We are all Equal under the Stars

An Education and Community Outreach Programme
for the
Armagh Observatory and Planetarium




This document was produced by the staff of the Armagh Observatory and Planetarium, in particular through discussions and contributions from Education Support Officers, together with input from the Governors and the Management Committee. The document was edited by the Director, Michael Burton and designed by Aileen McKee.

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Front Cover Images

The Four Pillars of AOP's Education and Community Outreach Programme

Inspiration

The Armagh Observatory was founded in 1790 as part of Archbishop Richard Robinson's vision to see the creation of a University in the City of Armagh, and inspired by curiosity about the Cosmos. The Observatory is the longest continuously operating astronomical research institution in the UK and Ireland.

Outreach

The Armagh Planetarium was founded by Dr Eric Lindsay, the seventh director of the Observatory, as part of his vision to communicate the excitement of astronomy and science to the public. The planetarium opened on the 1st of May, 1968 and is the oldest operating planetarium in the UK and Ireland.

Education

Visitors to the Planetarium, young and old alike, bring with them many questions about the world around them. We help to answer these through education, teaching them about the planets and the stars and the methods of science, and by encouraging critical thinking, to look more deeply into their questions so as to better understand the nature of the cosmos.

Entertainment

Learning can be fun at times. Nowhere is this more true at the Planetarium than when children build and launch their own rockets, all a part of the experience of a visit. Here we see a rocket being aimed and fired up the hill towards the Observatory, often the highlight of many a school's visit to AOP.

Table of Contents

Foreword

Armagh Observatory was established by my predecessor Archbishop Richard Robinson in 1790 with the aim of increasing our understanding of the universe, its origins, and the processes which maintain and cause it to develop.

While the dissemination of astronomical research has always been a key component of the work of the Observatory, the seventh Director, Dr Eric Lindsay, saw the need to make such knowledge available to a wide audience, and so he established the Planetarium for this purpose. We look forward to celebrating in 2018 the 50th anniversary of its opening. Over that time, the Planetarium has provided opportunities for the general public, of all ages and backgrounds, an insight into the universe in which we are all equal 'under the stars'.

For the last three years, we have been engaged in bringing more closely together these two arms of the astronomical organization. We have appointed our single Director – Professor Michael Burton – for the whole of AOP, and the process is well in train for the appointment of other staff to support this single-organisation structure.

Our vision for the future is not just organisational, however. Already, the research astronomers are working together with our staff who present the Planetarium shows and create the displays to ensure that current astronomical research is being presented in a way which is accessible to the general public. We also wish to update the display areas, refurbish and even rebuild the dome, and to provide (using a portable dome) opportunities whereby we can take the planetarium shows out into the community. In this way, we seek to enhance the experience for our visitors and those to whom we reach out.

This document sets out our vision in more detail, both in terms of what facilities we hope to put in place and of the benefits to our community achieved through those new and enhanced facilities. I commend this document to you, and hope that, as the facilities are enhanced, you will have continuing opportunities to engage with the wonderful world of astronomy.

Archbishop Richard Clarke
Chairman
Board of Governors of Armagh Observatory and Planetarium

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Executive Summary

The Armagh Observatory and Planetarium is a special place that brings together fundamental research and public curiosity about the nature of the cosmos, all within a heritage environment that is rich in scientific history. Four pillars underlie and support the public programme that is conducted. These are the pillars of education, of inspiration, of entertainment and of outreach.

Visitors come to AOP with many questions. Theirs may be simple enquiries or deep musings. Sometimes their questions are motivated by popular culture, at other times by misconceptions about science. Our aims at AOP when they come are several. We may teach. We may help develop critical thinking skills. We might provide fun around science. We might reach out to reassure and calm fears about phenomena in the cosmos. All who come to our domain in Armagh experience a shared space, one where everyone can see that we are all equal under the stars.

This vision for the education and community outreach programme of the Armagh Observatory and Planetarium has been built on these four pillars, on the questions that inspire, the reasons people visit the AOP and the experience we can then provide. The programme we propose here is developed around the resources that are available and are needed; in the Planetarium Dome and the Observatory, in the exhibition space and the grounds, as well as online and external activities that complement and add value to them. The programme is also predicated on having the human resources that are essential to make it happen; the qualified and dedicated staff that run a diverse and extensive range of activities, and are the source of the inspiration that we endeavour to impart to all who interact with us.

The centrepiece of the vision requires a capital development programme to bring it about, a new and iconic Dome that provides for a planetarium experience fitting for the third millennium, 50 years after the founding of the oldest planetarium now running in the UK and Ireland. A new planetarium that provides an immersive digital experience for viewing the heavens and exploring the cosmos around us. Accompanied by a revamped and rejuvenated exhibition space, together with rooms for workshops and interactive activities for our visitors, ranging from school groups to incubators seeding new ideas for the space industry.

The integration of the Observatory and the Planetarium now facilitates the running of activities across the estate of the AOP, opening up the heritage to wider audiences, and incorporating the Astropark and the environment into the visitor encounter. These then can be linked to the wider tourist experience in Armagh and its other cultural attractions, where depth and quality is stressed over transience and quantity. The Dome itself might also be used for cultural events, such as musical performances, able to transport the audience to another location, whether that be on Earth or in space or time, to create for them a special experience.

The external events programme needs to be greatly improved, where AOP goes out to reach audiences, particularly to regions of social disadvantage or deprivation from where visitors to the Planetarium are less likely to come from. This will be facilitated through the acquisition of a new lightweight portable dome and digital projector, enabling ready set-up and quality presentations by a single person. AOP enhances its brand by being able to be present at community events, and performs a public service by doing so. Opportunities to promote regional tourism are also facilitated, for instance in supporting the establishment of dark sky reserves in nearby, but remote, mountain domains.

To support these activities a revitalised web and social media presence is needed, bringing together the two arms of the organisation, and providing a professional and authoritative

public face. Urgently, an online booking system needs to be implemented, with benefits not just to the freeing of staff resources, but to enabling the development and marketing of programmes tailored to different target audiences. To round off the visitor experience to the Planetarium a greatly improved café is needed, consistently the only area that is poorly rated in visitor surveys.

Qualified and enthusiastic staff are the key to any successful organisation, especially in a small one like AOP where, of necessity, they need to be able to multi-task to carry out the diverse range of activities we are engaged in. The current staff complement is, however, inadequate to undertake all the activities described in this vision. It needs to be grown, in particular to cover critical areas of support for this programme.

This includes a head of education and community outreach to oversee and drive the programme, a theatre manager to oversee the operations of the Dome and their content, a science and media manager overseeing the public presentation of the science across all of the AOP, and enhanced roles and staff for the education officers to run all the activities proposed. To support these activities, the Planetarium needs to have a dedicated receptionist to greet the public, marketing to reach out to audiences and engage them with our activities, and greater ICT and technical support to ensure continuity of operations. Finally, to enable the opening of the estate of AOP and showcasing the heritage, the grounds and Astropark to its true potential, needs full time rather than piecemeal attention.

The Armagh Planetarium, with the famous Dome built in 1968 to right and the Lindsay Hall of Astronomy to left, named after the Planetarium's founder, Dr Eric Lindsay, 7th Director of the Observatory. The Planetarium was built in order to inform and inspire the public about astronomy, and has pioneered ways and means of visually presenting the subject to its audiences, and creating lasting memories of their visit.

Questions that Inspire

Since the dawn of humanity we have been fascinated by the night sky. Anyone who stands under a dark sky filled with stars invariably is filled with awe and then asks questions about the cosmos. These can be simple and direct, such as "what is that bright star?" They might be profound and deep, such as "how did the universe begin?" Sometimes questions are inspired through cultural experiences. Popular television documentaries can prompt viewers to seek out information on leading-edge research topics such as black holes and the possibility of life elsewhere in the Universe. Movies and posts to social media can lead people to ask esoteric questions like "could a lone astronaut really survive a year on Mars?" Commonly, though, questions will be based on misconceptions like "is it true that Neil Armstrong saw alien spaceships on the Moon?"

Some people will think about such questions for a little while before moving on. Others will actively pursue their answers. All are questions that can be stimulated by a visit to the Planetarium. Seeking answers to them can also motivate research in the Observatory. Together, the Armagh Observatory and Planetarium provides a special place for everyone and anyone wanting to learn more about the universe and our place in it.

Responding to questions about astronomy from the general public and the interest this revealed was one of the primary factors that inspired Eric Lindsay, Director of Armagh Observatory from 1937 to 1974, to pursue the founding of a Planetarium in Armagh. Since the Planetarium opened its doors in 1968, it has endeavoured to meet the public demand to learn more about the cosmos. This is done in many ways, as we outline below.

The Planetarium presents informative, exciting and spectacular shows in its famous Dome, for everyone from nursery-age children to seniors, meeting a demand to know more about what is out there in the night sky. Feedback from visitors indicates that these shows generate lasting memories. Informed and friendly presenters talk directly to them, whether they are small children, teenagers or adults, describing and demonstrating what we know about the planets, stars and galaxies with charm and enthusiasm. The Planetarium is regarded as an authoritative source of astronomical information, and receives many queries and questions by telephone and email. These are answered patiently, whether they are a request from a journalist to explain a planned space mission or an ill-founded demand to prove that the Earth is not really flat. When first introduced the Planetarium newsletter attracted subscribers from around the world. Now that it has been replaced by a blog and social media these are even more widely read.

The education and community outreach programme for Armagh can be encapsulated through four illustrative questions that have been asked by many visitors to the Planetarium, and the knowledge and understanding that attempting to answer them brings.

- *What star is that in the sky?*
  Stimulating an interest in science.
- *What are black holes?*
  Deep questions developing advanced thinking.
- *How could a lone astronaut survive on Mars?*
  Inspired by science in popular culture.
- *Were aliens found on the Moon?*
  Addressing misconceptions in science.

We now explore these themes further to provide a foundation for the education and outreach programmes that we aim to run.

An image of the Moon seen during an eclipse by the shadow of the Earth, as taken using Armagh Observatory's 10" Grubb Telescope. The ghostly red glow comes from sunlight refracted through the limbs of the Earth by the atmosphere atmosphere, and then reflected back from the Moon to the telescope.

Why Come to the Armagh Planetarium?

People come to the Planetarium for many reasons. When they arrive we provide them with a range of experiences. We might open their eyes to the wonders of space. They may be enlightened about a mystery that is puzzling them. The visit could be simply for entertainment, perhaps motivated by a recent news item in which science features. Sometimes we calm fears about a cosmic event that has been heard about and misunderstood.

These reasons for their visits echo the four illustrative questions listed earlier that are regularly asked in the Planetarium. The experience then provided is supported by four pillars on which our programmes are built. These are the pillars of education, of inspiration, of entertainment and of outreach. We teach, we develop thinking skills, we provide fun around science, and we reach out to reassure.

It can at first be unsettling to realise how little some people know from their questions. Fundamental concepts in science are not widely known. Many are surprised to hear, and then excited to learn, that the Sun is star?! There is a dearth of basic knowledge about science and its methodology. Armagh provides a unique facility to address this through the special combination of the Observatory and Planetarium, brought together in one place. A visit to the Planetarium can be a starting point for an appreciation and an education in science.

The Planetarium is sometimes known as the "space place" in Armagh. People come because they trust that we are knowledgeable about their questions and know the answers. The visit creates lasting memories. The experience can then become inter-generational. Parents bring their children to Armagh because they remembered their own first visit as a child.

A visit to the Planetarium inspires. We encourage people to look at the cosmos, and then to think deeply to understand phenomena in the heavens. This can stimulate them to translate that thought process into comprehending better the world around us, and the many mysteries and challenges for which scientific comprehension provides a basis for improved understanding.

Science features regularly in the news and popular culture. People may hear a story about the latest astronaut to travel to the space station. Perhaps they have seen a new film involving an astronaut surviving on Mars? They then want to know more. Armagh is associated as a resource where they can come to find the information they seek. They expect we will know the answers to their questions. The Armagh Observatory and Planetarium provides a beacon for knowledge and for explanation.

Sometimes there may be an irrational fear. Perhaps derived from a news item about a potential cosmic cataclysm, such as an asteroid colliding with the Earth, causing the end of the world? We can become a place of reassurance for easing fears about an event that is not understood. We can treat these concerns with respect and provide a sympathetic voice, yet at the same time standing by the science as a way of understanding the issue they fear, the likelihood of it occurring, and the consequences that may result.

The Planetarium is not just a place where a person comes to view the stars of the night sky in comfort. It is home to a storehouse of knowledge and experience, all found together under one roof. We provide a variety of ways of communicating this knowledge, whether through words, or visuals, or sound or just by being there and feeling the wonders of space up close. All experienced while being entertained and having fun. "This is the best day of my life" is a comment that is regularly heard from a visiting child!

The Horsehead Nebula in the constellation or Orion, one of the most famous of astronomical nebulae. The familiar shape is actually a silhouette, a cloud of gas dust blocking the light from the hot ionized gas that is glowing red behind.

An Education and Outreach Programme for the Observatory and Planetarium

The education and outreach programme that Armagh runs needs to be wide-ranging and diverse. The programme is motivated by the questions that inspire and the reasons people visit. It must offer activities that span the many different audience types we have to reach. Simultaneously, their level of delivery must be commensurate to the widely contrasting experiences of the participants, ranging from the first taste of "space" for young children, to advanced and specialist training for graduate students and post-doctoral researchers.

The programme can be naturally spread across the different precincts of AOP's own expertise, while also drawing on the synergies that the Observatory and Planetarium offer each other. We divide its content across the following six focus areas:

- The Planetarium Dome;
- The exhibition space and workshop areas;
- The Observatory;
- The grounds and estate;
- Online;
- External

Armagh Planetarium's Astronaut welcoming visitors.

Wonder at the Cosmos, as experienced during a school's presentation in the Planetarium Dome.

A summary of current education and outreach activities undertaken at AOP is given in Table 1, with proposed new activities listed in Table 2.

The Dome

The Planetarium Dome is, and always will remain, at the heart of the education and outreach experience offered by the AOP. Approaching its 50th anniversary in 2018 and now the oldest Planetarium operating in the UK and Ireland, the grand vision of the then Director, Eric Lindsay, of a centre to meet the public demand for knowledge about astronomy has been fulfilled. The Armagh Planetarium is renowned for its pioneering activities inspiring wonder about the cosmos. The Planetarium is a widely known institution and a source of pride in Northern Ireland.

Nevertheless, the Planetarium is aging. It is in urgent need of rejuvenation if it is to maintain its status and appeal across the community. It needs to remain equipped with the best of the advances that continue to occur in digital projection technology and participant interactivity. Lasers and virtual reality (VR) now also need to be incorporated into the projection capabilities. The size of the Dome, a relatively small 12m in diameter, also limits audience numbers. An appropriate expansion in capacity would greatly facilitate new offerings and the bringing in of new audiences, and at the same time provide for income-generating opportunities aimed at self-sustainability of operations.

The base audience of the Planetarium – primary school children – needs to be broadened and

diversified. Full year groups from secondary schools cannot all be accommodated with the current size, which limits flexibility in scheduling visits from this key target audience given school timetabling constraints. Adult audiences need to be developed in addition coming mostly when in family groups. This might be advanced, for instance, through incorporating cultural activities within the Dome, such as musical and artistic performances that are played against the backdrop of the night sky as provided by the Planetarium projector.

The presentation and visualisation of 3D data sets, now increasingly common across all the sciences and not just astronomy, needs to be utilised with the Dome as a new tool for both education and for research. The unique synergy available due to the expertise of the staff of the Observatory and Planetarium allows this potential to be explored and developed at Armagh, aimed at providing insights into understanding for audiences of the behaviour of many complex phenomena. The Dome might also be used to attract bespoke workshops for specialists to come to Armagh to analyse and interpret their 3D datasets, or for advanced students to better understand concepts relating to extended systems, on Earth or in space.

The Dome may also provide a suitable venue for cultural activities, such as art or music shows. It can be used to provide a variety of backdrops for a performance, in particular of the stars and celestial objects. This can also be set to slowly rotate or transform as suits the show. The experience of being outdoors at night is being brought inside, to a controlled environment where the performance cannot be interrupted by the weather. The audience may be translated to any location on the Earth, or indeed in the Solar System, and feel immersed in the environment there. This may even be used to provide a backdrop for a wedding, with the exhibition halls a location for an accompanying reception. Opening the Dome to events of this nature has been little explored by planetaria. There may, of course, be issues that limit some modes of use this way, such as the effect of background noise on the acoustics for a musical event. Nevertheless, this is an opportunity that needs to be explored, then suitable programmes devised and marketed.

Exhibition and Workshop Space

The exhibition space adjacent to the Planetarium Dome provides an enticing and attractive snapshot of activity associated with spaceflight and astronomy. Models of spacecraft hang from the ceilings. Spectacular imagery of the stars and galaxies from new telescopes line the walls. Displays of meteorites provide a tactile experience. Workshop rooms provide for hands-on activities, including the ever-popular building and launching of rockets.

Astronaut training for the young during a workshop in the Planetarium exhibition space.

The exhibitions are, however, now dated. Displays of future missions, as they were when installed a decade ago, are slowly turning into echoes of past history. They are no longer about latest missions being undertaken by ESA and NASA that our visitors may have heard about in the news. The display materials are largely passive, suitable as the subject of discussions led by our Planetarium presenters, but largely inert for the self-guided visitor.

The exhibition area is in urgent need of a major revamp to make it current, looking towards the future, rather than its slow drift towards that of a museum recording past glories. The Planetarium can provide a showcase for the space industry, able to display the latest developments, particularly those associated with industry in Northern Ireland, and, equally importantly, inspiring enthusiasm in science and technology and so encouraging students to study these subjects at school and university. ESA and ESO (the European Space Agency and Southern Observatory, respectively) feature prominently in the current exhibition space. They would do so in the future, but with displays of the latest projects, not past ones.

ESO and ESA are endeavours that involve members of the UK science community and industry as integral partners, and will continue to do so whatever happens in the post-Brexit era. It serves these organisations as well for the AOP to promote them and tell their story, as it does for the AOP to use their activities and attractions to bring people to Armagh. We are all part of the same journey.

There also needs to be introduced into the Planetarium material relating to the history of Armagh Observatory and its important and leading role in the transformation of astronomy into astrophysics over the past two centuries, i.e. from the measurement of the positions of the stars towards an understanding of what they are, leading on to the current research being tackled by astronomers in Armagh today.

There also needs to be exhibition space available for fresh displays, regularly updated and enticing so as to attract return visitors to the Planetarium. Space that is available for the holding of special events and for the hosting of headline activities.

The workshop space needs to be greatly enhanced, to facilitate more than just school groups undertaking hands-on classroom activities. This is a special place, immersed within both a Planetarium and an Observatory, as well as its history and heritage. Such a backdrop can provide a source of inspiration. There is a unique opportunity to attract workshops to Armagh that encourages free-range thinking and the brain storming of new ideas and directions.

Armagh can also provide a place to seed the development of incubators, a shared space whereby participants interact over extended periods with the staff of the Observatory and the Planetarium while exploring and developing a particular theme, perhaps prior to their later commercialisation as a start-up. Working within a stimulating environment, freed from the daily demands of the workplace, the thoughts of participants can flow. Armagh can position itself to attract this high-end segment of the conference industry, as well as align itself with the development and growth of the space industry in Northern Ireland and the UK.

The Observatory

The Observatory's role in education and outreach will remain primarily connected with the advanced training of students at postgraduate and undergraduate levels, closely connected with the academic environment within universities across the UK and Ireland and in Europe.

A double rainbow, where the pot of gold at its end apparently is in the 1827 Dome in the Observatory.

The view from the Hyper Cube looking up the Hill of Infinity in AOP's Astropark. A journey through the universe and back in time to the Big Bang awaits the visitor, ending at the stone circle overlooking Armagh.

The integration of the Observatory and Planetarium, however, greatly enhances the opportunities for developing the outreach programme and for ensuring that the material shown within the Planetarium remains current and connected with the latest discoveries.

Small snippets from research carried out in the Observatory can be inserted into Planetarium shows to demonstrate the direct link between education and research. Expert commentary is available on recent news items in science, often able to provide a local perspective in translating the message into one understandable by the public. At the same time, the researchers can learn, through their interactions with the Planetarium presenters, how better to deliver a message to ensure that it is understood by a wide audience.

There is a special opportunity for the AOP research students to engage in outreach activity that is generally not available to students based at universities. They may, for instance, assist the Planetarium staff in giving public presentations and demonstrations, and even enhance the content of these events based on their own research work. This allows them to gain the invaluable experience of communicating their subject across a variety of levels, and not just to a narrow field of speciality that most research students at universities interact within. This can prove to be important as they progress their future careers and encounter increasingly wider audiences, when needing to deliver a message or when seeking to promote an idea or proposal.

AOP-wide Activities

The integration of the Observatory and the Planetarium as one institution facilitates the running of activities that take place across the site of AOP, utilising the grounds as well as the buildings. The Planetarium provides an entry and assembly point to the AOP, easily accessible, including parking, able to collect admission fees, provide information etc. in a manner that cannot readily be handled in the restricted space of the Observatory.

The Observatory provides a remarkable heritage, a public face on a fascinating history of astronomy and human endeavour since 1790. This includes the oldest research institution in the UK and Ireland still in its original building, the oldest telescope in the world still in its original location, the home of a fundamental catalogue of astronomical nebulae – the NGC (New General Catalogue) – that remains familiar to all professional astronomers today, and the longest daily meteorological record in the UK and Ireland, still maintained today.

The heritage has, however, only been available to selected visitors or made visible on special occasions, such as the Armagh Georgian Day. Few of the precious historical instruments are on show, most being hidden away in boxes in a poorly accessible archive room.

A tour of the Observatory showing the Human Orrery, where visitors can assume roles as planets and comets in order to learn about how they orbit about the Sun.

Regular heritage tours could now be run, at set times and chosen so as to minimise any disruption to work in the Observatory building. They would start and finish at the Planetarium, and include aspects of the grounds. An initial programme should be trialled along one route – "highlights of AOP" – but this could readily be expanded to a series of tours concentrating on different aspects of the history and heritage, such as the science, the architecture and the astronomers. Such a programme could also be integrated with activities held at other locations within the city of Armagh. The most natural partner are other locations on the "Robinson Trail", in particular the Robinson Public Library also founded by the Observatory's great benefactor.

AOP has allowed its extensive grounds to be publicly accessible at all times, much to the appreciation of many residents of Armagh who regularly use it for exercise. The grounds contain the remnants of an ancient woodland, a considerable number of plants, birds and animals of environmental interest, together with impressive views over the city of Armagh. There is also the remarkable Astropark, including a scale model of both the Solar System

and of the universe, a human orrery that provides a unique classroom experience for explaining the motions of the planets about the Sun, and a modern stone circle that provides a link back to human kinds first understanding of the cycles of the heavens, developed in Neolithic times. Few of these facets are well appreciated by the visitors to AOP, however, and indeed very few venture beyond the Planetarium into the grounds. Mostly it is the local dog walkers who are there, appreciating and enjoying the environment around them. We can do more to encourage the community into our domain.

The scale model of the Solar System in AOP's Astropark, looking from Saturn and Jupiter back towards the Sun and the inner rocky planets.

All these aspects of the grounds are in need of maintenance and gentle promotion. Mostly it is a matter of replacing and enhancing signage. For instance, providing information on the natural environment and the history of the buildings, in addition to improving the legibility of those signs devoted to explaining astronomical concepts. A nature trail could be developed, with appropriate signage explaining the environment and the cycle of the seasons, complementing the cycle of the heavens explained through the Astropark. Enhancement to the grounds could including hosting outdoor sculptures, perhaps incorporating a space theme? The gardens are also in need of further care than is possible with current staffing levels, including restoration to their Georgian form. Such a programme might be undertaken through encouraging the development of a "Friends of the AOP", using volunteers to look after the grounds for all to then enjoy.

Online Activities

All progressive organisations require an active and current presence on the web, together with associated social media channels to promote and advertise their events, and to encourage interaction and engagement from outside users.

AOP has an active web presence, through sites hosted by the Observatory and the Planetarium. However these sites are only partially maintained, the Observatory site in particular having accreted via direct coding since the formation of the world wide web, so making it very hard to maintain and to develop anew.

There is a need to unify the public face of AOP, even though for operational reasons it may prove easiest to still to continue host material related to research and to outreach through separate channels.

There are also clear opportunities for enhancing the current content and for engaging with the public further when doing so. The Astronotes blog covering topics of astronomical interest could be enhanced through involvement of the research astronomers and their students, particularly by providing knowledgeable commentary on current news items. These might be expanded to include regular podcasts and vlogging. A virtual tour of the AOP could be provided, with video commentaries given by staff at selected locations around the institution that the tourist might wish to learn more about.

Associated with developing the web presence is an urgent need to introduce an online booking system. AOP currently takes all bookings over the phone, which is both intensive of staff resources and out of keeping with expectations that customers have for a front line organisation. Online booking will provide opportunities to expand our programmes as well as link events together, and to include additional revenue opportunities such as shop sales. These then might be expanded into other arenas, for instance higher quality items than currently stocked, including books. An online booking system will also enable targeted marketing through the building of a customer database. Furthermore, it also reduces the need for cash handling and will simplify record keeping. Importantly, it will free up staff time to allow them to concentrate on their core

activities of delivering education and outreach activities.

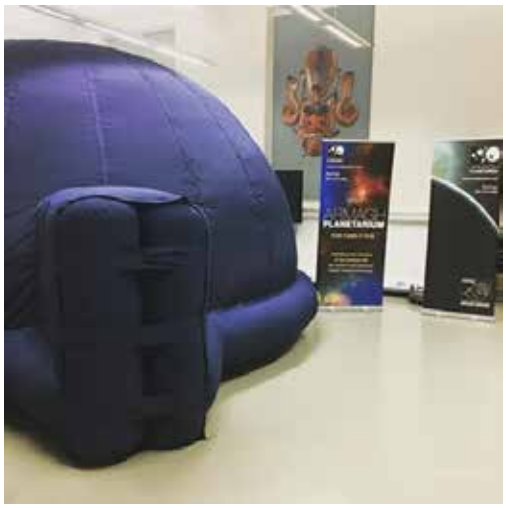
External Activities

AOP has an active programme of external events, held away from the institution. These include public talks, science festivals, participation in public events and shows, and school visits.

School visits generally use a telescope to show the Sun and/or a portable dome and projector to provide a mini-version of the full dome show in our Planetarium. However our portable dome is old, heavy and awkward to handle, and uses a fixed cylinder projection system. Its poor quality is evident, particularly to school children used to high standards of media imagery and video displays.

This greatly limits AOP's reach via school visits, especially to hard-to-reach groups such as those from areas of social deprivation who are the least likely to visit the Armagh Planetarium in person. These are also the groups who would benefit the most from exposure to AOP's activities as they are less likely to have received an education that is strong in the sciences.

A new lightweight portable dome and associated digital projection system has just been obtained, an urgent upgrade in order to bring AOP's offerings up to standard in this arena. This would simplify the logistics of operation, as the system could be set-up and run by a single person, not two people as are needed at present. It would also greatly enhance the quality of the presentations, as well as their range, as a digital system offers enormous flexibility regarding the content and form of shows. Such a system will have multiple uses as well, for instance at science festivals and public events, in addition to being used for visits to schools. It also provides an additional facility for use in Armagh with the fixed Planetarium, for instance when running tailored workshops for small groups alongside a larger public presentation in the main Dome. In an emergency it also provides a backup should the Dome be out of action due to a failure, where high level production can still be given, though of course to limited audiences.



AOP's Portable Dome used for outreach visits. Equipped with a digital projector it would bring the immersive experience of our Dome to all audiences.

Further engagement with schools may also be developed through online interactions, for instance video chats to schools, question and answer sessions. These might be in response to activities started during AOP's visit of the school with a portable planetarium, or from the school visiting the Planetarium. Teacher packs would need to be developed to guide teachers through the learning experience, and the offerings that AOP could facilitate.

Dark skies are now rarely seen by most of the peoples of Europe, high population densities and inefficient street lighting masking the glorious spectacle of the heavens. There are few places in Europe where true dark skies can still be experienced; Ireland retains some of these. Two locations are within an hours drive of Armagh, in the Sperrin Mountains of County Tyrone and the Slieve Beagh plateau of County Monaghan and Fermanagh. They have the advantage of being within 1-2 hours drive of population centres in Belfast and Dublin, unlike dark sky sites on the west coast of Ireland. Community groups in these areas, supported by their local councils, are endeavouring to develop them as destinations for the discerning and environmentally aware traveller. Armagh, as a recognised authority on the heavens, has an opportunity to engage in and guide the development of such programmes, increasing awareness of the shared cultural heritage we all have in the spectacle of the night sky.

The Needs

To develop the education and outreach programme presented here AOP needs to invest in infrastructure and in human resources to ensure that it has the necessary structures, equipment and capability to implement it. We discuss these two arenas below, highlighting some of the areas in need of investment. A full discussion of this investment, in particular the upgrade and revamp of the exhibition area and workshop spaces, should feature as a central element in the planning of any capital development programme to realise this vision.

Infrastructure Resources

The Planetarium Dome

A new dome for the Planetarium does not need to incorporate all the enhancements that can be seen in planetariums around the world. Some of these offer modest gains for significant costs. Given consideration of our audiences we suggest the following features be incorporated in a new Planetarium Dome:

- Increasing the size to accommodate a minimum of 150 people in comfort, from the current capacity of 93. This would accommodate the largest school groups who currently visit in a single show, rather than having to be split into multiple shows. This suggests a minimum size of 16m for the dome, compared to the current 12m (internal) diameter.
- Tiered seating provides for a superior experience than the current flat seating plan, providing the viewer with a more complete immersion under the dome.
- 3D projection is not, however, an essential feature for the projection system. The number of shows where 3D truly provides a better experience is quite limited, and indeed can be discomforting to some. The cost is significantly higher due to the increased complexity and greater luminosity required of the projectors.
- A 3D sound system would provide for a richer audio experience, however, for a relatively modest cost increase. In particular, it will minimise dead spots due to interference arising from reflections off the dome.
- The addition of a laser projection system would add to the flexibility of performances, in particular facilitating musical and cultural events.

Portable Dome

This is required to facilitate an outreach programme centred on school visits. It also provides temporary facility to provide cover in case main dome ever needs to be shut down, e.g. for maintenance purposes.

The portable dome and accompanying projector system needs to be sufficiently lightweight to be carried and easily set-up by a single person. It also needs to incorporate a digital projector rather than a fixed cylinder to create an experience commensurate to the expectations of audiences familiar with CGI for movies. A diameter of 6m is suitable, and can readily be installed in most available spaces. Larger diameter domes are more restrictive as venues often will not have a room large enough to accommodate the dome, especially in the more remote and disadvantaged areas we wish to reach out to.

Café

One aspect of AOP that is constantly criticised in visitor surveys is the café. The current offering is little more than would be available in a staff tea room. It is barely adequate for supplying basic refreshments to school groups. It does not provide the level of service expected of a leading visitor attraction. A good café would enhance the visitor experience, complementing the inspiration provided through the Dome with an opportunity for contemplation and reflection. There is also the potential for attracting new audiences to the Planetarium from the local population of Armagh. Two schools (the Royal and Armstrong Primary) are beside AOP and our car park (and indeed the Planetarium itself) is used as a waiting area for parents when collecting their children after class. They could provide a core set of customers for a new café. In addition, there is the potential for attracting residents and workers in Armagh due to the convenience of easy parking near to, but outside, the city centre. A suitable re-design of the existing café area, appropriately themed for the location, would provide a unique experience to attract customers to the Planetarium.

Running a café should not be a core activity of AOP employees, however. This would be best facilitated through a contract arrangement with an external supplier. The arrangement would need to be cognisant of the times when footfall

can be expected and when it is not to facilitate commercial viability. It may still be necessary for AOP to continue running a simple snack bar service for school groups, for instance.

Human Resources

AOP requires qualified and motivated staff to be able to undertake such a wide-ranging education and community outreach programme as that proposed above. Here we outline the key direct staffing needs for this purpose[1], in addition to the research and administration staff.

Head of Education and Community Outreach
The member of the Senior Management Team with direct responsibility for overseeing the running of the Planetarium and the associated activities, ensuring their standards of delivery, appropriate levels of interactions with the research arm of AOP, and the meeting the demands of governance and management of the organisation. Knowledgeable about the operation of the Dome and with deep understanding of the capabilities and scientific content needed to meet educational and outreach needs.

Theatre Manager
With principal responsibility for the day-to-day running of the Planetarium Dome, including scheduling of activities and of staff, as well as participating in their delivery. Needs to be familiar with both operation of the projector systems and scripting of the planetarium software so as to be able to provide bespoke shows tailored to audiences, seasons and special events.

Science and Media Manager
A qualified scientist as well as press officer, able to provide a link between the research astronomers and the education support officers, to ensure both the scientific integrity of productions as well as their appropriate delivery level to target audiences. Responsible for coordinating AOP's media programme, dealing with media requests, involving the researchers when their expertise is appropriate, overseeing science content of websites and blogs and developing suitable online engagement platforms.

There is an opportunity for AOP to create a joint research-outreach position here, in contrast to academic appointments at universities, which are generally joint research-teaching positions. Instead of teaching at undergraduate level this person would devote the education aspect of their work to interacting with the education officers regarding the public presentation of science content, and to being fully conversant with digital media tools and platforms as well as the science conducted by AOP, so as to be able to present it across a variety of media platforms. This could be a rolling position of three years duration, similar to that of a postdoctoral fellow. It may be attractive to a digitally savvy scientist looking at a different career route than the standard academic path following graduation with their PhD.

Education Support Officers (ESOs)
Responsible for the daily delivery of programmes in the Dome and associated workshop activities, as well as the delivery of events outwith AOP. Provide support and content for delivery of media material. The increased number of activities being undertaken by AOP under this education and outreach programme, particularly external events such as visiting schools with the portable dome, will also require an increase in the number of ESOs from the current complement of six to be sustainable. While there are opportunities for the engagement of PhD students in some of these activities, the primary attention of these students must be to their research.

Marketing Manager
To engage in the full range of activities presented here requires AOP to develop a professional and coordinated marketing strategy. This requires significant attention from a staff member, and not carried out in an ad hoc manner as at present. Marketing is not necessarily a full time position; it could be shared with other responsibilities at AOP. This role will be greatly facilitated once an online booking system is implemented, with database handling tools that allow AOP to better engage with target audiences, and to flexibly plan programmes for them.

[1] We note that some of these skills need to be shared across several people, but also that some key needs are not full time responsibilities.

Planetarium Receptionist

The role of receptionist at the front desk of the Planetarium is a full time one, a person able to meet and interact with visitors, handle bookings and sales etc. While it is possible, and indeed necessary at times, for the ESOs to partake in this role when demands dictate, this takes them away from their core duties. In particular, it limits their efforts at developing new programmes and activities, and contributing to AOP's online presence. Introducing as a permanent position a receptionist provides stability to a front line position, and will facilitate the growth of the education and outreach programme by freeing up the time of qualified staff to devote to this purpose. This person could also assume prime responsibility for maintaining the Planetarium shop, including enhancing the offerings available.

ICT Support

The ICT infrastructure underpinning the operation of the Dome and exhibition areas is specialist. If not adequately supported it provides for a single point failure that could put the Dome – the central feature of the AOP education programme – out of action for extended periods. It is important that the skills to maintain essential operations are spread across more than one person, although the expert support needed for the maintenance of the digital projector software and hardware is best served through an external contract.

Gardens and Astropark

To fully realise the potential of the AOP's grounds, combining the Georgian gardens and its heritage, the Astropark and the natural environment of the woodlands, needs the full-time attention of a dedicated person to the job, conversant with the needs of maintaining these features. AOP has only been able to give limited resources to maintaining the grounds over recent years, the groundsman steadily accreting a diverse range of additional duties associated with building maintenance, administration support and health & safety. AOP will not be able to properly open up its estate to the public unless it is able to devote more resources to maintaining and presenting them.

The start of the Woodland Walk through AOP's grounds, leading from the stone calendar on top of the Hill of Infinity back to the Planetarium.

Realising the Opportunity

Education is a central task of all civilised societies. Inspiring the young is especially important to future growth and advancement. Showing the next generation that astronomy and its supporting sciences are exciting and enjoyable adventures can stimulate a lifelong interest and career involving the science and technology. These are the STEM activities – science, technology, engineering and mathematics – that underpin our modern civilisation.

Despite all the sources of science education available today, there are surprising gaps in knowledge and failures in critical thinking amongst many. In today's complex society making decisions based on the application and evaluation of evidence needs to be encouraged. In Armagh we demonstrate these skills in action at the Observatory and Planetarium.

People have a right to know about the research they are helping to fund through their taxes. Communicating this research to wide audiences can benefit the researcher too, encouraging new ways of describing the science and the techniques behind it. Beyond these are the fundamental justifications for public outreach, that education is a human right and worthy of supporting in of itself.

The joining together of Armagh's Observatory and Planetarium provides a wonderful opportunity to expand and enhance the service provided to anyone seeking a deeper insight to the mysteries of the Universe. Almost uniquely, an experienced team of science communicators and a cadre of world-class researchers are now co-located to their mutual benefit. Astronomers can work together with educators, sharing experience and facilities to better explain the significance of their own research to the public to inform and inspire the next generation, bettering society in the process.

Armagh Observatory and Planetarium seeks to help everyone, regardless of age, experience or background to learn more about the wonders of our vast and intriguing cosmos. We provide a shared space where we are all equal under the stars.

Table 1: Current Education and Community Outreach Activities

Activity	Demographic	Regularity	Location
Schools Digital Theatre shows	Students KS1-3	Daily	Dome
Adult Digital Theatre shows	General public	Daily	Dome
Family Digital Theatre shows	General public with young families	Weekly	Dome
Night sky shows	General public	Weekly	Dome
Higher Education	PhD Students from NI, UK and international	PhD takes 3-4 years	Observatory
Summer Students	Undergraduates, mainly NI but also UK, international	Seasonal	Observatory
Work Experience Students	High Schools	Throughout year	Observatory
Human Orrery	Public, Schools	Throughout year	Observatory
Telescopes	Public	Occasional	Observatory
Heritage	Public	Special occasions	Observatory
Adult groups	General public	Weekly	Exhibition area, including Dome
Special needs groups	Community groups and support groups	Weekly	Exhibition area, including Dome
Corporate or other hire	General public	Occasional	Exhibition area, including Dome
Late night openings	General public	6 per year	Exhibition area, including Dome
School workshops	Students KS1-3	Daily	Exhibition area
Public workshops / presentations	General public with young families	Seasonal	Exhibition area
Exhibition areas self-guided tours	All	Daily	Exhibition area
Schools exhibitions tours	Students KS1-3	Daily	Exhibition area
Special needs exhibitions tours	Community/support groups	Occasional	Exhibition area
Groups exhibitions tours	General public and specialist organisations	Occasional	Exhibition area
After schools clubs	Students KS1-2	Seasonal	Exhibition area
Special themed events	General public with young families	Seasonal	Exhibition area
Online outreach (e.g. videoconferencing)	Students KS1-3	Occasional	Online
Social media, including blogs	General public, students KS1-3	Daily	Online
Astronotes	General Public	Monthly	Online

Activity	Demographic	Regularity	Location
Astropark self-guided tour	Public	Daily	AOP grounds
School outreach visits, with portable dome & projector	Students KS1-3	Occasional	External
Specific Events; e.g. meteor showers, eclipses, solstices	General Public	Through year	External
Public Talks	General public and specialist organisations	Occasional	External
Marketing events	Community groups, support groups, general public and specialist organisations	Occasional	External or AOP
Co-operative events with other organisations	General public with young families	Seasonal	External or AOP
Participation in Science Festivals	General public with young families	Seasonal	External or AOP
Media presentations	General public	Occasional	External or AOP

Table 2: Proposed New Activities

Activity	Demographic	Regularity	Location
Virtual Reality	General Public, students KS4-5	On-going	Exhibition area
Heritage guided tours	General public	Weekly	Across AOP
Space-themed Sculptures	General public	On-going	Across AOP, Astropark
Culture Tours and Events (inc. weddings)	Adult groups, inc. U3A, Cruise Liners	Monthly	Across AOP
Musical Performances	Adult	Monthly	Dome
Art House Cinema	Adult	Monthly	Dome
Podcasts	General public, students KS1-3	Monthly	Online
Vlogging	General public, students KS1-3	Monthly	Online
Virtual Q&A Sessions	Schools KS1-5	Monthly	Online
Bookshop	General public, students KS1-5	Occasional	Online, Shop
Publications on the history and heritage of Armagh	Culturally aware audiences, inc. U3A	Occasional	Online, Shop
Dark Sky Reserves	Environmentally aware adults, via community groups	Occasional	Slieve Beagh, Sperrin Mountains

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Cover (bottom right)	Rocket Launching, Armagh Planetarium	Armagh Observatory and Planetarium
Page 4	Archbishop Richard Clarke	Church of Ireland
Page 6	Armagh Planetarium	Armagh Observatory and Planetarium
Page 7	Moon	Armagh Observatory and Planetarium
Page 8	Horsehead Nebula	ESO – European Southern Observatory
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Page 12	A tour of the Observatory showing the Human Orrery	Armagh Observatory and Planetarium
Page 13	Scale Model of the Solar System, AOP Astropark	Armagh Observatory and Planetarium
Page 14	AOP's Portable Dome	Armagh Observatory and Planetarium
Page 17	Woodland Walk, AOP Grounds	Armagh Observatory and Planetarium