



Scientific Exploration Society: Arclight Tandem Africa report.

Summary

Arclight Tandem Africa was an eight-month expedition, undertaken by two University of St Andrews students. The project had the joint aims of cycling the length of the continent of Africa by tandem bicycle and delivering the Arclight, an innovative medical device pioneered by the university.

It was in St Andrews that Alex and Merlin met, both sharing a love for running and the outdoors. When a group of friends gave Alex an old second-hand tandem for his birthday, he and Merlin could not help but look beyond the roads of Fife.

80% of blindness and 50% of deafness is avoidable, meaning that it can be prevented or treated by cost-effective means. In Africa 1 in 100 people are blind, for many this is needless and could have been stopped. The World Health Organisation (WHO) and International Agency for the Prevention of Blindness (IAPB) developed Vision 2020 to eradicate preventable blindness by 2020. Key aims of this programme were the development of resource appropriate technology and human resource development. The University of St Andrews had pioneered the development of the Arclight. The Arclight is a pocket-sized instrument that can be used to screen for and diagnose the main causes of blindness found in low-income countries including cataract, trachoma, glaucoma and diabetic retinopathy. It can also be used to look for infection and disease within the ear. The Arclight was designed specifically for the needs of low income countries, it doesn't need replacement parts, it is robust, easy to use, solar powered and affordable. The complexity and cost of traditional ophthalmoscopes has been seen as a barrier in training and equipping the eye-care workforce in much of Africa. The Arclight showed promise to empower eye-care workers to be able to do more for their patients, we wanted to get involved with the training and distribution of the device.

The route from Cairo to Cape Town holds a place of prestige in the cycling world and passes through parts of the African continent where there is a great need for technology such as the Arclight. The project paired these two elements in a way that allowed us to deliver the Arclight and raise awareness of the device and the burden of preventable blindness and

deafness. A range of partners were brought on board and provided a great deal of help in putting the project together. We worked closely with the IAPB to develop a plan for setting up training events in the countries that we travelled through. We presented the project to the ministry of health in each of these countries, and then worked with the leaders and teaching staff of institutions to plan the sessions. The project focused on training medical and optometry students, allowing for training to take place at an institution without having to bring students in from far-a-field and increasing the outreach of the Arclight.

The journey took us over 11,000km by three means of transport. During that time, we were able to train almost 1000 people with the Arclight in ten countries. The project raised £24,000 through donations, which were used to fund Arclights and some of the costs associated with the expedition. We are continuing to send Arclights to institutions in the months following the trip, and aim to distribute 2000 devices in total.

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In Kenya we were welcomed in to the home of Tonya and Nigel Shaw, for some much needed respite. Helen Roberts was an inspirational woman who allowed us to be involved in the Kwale Eye Centre, which she has set up on the Kenyan coast. As well as spending time on the coast with Helen and her family, they invited us to the lodge managed by her husband, Ian, for Christmas. This was a truly wonderful experience that we will not forget.

For a period of almost a month we became part of the Leike family in Arusha, Tanzania. We will forever be grateful to Manfred and Maria, Sophie-Dorothe, Anna-Catharina and Pluto, who helped us to get back on our feet when we had to make changes to our plan. Together with their friends and neighbours, they were able to see us on the road again with a new method of transport and an incredible adventure ahead. The Arclight training at KCMC hospital, Moshi, surpassed all expectation and was made possible by Dr Furahinini, Dr Heiko, Dr William Howlett and Dr Marieke Dekker. Dr William Howlett also mentored Merlin and organised for him to spend three weeks as a student at KCMC hospital. When crossing the Maasai Steppe on foot, we relied on the friendship of Yohanna and Noah, two Maasai Warriors who showed great resilience and kindness in our journey together. Following this we met with Brian and Angela Savage, who showed us great hospitality in Mvumi Village, southern Tanzania. While Merlin was at KCMC hospital in the north, Alex spent three weeks with the Savages, and Gill and Andrew Barclay. They assisted greatly in his research into community-based forest management, which will become his undergraduate dissertation. Emmanuel Chidong'oi was also extremely helpful in this project. Dr Bernadetha Shilio received Arclights on behalf of the Ministry of Health in Tanzania.

In Malawi we were greeted by Dr Andrew Blaikie and Ian Gordan, who brought the Eliptigo bicycles to Mzuzu. They spent a week with us, assisting with Arlight trainings and capturing footage for a film. Isabelle Shaefers was a good friend at Nkoma Mission Hospital, and facilitated a brilliant training session.

It was in Malawi that we met Tomás Mac An T-Saoir, who joined us for two months of the journey on his bicycle, and was a truly fantastic friend throughout.

The energetic Dr Muma, and his staff, ensured a line-up of Arlight trainings in Eastern Zambia over a number of days as we travelled through. In Lusaka we were welcomed in to the home of Deputy British High Commissioner, Andy Hamilton, and his family. Their kindness during our stay was phenomenal, and we are also grateful to the Irish Ambassador for a fantastic celebration of St Patrick's Day. Arlight trainings in Lusaka were arranged thanks to Elfreda Whitty, and UTH and Beit Cure Hospital. In western Zambia we were welcomed by Brighton Samoyo and Dr Yanjean at Zimba Eye Hospital. We ran a short Arlight training with the staff here.

Trainings in Namibia would not have been possible without the help of Dr Ndume and Dr Sydney. Likewise, in South Africa it was Dr Will Dean who organised a training event at the University of Cape Town. In South Africa we are also incredibly thankful to Burre Burger and Alan Fleming for taking such great care of us in the last stage of our journey.

We would also like to express our gratitude and appreciation for the wonderful welcome and friendliness we received from people throughout these countries. The overwhelming majority of the time we felt very safe. People's enthusiasm for our cycle and for the Arlight device was always a morale boost.

Personal Reflections

I feel overwhelmingly grateful to everyone who helped us through this process. Whilst Alex and I worked tirelessly organising the trip before our departure and endured the demands of cycling across a continent to simultaneously carry out medical training, what we achieved could not have been realised without the widespread support we had and hard work of so many people:

- Generous financial contributions made the trip possible;
- The Arlight device itself is the real marvel to this project, the brainchild of William J Williams – itself also the product of collaborative support from Fred Hollows Foundation, the University of St Andrews and many others;
- The hospitals and teaching institutions where we trained people, existent thanks to the dedicated work and contribution of hundreds of people over many years;
- The knowledge and advice garnered from those who had travelled a similar path;

What was achieved through this project may appear like it is our achievement, perhaps because we undertook the cycling challenge. However, the accomplishment is collective, and the success should be shared with the individuals and institutions that have been supporting

eye-care in Africa for many years; with the staff who assisted us with the project planning and the SES and University of St Andrews. Perhaps we even have to give some credit to the Chinese road builders, for without their roads we may not have got there.

It is present in our minds that progress may appear to advance in leaps and bounds, but really it is the product of small contributions in the right direction by lots of people – like termites building a termite mound. Or like molecules of water shaping a rock in the bend of a river. We hope that in a similar way, the efforts of this project help nudge eye care in Africa in the right direction, benefitting patients and practitioners.

The journey bore us witness to the extraction, exploitation and disregard of the planet on a scale that at times felt overwhelming. 'Sumed' petroleum pipes near the red sea; generator towns in Sudan surrounded by plastic and prospecting for gold; food insecurity and overpopulation – much of which is driven by industry and demands from us in the West. One alarming situation was insidious deforestation for small scale charcoal production (people's primary fuel source). This reportedly had visible changes to the landscapes and increased susceptibility to extreme flooding. In Namibia (and elsewhere) this deforestation was being blamed for altering the transpiration effect across Eastern and Southern Africa, causing the seven-year long drought they are enduring. Whilst carbon dioxide and plastic are important things we need to address in our society, there needs to be a fundamental change in the way we humans interact with the planet. How we do this and what this means is still cause for much rumination. The changes to economy and lifestyle, could and perhaps should, be drastic.

There was reason for positivity as well. Numerous National Parks in Eastern and Southern Africa, as well as bringing more sustainable income through tourism, seemed to be playing a part in changing peoples' attitudes toward the natural world. There was awareness and conversation about climate change and deforestation. Similar to the situation in more affluent countries, no one wants to make sacrifices to the way they live, and it seems the choice to make those sacrifices is more often a luxury of the more affluent. Kenya had made good progress with strict bans on plastic bags – governments should follow this approach of top-down behaviour change to limit the ecological and climate catastrophe facing the world.

On the one hand I feel like rejecting for the current economic system which is wrecking the planet, wishing to see an alternative system, one of subsistence and coexistence with the environment. However, economic growth in Africa seemed to be providing a quick route to development and shouldn't be so quickly dismissed. Undoubtedly, capitalism is a great incentiviser and, if applied correctly, could provide a fast route to improving health service and sustainable development. That said, the risk of monetising healthcare in such a way that it creates a two-tier system or doesn't have universal coverage should be not be overlooked. Through the trip I have strengthened my interest in health service provision and public health. Global population is increasing and there is a huge need for medical staff, especially in less economically developed regions.

In the future, I would like to dedicate a portion of my time to teaching and sharing skills in low-income settings. Service provision from a national perspective is also important: in Tanzania doctor employment rate was reportedly 60%; on the Masai Steppe cost of travel meant patients were unable to follow through with referrals and in many nations inadequate or frozen pay meant staff were lost abroad or to the private sector. Healthcare needs to be driven by a

holistic approach, both for the patient and for the country. For example, there is little logic in establishing specialist trauma units when most of the trauma comes from road accidents when road safety is dismal.

With the limited time we were able to spend at each health site, it was hard to accurately or fairly gauge the quality of education or service provision. However, what we saw generally seemed positive, with most facilities expanding and aiming to take on more staff or students. Eye health in Africa has been improving and that is thanks to the VISION2020 initiative and the hard work of governments and NGOs. In places, the infrastructure does appear fragile, where government has reduced funds services have collapsed, or when a specialist member of staff leaves the whole operation shuts down. How to build resilience to these changes is complicated, training and remunerating staff appropriately is important. Whilst things are good there is a lot of work to be done. Coverage is often only in cities; is not affordable; not available or does not have adequate follow-up. To boast comprehensive eye-care systems as seen in the UK, there is a long journey along this continued trend of progress.

For all areas of health service delivery, it is important to anticipate the increase due to expanding and ageing populations. Eye-care services in particular will see an increased demand as people start living longer and are more likely to develop cataract and glaucoma. More alarming though, is the rise in lifestyle diseases we more naturally associate with affluent western lifestyle; diabetes is set to be a huge public health problem in much of Africa. Up to 50% of diabetics (in the US that is, as statistics in Africa are limited) have some sort of retinopathy (damage to the retina of the eye) and that's in country that has good diabetic control. In much of Africa diabetes is poorly managed and the effect that its increase will have on the burden of diabetic eye disease is going to be colossal.

Hours at a time spent on the bike were beautiful opportunities for contemplation. Some days felt like a long struggle with no end in sight, others were some of the most elated days of my life. In most ways we lived a simple life, living cheaply and grubby on the side of the road; bed was often just a hard bit of desert ground; dinner some plain pasta. But these were also some of the best moments and its strange to think that for other people they could have been hell. Instead of choosing what we want in life, we should concentrate on the struggles we want – what challenges do we want to endure? The challenge of this expedition was one I enjoyed enduring.

Expedition purpose, route and logistics

Purpose

The World Health Organisation (WHO) teamed up with the International Agency for the Prevention of Blindness (IAPB) to develop a set of goals under the 'Vision 2020' agenda. The aim was to eradicate preventable blindness by the year 2020. Globally about 220 million people have significant visual impairment or are blind. However, 80% of blindness and 50% of deafness is avoidable in that it can be prevented or treated by cost-effective means. According to the inverse-care law, the greatest burden of disease is often found where there is the least access to the resources that can be used to prevent and treat it. A significant proportion of eye disease can therefore be found in sub-Saharan Africa, India and south-east Asia. It is here where there are less health workers and less access to equipment.

The Vision 2020 goals set aims within three categories: (1) Control strategies for the main causes of blindness; (2) Develop human resources; (3) Develop infrastructure and appropriate technology. This project was designed with the latter two points in mind. We aimed training at medical students and optometry students who will become the next generation of eye care workers, and where the Arclight can be incorporated in their training. The Arclight is also specifically designed to meet the needs of people working in low-income countries, as outlined below.

The Arclight was invented by William J Williams and developed through the University of St Andrews Global Health Team. It is a pocket-sized instrument that can be used to diagnose the main causes of blindness found in low-income countries including cataract, trachoma, glaucoma and diabetic retinopathy. It can also be used to look into the ear and examine the ear canal and ear drum to look for and diagnose infections and diseases of the ear. The device is small, robust and light-weight making it ideal for use in rural areas and community outreach. A slim rechargeable lithium battery linked to an integrated solar panel powers the long-lasting LED illumination, removing the need for expensive and hard to find consumables. Clinical trials have shown the Arclight to be just as effective but easier to use than more expensive traditional ophthalmoscopes. It is also possible to attach the device to a mobile phone camera offering the potential to develop and strengthen telemedicine initiatives.

Route

The route from Cairo to Cape Town holds a place of prestige in the cycling world and passes through parts of the African continent where there is a great need for technology such as the Arclight. The project paired these two elements in a way that allowed us to deliver the Arclight and raise awareness of the device and the burden of preventable blindness and deafness. These aims were achieved through extensive coverage in press and social media, but most importantly by interacting with key players in the world of eye care who have since become familiar with and supportive of the Arclight.

Logistics - Cycling

When it came to cycling the length of Africa, world-record holder Mark Beaumont was a good friend and provided us with great help and advice. We discussed the route with him and some of the difficult aspects of logistics. For most of the countries we aimed to travel through, visas could be obtained at borders. However, getting a visa for Sudan was a tricky process that had to be done in advance. With a great deal of help from Jonathan Lamont and his friends in Sudan, we were able to get a letter of invitation which we took to the Sudanese Embassy in London for approval. We aimed to cycle an average of 150km per day and went through a training programme put together by Saints Sport to prepare for this. Equipment on the bike included a tent, multifuel stove and fuel bottle, first aid and trauma kit, sleeping bags and mats, bicycle repair and maintenance kit, clothes plus food and water carrying capacity. We also carried water filters and chlorine-dioxide tablets as backup. Our plan for food was to rely primarily on what was available at roadside and in small towns, taking provisions through less populated areas.

Logistics - Arclight

The greatest logistical challenge was in organising the Arclight training events. To begin, we worked with Dr Andrew Blaikie and Ronnie Graham (International Agency for the Prevention of Blindness) to develop a strategy. Through the IAPB, we were able to get in touch with officials in the Ministry of Health for each country. We presented the idea to officials and they put us in contact with their colleagues at their desired training event locations. They also connected us to collaborators at each institution with whom we then worked to plan the events. In some cases, this was done through NGOs such as Vision Aid Overseas and Christian Blind Mission. We had the opportunity to travel to Addis Abeba, Ethiopia before the start of the trip this allowed us to present the project to many of the key players that we hoped to work with at the congress of the College of Ophthalmology for Eastern, Central and Southern Africa. This allowed us to make firmer plans and increase the reach of the project and the Arclight. Arclight devices were delivered from the UK in batches by friends, family, or collaborators in each country, and we carried up to 200 at any one time on the bike.

Training sessions were designed to be able to train up to 30 people in 1-2 hours depending on their level of prior knowledge and skill. Group sizes were expected to be smaller in more remote institutions, in larger training sites where there were more than 100 participants the aim was to break these down into 3 groups, running training consecutively through the day. Facilities at training events would vary, and the whole programme was designed to be deliverable without a projector. We carried simulation eyes and posters to display pathology, practice with a partner is the best way to develop skill.

Itinerary

29-30 Aug	COECSA Congress, Addis Ababa
17-18 Sep	Personal Security and First Aid training, London
2 Oct	Press Conference, St Andrews
3 Oct	Fly Cairo
-9th	Arclight training at Ophthalmology Institute of Cairo Arclight training at University of Cairo
10 Oct	Begin Cycle
18 Oct	Arclight training at Luxor General Hospital
22 Oct	Enter Sudan
2 Nov	Arclight training Al Neelian University, Khartoum
8 Nov	Enter Ethiopia
12 Nov	Arclight training in Gondar University
27 Nov	Arclight training in Minilik II Hospital, Addis Ababa
1 Dec	Arclight training in Awassa University
4 Dec	Enter Kenya
12 Dec	Arrive Nairobi Arclight training at Kwale Eye Centre, Diani
24 Dec	Christmas at Lions Bluff with Helen Roberts' family
28 Dec	Arrive Tanzania
1 Jan	Break with family
16 Jan	Arclight training KCMC Moshi
24 Jan	Begin walk across Masai Steppe

- 3 Feb Arclight training in Ndedo Dispensary
- 6 Feb Arclight training in Kibaya District Hospital
- 8 Feb Arrive Dodoma
- 27 Feb Enter Malawi
- 6 Mar Dr Andrew Blaikie and Ian Gordon arrive for Arclight trainings and filming
- 7 Mar Arclight training Mzuzu Hospital
- 11 Mar Arclight training Nkoma Mission Hospital
- 12 Mar Arrive Lilongwe, Andrew and Ian leave
- 15 Mar Enter Zambia
- 15 Mar Arclight training Chipata District Hospital
- 16 Mar Arclight training Kitete
- 21 Mar Arrive in Lusaka
- 22 Mar Arclight trainings at Beit Cure Hospital and UTH
- 28 Mar Arclight training at Simba Eye Centre, Western Zambia
- 29 Mar Arrive Livingstone
- 3 Apr Enter Botswana
- 15 Apr Enter Namibia
- 18 Apr Arrive Windhoek
- 29 Apr Arclight training Keetmanshoop Hospital
- 2 May Enter South Africa
- 15 May Arrive Cape Town
- 16 May Arclight training at University of Cape Town
- 23 May Fly Edinburgh

Partner institutions along the route:





Team

The expedition team was Merlin Hetherington and Alex McMaster, both students at the university of St Andrews.

Having had an itinerant upbringing between Ireland, England and Spain, Merlin has grown up with a fondness and adaptability for travel. Utilising his Spanish his first expeditions took him to South America and the Andes. Here he was confronted with the inequalities of the world we live in and the lack simple of healthcare provision. His pursuit of medicine will always be influenced by a desire to improve the lives of many and eliminate the unnecessary suffering in the world.

Alex grew up on the west coast of Ireland where the sea, mountains and forests cultivated his love for the wild. He was eager to explore and learn about the world around him and spent many childhood summers sailing a little wooden boat around the many bays and islands of Donegal. Alex took to the high seas for his first expeditions, crewing on racing yachts and longer-distance passages. He spent a year in New Zealand and Australia, building up experience that would later take him on one of the world's most notorious ocean races, and a six-week expedition to the Arctic. Whether wandering around his own patch or taking to more distant places, a desire to learn more about the natural world and our own place in it led him to St Andrews to study for a joint degree in Biology and Geography. Through his university studies, he has gained an insight to the intricately linked human and natural systems, if a division between them exists. Taking on this project has allowed him to better understand systems of society and development, through working closely with healthcare and interacting with people from all walks of life on the journey through Africa. This has encouraged him to pursue topics in his studies that provide more holistic approaches to the socio-ecological system.

It was in St Andrews that the pair met, both sharing a love for running and the outdoors. When a group of friends gave Alex an old second-hand tandem for his birthday, he and Merlin could not help but look beyond the winding roads of Fife. Taking the old relic across the Spanish Pyrenees planted a seed that would later become part of a great idea.

Motivated by the joy that is vision; the anguish that its loss must bring and the injustice that millions of people need not suffer this anguish if they had access to relatively simple eye-care resources Merlin and Alex teamed up with consultant ophthalmologist Andrew Blaikie. Andrew helped pioneer the development of the Arclight in 2015 and dedicates a lot of time to increasing its deployment in low-income settings around the world. Merlin worked with Andrew on Arclight training materials for his dissertation as momentum grew behind a project to distribute and train people in the use of the Arclight. Using a bike as the means of transport appealed on many levels, rationally it was cheaper and carbon neutral, but it also brought with it the promise of a challenging adventure and a way to bring attention to the cause. Merlin graduated St Andrews in 2018 and will complete his full medical degree at St Bartholomew's and the Royal London Medical School in 2021.

Both Merlin's and Alex's roles in the trip have been collaborative and responsibilities collectivised. The answer to the common question – 'who goes in front on the tandem?' – is that they share it, and so it has been for most of the expedition's tasks; delegating and dividing jobs between the two of them or working on them together. On reflection they would say their differences complemented each other. Alex the early bird would ensure that days got off to a productive start later to flag and tire; Merlin would then have high energy to plough on and finish off the day. Consideration of many aspects and attention to detail from Merlin complemented Alex's drive for immediate action.

Project aims and methods

Aim: Train and equip 2000 healthcare workers with an Arclight.

On consultation with Ronnie Graham (IAPB), we decided to set the ambitious aim of training 2000 health care students or professionals. His calculations estimated that this would be close to 10% of the eye-care work force in the countries we were working with. One primary aim was to equip students and professionals with an Arclight and the skills needed to operate one, allowing them to provide a higher standard of care to their patients, using what was previously unavailable or access limited equipment.

Method: As detailed previously (see logistics) we initially made contact with National Eye Care Coordinators (NECCs), requesting their permission and advice as to where Arclights would be most beneficial for their national eye care plans. This would guide where we would carry out training, they would be able to assist us with contacts in each institution and provide any necessary permissions or import papers. In practice this was successful to a varying degree depending and in each country we had to somewhat vary our approach. Mission hospitals and eye care NGOs were particularly helping in setting up training sessions with relevant people. The ability to try a mixed approach, stay determined and resourceful was paramount. Organisation like this can take a while and this process commenced more than 5 months before departure.

Training sessions were conducted in two main parts. The first was an introduction to the Arlight that was conducted by ourselves, and instruction on how to use it. Time would be taken for people to practice using the device, and in larger groups the older students or staff would be able to assist younger students with familiarising themselves with the device. The second section would sometimes be led by us, but preferably by a local expert who could give context-specific training. This would focus on the application of the Arlight in terms of the diseases that would be most common to come across, and recognising these for diagnosis. The second practical aspect of the training would involve the use of simulation eyes. These small plastic pieces of equipment are a product by Arlight that is cheap and easy to construct and use. They provide a cost-effective alternative to traditional electronic training eyes and we were able to carry a set with us on the bike.

At the end of the session, we would take questions and collect contact details from participants. We encouraged participants to follow the journey on social media.

- Introduction, who we are, who the class is, skill level, experience
- Discussion of Vision 2020 and role of Arlight

- Demonstration of **anterior segment** examination and discussion of findings
- “Give it a go” with a partner, supervision and technique adjustment
- Input from facilitator - extra information or context specific knowledge

- Demonstration of **red reflex** examination and discussion of findings
- “Give it a go” with a partner, supervision and technique adjustment
- Input from facilitator - extra information or context specific knowledge

- Demonstration of **posterior segment** examination and discussion of findings
- “Give it a go” with a partner, supervision and technique adjustment
- Input from facilitator - extra information or context specific knowledge

- Demonstration of **otoscope** examination
- “Give it a go” with a partner, supervision and technique adjustment
- Input from facilitator - extra information or context specific knowledge

- Local expert, context specific teaching
- Use posters to review all areas, discuss and answer questions
- Use Arlight simulation eyes to run a mock test of identifying pathologies
- Review of main points

- Contact details, feedback, photo

Aim: Gather feedback.

Gathering feedback on uptake of devices, usage and appropriateness to low-resources setting. Not only is this valuable appraisal but can also inform future projects, health programs and equipment procurement decisions for other organisations. Secondly we aimed to establish contacts both in education centres and in hospitals who could operate as Arclight Ambassadors. Ambassadors would be mediators between the Arclight Social Enterprise and end users in their institutions with responsibilities including procurement of additional resources and replacements; advocacy for uptake of the Arclight device; facilitating or providing Arclight training.

Method: Contact details were collected for each participant on a small laptop or on paper. Direct links were created between partner institutions and the Arclight board at the University of St Andrews. Feedback will be gathered from participants through online surveys once sufficient time has elapsed, including questions on usage, perceived usefulness and training. This will allow improvements to be made to the Arclight itself and future training programmes or distribution efforts. It will also hopefully provide data that gives greater authority to adoption of the Arclight.

Aim: Raise profile of the Arclight.

Another primary aim was to raise the profile of the Arclight. We wanted to make more people aware of the existence of the device, what its applicability was, where it could be used and therefore contribute to increasing uptake and usage of the device. By virtue of its widespread applicability this meant potential users were health professionals and students in the UK and other affluent countries as well as health professionals and students in the economic south. Sales in affluent countries subsidises provision of devices in low income countries.

Method: Social media was our main information outlet, and we had a considerable following on Facebook, Instagram and twitter. Content included photographs and updates on the journey and Arclight trainings. Film footage was gathered that is currently being used to create a number of short films on the journey. These include a film on the Arclight trainings, the journey by bicycle, and the walk across the Maasai Steppe. Our hope is that the latter two can be shown at adventure film festivals, while the first can be used to promote the Arclight and Eye care through appropriate distribution. The University of St Andrews press office offered to help and we planned to run three major press releases, before, during and after the expedition.

Aim: Cycling from Cairo to Cape Town.

Method: This is outlined in previous sections, although the mode of transportation was altered half-way through, the journey was still completed under our "own stream".

Results

Aim: Train and equip 2000 healthcare workers with an Arclight.

Arclight trainings were carried out at 23 institutions in 9 different countries. Almost 1000 students were trained and 1200 devices were provided. We are close to reaching the target of distributing over 2000 devices, through sending additional Arclights to institutions who wish

to carry out further training initiatives. This process will continue as further funds arrive from the SaintsFunder page.

The total funds raised through the SaintsFunder currently sits at £24,572. This money has been used to fund the provision of Arclights as well as additional project costs (<https://saintsfunder.st-andrews.ac.uk/p/Arclight-Marathon/>).



Aim: Gather feedback.

This process is still ongoing and will involve delivery of a questionnaire to recipients of an Arclight.

Aim: Raise profile of the Arclight.

The University of St Andrews press office was utilised to gain attention in national and international press. This included radio interviews with the BBC; television appearances on STV; and articles in national newspapers and magazines. An article was published by the Royal Scottish Geographical Society.

Before our departure, we held speaking events at the University of St Andrews and King Edward School, Bath.

Upon our return, we gave a public lecture at University of St Andrews, as well as a main stage talk at the Royal Geographical Society Explore conference. Merlin has spoken at the Royal College of Ophthalmology, while Alex has spoken to Rotary Clubs in St Andrews.

Aim: Cycling from Cairo to Cape Town.

Undoubtedly this was an ambitious aim on and a tandem and as expected, required wit perseverance and some luck to get us to Cape Town. Our main obstacle was in Tanzania when we decided that nerve compression from many hours on the saddle warranted serious concern and alternative saddle-free transport would be preferable. From Arusha 350km of the Masai Steppe wasn't covered on foot, following that we continued on Elliptigos from Malawi until Cape Town.



Discussion

We were met by a large number of difficulties that made aspects of the project difficult to complete according to the aims. However in most cases perseverance saw us eventually reach success. While we set out to train 2000 people with the Arlight, the practicality of this while delivering meaningful and useful training proved a difficult task for two people. Knowing how much work was required to achieve what we did, and the thoroughness with which we carried out the training events, we are very pleased to have achieved what we did. As we continue to work with institutions to provide additional devices we are growing closer to the target of 2000 devices. The recipients of these devices can now be trained by the collaborators in each institution. For instance, we have just sent additional devices to Khartoum for the next year group of optometrists to be trained with.

The funds raised through the SaintsFunder are beyond what we had anticipated. This is largely down to the impact that the project had through press and media. It is evidence that the project gained a high public profile, thus increasing awareness around the Arlight and eye

care. Press coverage extended beyond national press with interviews featuring on South African radio and BBC Africa radio.

While we did not complete the journey by tandem bicycle, we are pleased with the way in which we were able to reframe the means by which we achieved our aims. The innovative solutions that presented themselves to us developed the story of the journey so that it became more interesting, not only for ourselves, but for the public who followed the journey. We are very grateful to everyone that saw us through the phase of transitioning from the tandem bike, including the SES who kept their community updated on our progress whilst providing great moral support.

We are both very pleased with the overall outcome of the project, and believe that we have exceeded many of the ambitious targets set when the idea was in its infancy.

Future objectives

Our focus is now towards maintaining links with the institutions that we collaborated with so that they can continue to collaborate with the University of St Andrews and Arclight Medical. We are also designing an online survey with Dr Andrew Blaikie and Ronnie Graham to gather feedback. Inspired by this project, students at the University of St Andrews are showing interest for working with the Arclight. This includes one student who recently travelled to Malawi to carry out research looking at the effectiveness of the visual acuity chart associated with the Arclight package. Another student is currently making plans for a project in India that will involve travelling between partner institutions by motorcycle, in a similar manner to what we did.

Communication and reach

Prior to departure, we publicised the project at the COECSA congress in Addis Abeba. We also gave talks at the University of St Andrews and Kings Edward School, Bath. The project was covered by press and media through the University of St Andrews, as outlined above.

Upon our return, we gave a public lecture at University of St Andrews, as well as a main stage talk at the Royal Geographical Society Explore conference. Merlin has spoken at the Royal College of Ophthalmology, while Alex has spoken to Rotary Clubs in St Andrews.

We are currently working with filmmaker Ian Gordon to produce a couple of short films. Some of these will demonstrate how we carried out the Arclight trainings in order to further publicise the device. One will portray our journey across the Maasai Steppe and the story of how we overcame the problems that we faced in doing so. Another will give a broader overview of the entire project from start to finish, including the physical challenge and the Arclight.

Adversities and challenges

Carrying out such a major training project using a bicycle was always going to be a challenge. Arranging training events in advance and then making our schedule by bicycle was an anticipated problem. Fortunately, we encountered few issues of this kind. Managing such a large number of events with so many people in ten countries was an administrative challenge, particularly where communication was difficult for some stretches of our journey. Immediately before setting off on the project, the Arclight factory in Hong Kong was severely damaged and this led to issues with the supply of Arclight devices. The bottleneck affected training events in Egypt and Sudan, where we had to supply Arclights as they became available after training. This was a major logistical challenge as Egypt and Sudan are countries where importing medical equipment can be difficult. We also had to keep accurate records of who had received training and then ensure that Arclights were distributed to everyone that was entitled to one. When Arclights became more available from Ethiopia onwards, they had to be carried on the bike. Carrying up to 200 devices in our luggage at any one time created extra weight and we had to ensure that the equipment was kept in good condition through wet and humid conditions, where we might be travelling on difficult terrain. The training events could throw unpredictable challenges at us. While we were able to manage most, our lack of expertise in the field of ophthalmology made some situations difficult. On one occasion we had expected 30 people at an event where 100 people turned out. While we were thrilled to have so many people interested in the Arclight, we did not have enough devices, and had difficulty teaching such a large number. However, we were fortunate to have a fantastic group of junior doctors who were able to lend a hand with teaching the younger students.

A significant effort went in to preparing ourselves for the physical and logistical challenge of riding a bicycle from Cairo to Cape Town. We expected issues along the way and were able to overcome enough of them to complete the journey. In Egypt we were prevented from cycling by the police for a range of reason that included not having permits, and a threat to our safety. We were forced to be driven by police from the Red Sea to Luxor, on the Nile, and endured two days of discussion between the Authorities, the British Embassy and ourselves, during which we were accompanied by armed officers everywhere that we went. While getting a visa for Sudan proved challenging, once we were in the country we enjoyed the hospitality and warm welcome of its people. On one occasion in northern Sudan we were confronted by a man who claimed to be a policeman and insisted on searching our bags. A crowd gathered to support him but we were able to stall the situation until someone intervenes and we made our escape into the desert, fearful of being followed. The desert posed challenges that we had anticipated but could not fully grasp until we were on the ground. The intense heat and lack of food and water made long days on the bike extremely difficult at times. We had to be careful to ensure that we had enough water, and lived on a very simple diet of fuul (a boiled mush of beans) and bread.

On our second day in Ethiopia we were forced to join a military convoy to pass through an area of conflict which we had been travelling through, encountering gunmen on the roadside and gunfire during the night. The army drove us into the Ethiopian Highlands to Gonder, where there was then a major police event surrounding the capture and arrest of a convicted

murderer. Ethiopia faced us with a huge range of physical challenges, including steep climbs and sickness. Having made a navigational error, Alex fell ill, closely followed by Merlin. We knew that things weren't great as people herding animals walked faster than we were cycling on their way to market. We had to spend several days in a very basic guesthouse while we recovered, and worried at one stage that Merlin might have Malaria. Ethiopia has a reputation for being difficult for cyclists. Children are known to throw stones while Adults can be hostile and aggressive towards foreigners. We were fortunate to be able to support each other through this so that the mental weight endured by many other cyclists on this stretch could be shared. Regardless, we were hit by a few stones and were relieved to escape the hassle of children when we arrived in Kenya.

Road safety was a matter that we took extremely seriously, and we felt unsafe at times on many of the roads. On the worst occasion, approaching Nairobi, we made the decision to load the bike onto a bus for the final stretch into the city, as traffic was a significant threat. We were involved in two collisions. Upon being rammed by a tuktuk in Egypt, we managed to maintain control, while we were knocked from the bike by a van in Arusha, Tanzania, causing some damage to the bike but fortunately not ourselves.

We encountered our biggest drawback in Tanzania, when Merlin began suffering from physical health issues related to long days in the saddle. It became apparent that we would not be able to continue by tandem, so we quickly began to look for a solution. While we waited for ideas to materialise, we were eager to keep moving towards our goal in Cape Town. We built a metal cart, hired two Masai warriors, and walked across the Masai Steppe for three weeks. Before leaving Arusha, the wheels on our cart had buckled and we were forced to turn back and replace them with more durable motorcycle wheels. While this was one of the most enjoyable and exciting legs of the journey, it presented us with a new set of problems related to being in total wilderness. After a few days our water filter became blocked and eventually ceased to function. With a limited supply of Chlorine Dioxide tablets, we were able to get through the remainder of the journey, although these had to be carefully rationed.

We are extremely grateful to Elliptigo, who were able to provide us with two new bicycles with which to complete our journey. In the first couple of weeks we encountered minor muscle injuries which were dealt with by ourselves and a physiotherapist in Lusaka, Zambia. The heat and humidity in eastern Zambia made for a difficult week, at the end of which we were totally exhausted. Entering Botswana, we were faced with a remoteness unlike that which we had faced in the Sahara. This remained with us much of the way through Namibia to South Africa. In western Botswana Alex fell off a horse and then suffered from an unrelated illness while recovering from his fall, which led to him being hospitalised for a day. His recovery took a week and delayed progress to Windhoek.

While we had encountered bike maintenance issues and punctures along the way, nothing compared to Namibia. As we took to dirt roads, our worn tyres did not manage well with the many thorns on the road. With several punctures a day, a total of eight wheels, and problems with Merlin's chain, we became pretty good at fixing bikes.

Travelling as only two people for such a long time can be difficult at times. Spending all day together in stressful and challenging conditions can test any relationship. While we had our

bad days, and many arguments, we managed to get through it all and form a mutual understanding on most issues. It is testament to our friendship that we have come through such a long journey, and endured such a vast array of challenges, to still hold such a strong bond.

Risk management – insurance, medical arrangements, accidents and incidents

The expedition was insured under the University of St Andrews staff policy with AIG. Due to the extreme nature of the project, an extensive risk assessment had to be cleared by the university and AIG insurance. We had a network of contacts throughout the journey and information on local emergency services, where these existed, and British Embassies and High Commissions in all the countries we travelled through. This information was held by Fiona Eason, our line manager at the university, who was always on hand if a crisis were to take place. We carried a Garmin InReach, which allowed our position to be tracked and could be used to send text messages via satellite. This allowed us to contact people at home at any time, regardless of mobile networks or electricity supply. Crucially, the device was linked directly to the International Emergency Response Coordination Centre. Under a separate insurance policy from GEOS, the IERCC tracked our daily progress and we made daily check-ins at 8pm local time. If the check-in was not made, the IERCC would make contact with Fiona Eason and our families to enquire whether they had heard anything. They could then launch a response based on our last known location. We could trigger an SOS from the InReach, which would initiate the same response.

In the event of a medical emergency we carried three separate first aid kits, so that we could provide basic but potentially life-saving care in remote areas. The first of these was a trauma kit, which was carried on the frame of the bike. This could be used where one of us had been critically injured in a road-traffic accident and included: chest seals; nasotracheal intubation; chest decompression kits; tourniquet; foil blanket; and massive haemorrhage kit. This kit also contained US\$500 so that someone could be payed to take the casualty to the nearest hospital immediately. In an emergency, we could grab this kit and our grab bag, which contained travel documents, the InReach, and further cash. Our second first-aid kit contained equipment for day-to-day injury and illness. This included a sterile needle kit, bandages, disinfectant wiped etc. Our third kit contained medication including broad-spectrum antibiotics. For malaria we took malarone as prophylaxis and carried one step malaria test kits and riamet, which could be taken while getting to a hospital. We reduced the risk of being bitten by mosquitoes by wearing long sleeved clothing in the evenings, sleeping under a mosquito net, and using insect repellent. There was a risk of contracting bilharzia when swimming in lakes and rivers, so Alex took a course of praziquantel on returning to Ireland, as prophylaxis.

We had several incidents with police, illness, and people. The most significant risk during the journey was from traffic, and we were involved in two collisions. The second of these knocked us from the bike in Arusha, Tanzania. Fortunately, we weren't injured, although some damage was done to our bike lights. We found the people whom we met to be warm and friendly along most of the journey, often welcoming us into their homes and showing us immense kindness. However, we had an incident in northern Sudan where a man claiming to be a police officer

insisted on searching our bags. The situation almost escalated out of control when a crowd of men gathered, backing him up until somebody defused the situation. It was in a remote area of the Sahara Desert and we were concerned after the incident that we might be followed and robbed.

Illness came upon us on a few occasions. In Ethiopia Alex became extremely ill in a remote mountainous area. We pressed on for a couple of days, but his condition deteriorated, and Merlin became ill too. We were forced to stay in a simple guesthouse for three days while we recovered enough to carry on to Addis Ababa and rest fully. During this time Alex took a course of antibiotics, and we tested Merlin for malaria, as he had flu like symptoms. He tested negative. Alex became extremely ill in Botswana and admitted himself to hospital. He was suffering from severe abdominal pain and diarrhoea. After extensive testing he was diagnosed with a bacterial infection and prescribed antibiotics and pain-relief.

Budget

The incoming and outgoings of the project are detailed below. The SES Gough Explorer Award was especially valuable to the project as it came at an early stage, giving us foundation to build upon.

Arclight Tandem Africa: Final Account					17/12/2019
Expedition and Travel			Arclight		
Tandem	Orbit velocity pro	£2,160	Arclight devices	£10 each 2000	£20,000
Tent	Alpkit/SES discount	£200	Logistics	Delivery	£500
Sleeping bags	Alpkit/SES discount	£100		Total	£20,500
Bike kit	panniers, racks, lights	£500			
Spares and repairs	tyres, pump, tubes	£200		Total Expenses	£44,060
Miscellaneous	glasses, gloves, deet, etc	£500			
Website		£300			
Flights	Edi-Cairo, Cairo-Edi	£2,200	Incomings		
Visas	on entry / e-visa	£1,200	SES Gough Award	£3,600	Expended on
Total		£7,360			Arclights £3,100
					Expedition and Travel £500
			R&A Scholarship	£14,000	Daily Expenses £9,600
Daily expenses	2 people at £20 per day	£9,600			Expedition and Travel £4,400
					Security and Comms £6,600
Security and Comms			Crowdfunding	£24,000	Arclight £17,400
Search and Rescue	GEOS	£2,000			
Medical training	Personal Safety London	£1,800	Subtotal	£41,600	
Security training	Personal Safety London	£1,200	Personal outgoings	£2,460	Expedition and Travel £2,460
Garmin inreach		£400			
Satellite subscription		£300	Incomings total	£44,060	
Website		£300			
Sim cards and data		£400			
First aid supplies		£200			
Total		£6,600			

The Medical School of pledged to fund £13,000 towards Arclight devices. However our fundraising for Arclight was very successful using our crowdfunding platform and they decided to allocate those funds elsewhere. Directly they helped the expedition with the purchase and delivery of the Elliptigo bikes in Malawi. During this time two members of staff also came out and captured footage which is now being edited and we hope to produce a couple of short

adventure films from. Our intention is to distribute these through film festivals. Material relevant to the Arclight will assist with the public outreach of the project.

Once again, we are thankful to the Scientific Expedition Society for their financial support, and for providing a platform from which our ideas could be launched with the success that they have had. The project has been able to reach thousands of people in multiple forms, whether they were direct recipients of the Arclight; gained an insight to the complex situation of eyecare in Africa; or took an interest in following the journey. It has been a small nudge in the right direction for eye care, as well as having a major impact on our own lives.

