interviewee J went a step further, admitting that they frequently hired people on the basis of seeing themselves getting along with the group, rather than on the basis of their knowledge and skill set.

Interestingly, Interviewee F described traits such as determination as a skill. Others such as Interviewees H and J also described traits such as confidence and positivity as a skill, with Interviewee A adding how

important they felt it was to "train emotional resilience". Interviewee I even mentioned that learning in itself was a skill, and that being self-aware of one's knowledge and limits is important in developing the skill. We already examined the concept of skills in section 3.1 but this adds a new level to the already ambiguous definition of what exactly constitutes a skill and therefore whether personality traits such as determination, resilience and assertiveness can be trained the same way. Likewise, would they be considered a 'soft' skill or require a new category?

If traits such as resilience can indeed be trained as a skill, this may alleviate some of employer concerns around flexibility and time management when hiring doctoral or post-doctoral candidates. Interviewee F holds a PhD, and found that many of the skills they learned during their research were applicable to industry; it was just that they had to apply them on a much more time-efficient basis. This difference in academic research and commercial research was also mentioned by Interviewee C who attributed it largely to time management rather than the actual work itself. A fear of failure or rejection had to be tackled early on, as the perfectionism associated with doctoral and post-doctoral students often proved an obstacle to achieving results. Interviewee I sympathised but expressed a wish that doctoral students become less subservient and instead see themselves on an equal level with their supervisors and not be afraid to take initiative or express disagreement.

Disagreeing with personality altogether, Interviewee E highlighted personal values as one of the most important factors when hiring, as they explained that the employee needed to align themselves with the culture and values of the organisation. If the candidate did not hold the same personal values as the organisation then they could not be expected to work in an environment that reinforces and acts on those values on a daily basis.

3.3 Adaptability or experience?

Further building on Section 3.2., multiple interviewees mentioned that having experience in a professional environment was an important factor in deciding whether to hire someone. Internships were thus seen as a valuable asset on one's CV. It was noted by Interviewee B, that doctoral or post-doctoral students on internships tended to have unrealistic expectations when beginning these placements. Interviewee F mentioned something similar as they highlighted the biggest difference between academia and industry being time management and how quickly projects must be carried out in an organisation versus in academia. As Interviewee C described it these are often "fast and small projects".

Some of the interviewees were experienced in teaching doctorate or post-doctorate students and found that those who returned to education after some time in industry tended to fit in better than long-time academics due to their interdisciplinary knowledge while others struggled to adapt to the research world. Interviewee I suggested that while engagement with industry was important, it might be wise to avoid it during the research period if the research topic is unrelated.

When asked about experience and adaptability, Interviewee H explained that they believed that experience itself leads to adaptability. To be able to adapt to a new environment, one must have the experience of fitting into multiple environments before.

3.4 Roles for PhD/post-docs

Doctoral or post-doctoral students or graduates were typically viewed as having a different role to play in organisations versus other professionals. For example, Interviewee E explained that they often placed

doctoral or post-doctoral employees towards the 'back' of the organisation or in technical positions. As described by Interviewee E "you wouldn't have a PhD in a sales role". Interviewee H explained that each role in the organisation would require a different personality. With their enterprise focused on selling business to business, they felt it was important for the candidate to be outgoing and a negotiator. Interviewee H also thought of doctoral or post-doctoral students as "super specialists" rather than salespeople and so would be less inclined to hire them unless they had shown previous retail experience.

The size of the organisation was also a factor for consideration. Those employed in smaller companies expressed desires for more well-rounded employees while those in big companies would hire doctoral or post-doctoral candidates if they had a highly technical specialist role available.

3.5 How and where PhDs/post-docs apply from

Some employers mentioned having partnership programmes with universities, most notably those working in research institutes. An example came from Interviewee D whose company had research centres on university campuses such as Cambridge. These research centres offer internship programmes whereby candidates would apply directly through the company's website. Other research partnerships on university campuses were described by Interviewee J, and candidates were largely hired from that specific university.

Others described doctoral or professional networks they were members of, such as Interviewee A describing an international PhD student network. These networks provided the company with direct access to a large group of researchers where they could advertise their requirements and find a student who could meet their needs and work inside the company for a period of time.

Finally, most of the entrepreneurs interviewed explained that doctoral or post-doctoral qualifications were not specific to their hiring process, meaning they did not engage with any particular university or network to deliberately seek these people out. In this case, LinkedIn was the most popular method of hiring, with Interviewee H using it exclusively in their hiring process.

3.6 Diversity

Several of the employers mentioned that diversity was important to them when choosing who to hire. Interviewee H noted that having employees from different cultures and ethnicities sheds light on other ways of seeing things and contributes towards a perfect blend between these new hires and others present in the organisation.

When we think of diversity, we tend to think of these demographic and sociocultural factors yet interdisciplinary knowledge was identified as another way of bringing diversity to an organisation. Interviewee I stated that many candidates coming from industry to academia were already interdisciplinary by nature, even if they did not think it themselves. Though they have held a specific role, they also have experienced working with different departments and learned to listen to others who are different from themselves.

Challenges to diversity were rooted less in knowledge and skills, and more in the organisational culture. This seemed particularly true in family businesses where Interviewee E admitted that such strong cultures could hinder innovation. Interviewee H also made the point that organisational cultures are typically directed from the top, thus making it difficult for a new entrant to bring about radical change.

3.7 Personal development and technical development

Interviewee E made the point that personal development and technical development are not the same, with technical development being much more supported by the company through funding for further education. However, Interviewee H described 'professional technical development' as an ongoing activity within their company that consisted of weekly "learning sessions" where employees would share what they had learned recently and get discussions going about how they could contribute to understanding it from a different viewpoint.

Interviewee G explained that monitoring and evaluation was important in their research institute to ensure that the PhD student was complying with ethical standards and regulations as these were not usually taught in academia. These evaluations occur every two months.

Additionally, Interviewee G also mentioned that personal development was key to the organisation, and so researchers were encouraged to be honest about where their strengths lay as well as areas where they may like to improve. Should they wish, the researcher could then request to move to a different position or project better suited to them thus offering flexibility in their work and providing opportunities to build confidence. Such confidence was cited as lacking in many doctoral students by Interviewees G and I.

3.8 Satisfying both sides of University-Industry collaborations

Interviewee I described the biggest challenge to university-industry collaborations as being the mismatched expectations of one another. They explained that companies will try to find "a cheap software engineer". It was important to the doctorate and post-doctorate students and their supervisors that their work be a research project, not a product. Interviewee J echoed this frustration as they explained that a past company had seen their research institute as a service provider rather than a collaborator on equal footing.

4. Proposed solutions

4.1 Toolkit Required

Sixteen modules were identified from the questionnaire in total. Thirteen were identified by young researchers and three by program directors. These courses are described in detail in Deliverable 1.2. Modules identified by early career researchers included: Developing and Managing an Academic Career; Creative Thinking & Innovation; Inclusive Physical Education - Making physical education inclusive and open to all; Python and Django Full Stack Web Developer Bootcamp; Career development for scientists; Opportunities for PhDs in Industry; Languages; Running Injuries; Exploring Intellectual Property; Python for Environmental Science; Programming for non-programmers; and Data Analysis in Systems Medicine. Languages and Running injuries were deemed to be too narrow in their application to be included in our toolkit. Programme Directors identified the following modules: Critical appraisal of the literature; Collaborative Writing; and Interdisciplinary learning through problem-based learning in the Clinical Environment. Again, the clinical module was considered too specific to be included in the state-of-the-art toolkit.

Additionally, students were asked what courses they believe that they should have taken in order to enhance their career opportunities. The students propose three more topics which will be included in the toolkit:

1. Time management/ Mental health during PhD
2. Business related courses
3. Scientific Writing and presentations

Since the aim was to include these modules in the state-of-the-art toolkit, we attempted to track these courses and explore their availability. In some cases, the courses were publicly available. In cases that the courses were not available, we searched for alternate courses from Open platforms, with similar content. Since there are numerous platforms providing online courses, we identified some of the most popular, described in Table 2. For each course we searched for alternative courses in these platforms. In cases that no alternative course was identified in these platforms, we searched in YouTube channels and written guides.

Table 2: Platforms with free Online courses

Platform	Link	Availability
Coursera	https://www.coursera.org/	Free Register
Stanford Online	https://online.stanford.edu/free-courses	Free Register
FutureLearn	https://www.futurelearn.com/courses	Free Register
OpenCourses	https://opencourses.gr	Open
MITOPENCOURSEWARE	https://ocw.mit.edu/#	Open
OpenCulture	https://www.openculture.com/freeonlinecourses	Free Register
IEEEtv	https://ieeetv.ieee.org/	Open
udacity	https://www.udacity.com/	Free Register

We reviewed the results based on the following criteria: (i) content match, (ii) free access, (iii) continuous availability. The results are presented also in Tables 3, 4 & 5 for the three aforementioned categories, along with the structural details of each course and the keywords used for the search.

Table 3: Alternative Courses (1)

Keywords	Course Title	Description	Platform	Type of Activity	Availability
{Academic Career, Developing, Managing}	Career Management for Early Career Academic Researchers	Explore different career options, learn what you want out of a career and understand how to implement good career decisions.	Future Learn	Course (asynchronous lectures)	Free Register
{Creative Thinking, Design Thinking, Innovation}	Mastering the Art of Creative Thinking & Innovation, Part1, Part2	Creative thinking and innovation are vital components in both our personal and professional lives. But boosting your creative and innovative abilities takes training and practice. Recognizing and honing your own creative potential is a process.	YouTube	video/lecture	Open
	Creative Thinking and Innovation		YouTube	video/lecture	Open

	Stanford Webinar - Design Thinking = Method, Not Magic	In this webinar Bill Burnett, consulting assistant professor and master in design thinking at Stanford University, as he shares three barriers organizations face when adopting an innovative culture and how to overcome them.	YouTube	video/lecture	Open
	Stanford Webinar - Apply Design Thinking in Your Work		YouTube	video/lecture	Open
{education, inclusive}	Education for All: Disability, Diversity and Inclusion	Discover ways to make education more inclusive, especially in areas where resources are limited.	Future Learn	Course (asynchronous lectures)	Free Register
	Inclusive Education: Essential Knowledge for Success	Discover what inclusive education really is, explore its benefits and learn to implement it at system, school and classroom level.	Future Learn	Course (asynchronous lectures)	Free Register
	Understanding Diversity and Inclusion	Develop your attitudes, skills and knowledge of cultural diversity so you're able to create inclusive environments.	Future Learn	Course (asynchronous lectures)	Free Register
{Career, Developing, Science}	Academic Career Development | How to Become a Successful Scientist | A Workshop for Students	This is a special episode of Pakistan Speaking. Dr. Rizwan Niazi has invited Dr. Ahmad Rasa Kirmani to share his expert advice with young students and researchers looking to make a future in academia and science.	YouTube	video/lecture	Open
	Building a Scientific Career Development Plan		YouTube	video/lecture	Open
{PhD, industry}	PhD Careers in Industry	Recordings from open Sunday webinars featuring interviews with researchers who successfully transitioned to industry and career experts.	YouTube	Video list /interviews	Open
	Passage2Pro Podcast by Tina Person	PhD: Tips for landing a good job in industry as an academic.	Podcast Hosting platform	Podcast/ lectures	Open
	Turning Science by David M. Giltner	PhD: Advice for PhDs in science and engineering who are searching to design and build rewarding careers in industry.	YouTube	Video list /lectures	Open
{Intellectual Property}	Intellectual Property Law Primer	Tyson Benson, Patent Attorney, Advent IP, discusses intellectual property laws and	IEEEtv	video/lecture	Open

keywords	Course Title	Description	Platform	Type of Activity	Availability
		how for young engineers full of ideas how to protect themselves while trying to enter the business and industrial world.			
{Python, Data Analysis}	Introduction to Data Science in Python	Introduction to Python programming language for environmental data analysis and visualization.	Coursera	Course (asynchronous lectures)	Free Register
{Python, beginners}	Programming for Everybody	This course aims to teach everyone the basics of programming computers using Python. We cover the basics of how one constructs a program from a series of simple instructions in Python. The course has no pre-requisites and avoids all but the simplest mathematics.	Coursera	Course (asynchronous lectures)	Free Register
{network analysis, medicine}	Social Network Analysis	This course is designed to quite literally 'make a science' out of something at the heart of society: social networks.	Coursera	Course (asynchronous lectures)	Free Register
	Network Analysis in Systems Biology	An introduction to data integration and statistical methods used in contemporary Systems Biology, Bioinformatics and Systems Pharmacology research. The course covers methods to process raw data from genome-wide mRNA expression studies (microarrays and RNA-seq) including data normalization, differential expression, clustering, enrichment analysis and network construction.	Coursera	Course (asynchronous lectures)	Free Register

Table 4. Alternative Courses (2)

keywords	Course Title	Description	Platform	Type of Activity	Availability
Clinical research methodology	Improving Healthcare Through Clinical Research	On this free online course, find out how medical treatments are discovered, tested and evaluated to improve healthcare for all.	Future Learn	Course (asynchronous lectures)	Free Register
	Academic Research Methodology for master's Students	Understand the academic research process at master's level	Future Learn	Course (asynchronous lectures)	Free Register

	and build the skills to define research questions for a written project.				
Collaborative Writing	Collaborative Writing- VANDERBUILT UNIVERSITY		Short guide		
	COLLABORATIVE WRITING/ WRITING AN ARTICLE		Short guide		
	COLLABORATIVE WRITING STRATEGIES		Short guide		

Table 5. Proposed Courses

Keywords	Course Title	Description	Platform	Type of activity	Availability
{business, management, risk}	Project Management Principles, Practices and Systems	Grow your project management skills, and understand project management methodologies and challenges.	Future Learn	Course (asynchronous lectures)	Free Register
	Foundations of Project Management	Explore the fundamental aspects of project management and develop your understanding of traditional project lifecycles.	Future Learn	Course (asynchronous lectures)	Free Register
	Fundamentals of Project Planning and Management	Improve your project planning and management skills and learn how to run effective projects at work or in your daily life.	Future Learn	Course (asynchronous lectures)	Free Register
	Decision-making and Risk: An Introduction	Explore big ideas about decision-making and risk and learn about the decision-making process, with this course for professionals.	Future Learn	Course (asynchronous lectures)	Free Register
	Emergency Management: Risk, Incidents and Leadership	An introduction to managing risk and providing leadership during emergency incidents.	Future Learn	Course (asynchronous lectures)	Free Register

{scientific, writing, scientific presentation}	Discovering Science: Science Writing	You'll learn about different types of science writing and look at the factors which you need to consider writing a story.	Future Learn	Course (asynchronous lectures)	Free Register
	Writing your article for paper publication	This IEEE Author Education course is helpful for authors interested in publishing in a journal especially first-time author.	IEEEtv	video/lecture	Open
	Best Practices for Writing Your Article's Title and Abstract	This IEEE Author Education course provides best practices for writing your article's title and abstract. A well-written title and abstract can help your article be more visible and attractive to readers.	IEEEtv	video/lecture	Open
	Writing Your Article for Magazine Publication	his video guides authors on how to publish in an IEEE magazine.	IEEEtv	video/lecture	Open
	What Makes an Effective Presentation?	Explore the key elements of a successful presentation and how to give an effective presentation in a business environment.	Future Learn	Course (asynchronous lectures)	Free Register

4.2 Toolkit Structure

The modules that were identified by the survey and the additional search will be embedded in the state-of-the-art toolkit created by CHAMELEONS project. The toolkit will provide courses aiming to help PhD students to broaden their career opportunities outside academia.

These modules can be divided into 4 categories, based on the knowledge/skills they are providing. Each one of these categories can be considered as a section that can be followed by students, depending on their needs. Each module contains a variety of choices, including courses, informative videos or guidelines. The four categories and the respective modules (depicted in Figure 1) are:

1. Research and Writing Skills:
   a. Research methodology
   b. Collaborative writing
   c. Scientific Writing & Presentation
2. Career management:
   a. Developing and Managing an Academic Career
   b. Creative Thinking & Innovation
   c. Career development for scientists
   d. Opportunities for PhDs in Industry
   e. Time management in PhD Studies
3. Programming and Data Analysis
   a. Programming for non-programmers
   b. Data analysis python
   c. Web development with python
   d. Network Analysis
4. Business
   a. Exploring Intellectual Property
   b. Project Management
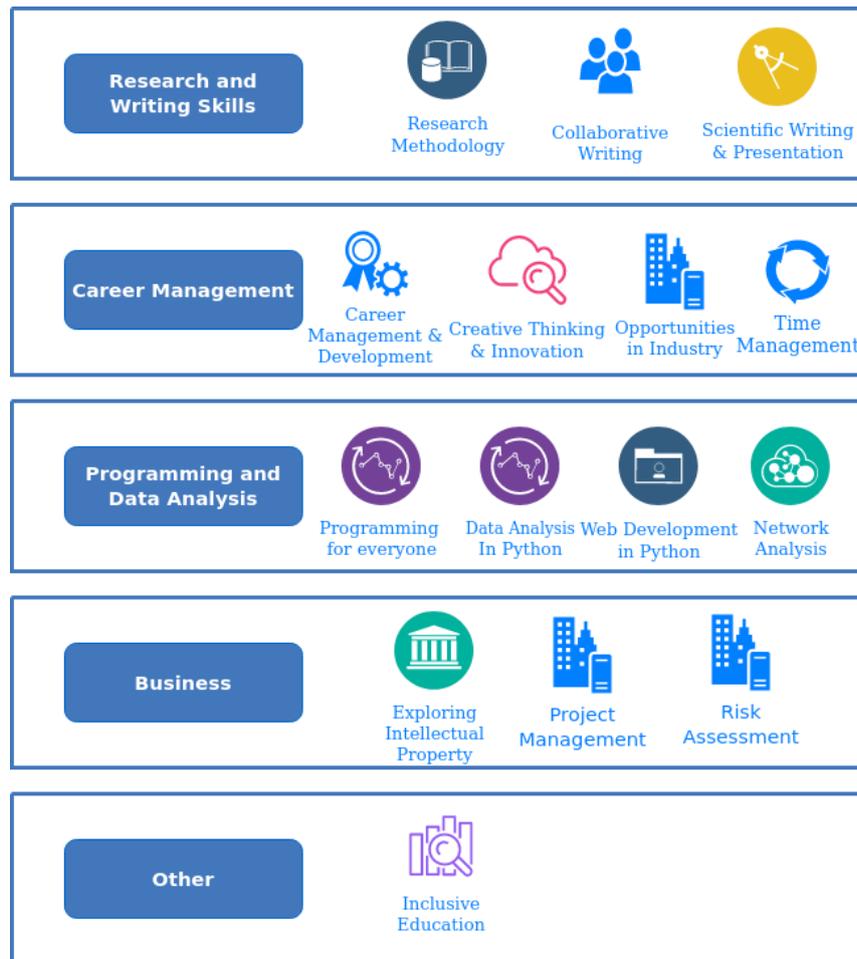   c. Risk Assessment
5. Other
   a. Inclusive education

Figure 1. State-of-the-art toolkit Modules

5. Conclusion

In the words of Interviewee B, "there is no ideal worker". However, our findings suggest the following can be said across the board of our interviewee base.

- Traits such as confidence, determination and resilience are important skills to be trained.
- Doctoral and post-doctoral candidates typically lack the skills identified above.
- It is important to fit into the organisation on a personal level as well as a technical level.
- Personalities must fit the job role. Perceptions of doctoral and post-doctoral education leads to customer-based roles being dismissed as potential jobs.
- Size of the organisation can affect the type of work expected by candidates, with small organisations preferring well-roundedness while large organisations assign doctoral and post-doctoral candidates to 'the back' in technical roles.
- Interdisciplinarity is another form of diversity for the organisation.
- Organisation cultures are difficult to change and can hinder innovation if too rigid.
- Internships and professional experience are valuable assets on a CV.
- Learning is an ongoing process, with technical development more frequently focused on and financially supported in industry.
- However, personal development of soft skills is crucial to securing a job and is often left to the individual to figure out for themselves – something that is often not encouraged through doctorate or post-doctorate education.

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- There must be better communication and expectations set between academia and industry when entering partnerships, to avoid unequal treatment and manage students' motivation.

The state of the art toolkit and associated modules proposed here (and rolled out within the CHAMELEONS modules and wider programme) aim to address these common goals with a particular emphasis on interdisciplinarity, soft skills, personal and professional development, and value alignment. While we under no illusion that we can create "the perfect worker" we hope to equip students to identify, pursue, and attain roles that more closely align to their values, skills and goals.