MISSENDEN CENTRE

Alex aims for a star

Dear John,

*Thanks for showing your interest in my PhD story at last week's workshop. I hope my experience can help other PhD students and inspire them to follow their dreams and passions in research even when they face challenges and discouragement.*

Straight after my undergraduate study, I worked in the steel industry for three years, from a graduate trainee position to a New Product Development Project Manager, leading a team of 10 – 12 across various UK production facilities. I continued to seek opportunities that allowed me to gain hands-on experience, to travel across the world and share what I do. But, most importantly, I had always wanted to work with cutting-edge manufacturing technologies.

Throughout my industrial work experience, my former personal tutor from my undergraduate degree offered me three different PhD positions, but I declined all the offers. Until one day, I received a job advertisement from him regarding a Postdoctoral Research Associate position in the field of Advanced Manufacturing and I was intrigued about it. The job position was part of a very large research consortium (involved 26 industrial partners), it provided many opportunities to visit different industries and to learn about various cutting-edge manufacturing technologies which fitted well with my personal interest. Though, as part of the selection criteria, the job required a PhD, I did not have one at the time.

Nonetheless, I got the job in 2013 and began my academic journey as a research associate in my former supervisor's lab. Whilst I was working as a research associate, I formulated 6 potential PhD topics and discussed them with my two supervisors to decide which one was most original.
In the end, I selected one of the most difficult topics – "X-ray imaging of powder consolidation during laser additive manufacturing".

It was a real risk, because:

1. my PhD would require the development of a laser-based additive manufacturing machine that has to be portable and easily installed in any synchrotron radiation facilities in the world
2. no one in the group has a powder or laser safety background
3. the machine I intended to build required stringent safety requirements that can be used in different facilities

4. the imaging requirement was unprecedented at the UK synchrotron light source
5. and, although my supervisors are world-renown experts in many different areas, including X-rays, materials science, and engineering, neither of them has a background in the development of a laser-based instrument.

So, to cut the long story short, I took on the challenge and began my PhD in 2014. I laid down the groundwork from powder to laser safety, implemented appropriate systems in the lab, led numerous safety discussions with multiple organisations to ensure everything complied with the Health, Safety and the Environment regulation.

## First-year transfer (2015): a setback

However, in my first-year transfer, the feedback from my main supervisor was, though very supportive, that I had less than 50% chance of success. But he did say "If you aim for the stars, you will always land somewhere beyond others' expectations".

My co-supervisor also thought the project was very risky and suggested that I should not put all my eggs in one basket, otherwise I would end up having nothing to write up.

My internal assessor questioned my research contribution to the field of materials science. He believed that my work was more towards engineering than materials science.

I appreciated their feedback but convinced them that I wished to pursue my PhD as it was. I demonstrated to my assessors why my PhD could fill the research gap in the field, explained the conceptual design of my custom-built instrument, and convinced them that my PhD topic was original.

In the second year of my PhD, I completed the design of the instrument whilst still working full-time as a research associate. However, I hit two major barriers in my PhD project: getting hold of a laser system and finding a safe working area to perform experiments.

I rang up several different institutions, companies, and professors in the nearby area to convince them about my research, hoping that they would lend me the required instrument/facility. Unfortunately, without success.

As a backup plan, I developed a rapid heating system - two-thousandth of the cost of a laser system - and successfully performed some experiments at the synchrotron facility. I used these preliminary data to develop new algorithms for data analysis. This

confirmed the feasibility of the imaging requirement for my final experiment and helped me to develop a data analysis pipeline.
I used these preliminary results to persuade a group leader from a government-led laser facility to mentor my work, to lend me a spare laser system and a laser safety room to perform such experiments.

## Second-year review (2016): more discouragement

During my second-year viva, my main supervisor said the same as the year before, and the co-supervisor expressed his concerns that I would not have enough results to finish my PhD. He advised me to wrap up my work generated from my research associate position to ensure I obtained a PhD.

Once again, my determination and perseverance helped me to convince them to allow me to continue.

The week after my viva, I presented the same work in a poster format at the annual postgraduate student conference organised by the School of Materials. Amongst 60 students across 8 different categories, I won the best poster award in the "Corrosion, Metals and Nuclear" category and the overall poster. The work was judged by other academic staff in the School and industrial experts. This feedback really strengthened my belief and motivated me to continue my PhD research.

## Third-year (2016 - 2017)

At the beginning of my third year, I was grateful to have a laser room available - but the spare laser system that I had borrowed was out of order. After exhaustive searching, I managed to find a local company to lend me a laser system. With financial support from my main supervisor, who covered the rental cost of the laser system and development cost of the instrument, and additional help from the laser group leader and a friend, we successfully developed and implemented the instrument into a synchrotron facility.

With my enthusiasm, I managed to convince a few other colleagues who were in the field of geology, physics, engineering, and materials science to support me in this campaign of experiments. They went incredibility well and captured new phenomena to explain the fundamental of the additive manufacturing process.

In early 2017, I presented this work in a leading materials conference and received great feedback from five US national laboratories. At that time, there were only two abstracts on this topic at the conference, including mine.

## Write-up period (2017)

In Dec 2017, I submitted my thesis whilst still working full time. I passed my PhD with minor corrections in Feb 2018. My thesis: X-ray imaging of powder consolidation during laser additive manufacturing led me to win the Sir Richard Brook prize - the Best Engineering PhD in the UK and the best thesis award by the European Powder Metallurgy Association.

While working on my PhD, I had also assisted many postdoctoral research associates and students in the development, commission, and application of custom-built laboratory equipment and participated in about two public engagement events per annum.

## After completion of the PhD (2018)

In June 2018, 4 months after I completed my doctorate, I became a group leader in additive manufacturing division within the same lab I did that PhD, providing day-to-day supervision of research fellows and PhD students, covering duties, including as a laser responsible officer, giving advice on experimental and instrumental design, report and proposal writing, providing health and safety advice.

With support from my supervisors, now converted to my approach, my research outcome has led to publications in top-quartile ranking (Q1) journals and related to "Materials", "Manufacturing", and "Engineering" topics, including Nature Communications.

It has contributed to a £10M UK EPSRC research grant, a £2.6M Royal Academy of Engineering Award, 4 commercial engineering projects, 5 individual awards, and 36 conference presentations, including 7 invited, 2 keynotes, and 1 planetary talk. I have been awarded 26 large facility experiments (equivalent to £1.9M) either as a principal investigator or a co-investigator.

My PhD work has also been highlighted by the Synchrotron Light Source Annual Review 2018 and mentioned in various online platforms. To date, there are over 20 publications related to my research topic, in addition, the leading materials conference is organising a dedicated symposium in 2020 on the topic related to my research area.

In Oct 2019, five years after starting my PhD, I was appointed Lecturer in Imaging of Advanced Materials and Manufacturing at University College London.

So I aimed for a star, and hit it. You can do the same...

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