

Institution: University of Edinburgh		
Unit of Assessment: UoA 9 – Physics		
Title of case study: Life in and beyond confinement: Space Science and Astrobiology in Prisons		
Period when the underpinning research was undertaken: 2015–June 2018		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Charles Cockell	Professor	2011–present
Beth Biller	Professor	2013–present
Susana Direito	Impact Acceleration Associate	2013–present
Ken Rice	Professor	2006–present
Period when the claimed impact occurred: March 2016–December 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact <p>Attribution: The research on space exploration and life in extreme environments carried out by the UK Centre for Astrobiology in the School of Physics and Astronomy at the University of Edinburgh (UoE) underpins an educational programme in Scottish Prisons.</p> <p>Impact: The deployment of this educational programme has improved the well-being and rehabilitation of prisoners.</p> <p>Beneficiaries: The prison population, the prison management and learning centres in prisons, and, ultimately, society.</p> <p>Significance: This programme has improved scientific literacy, writing skills, education engagement, and a sense of civic accomplishment and responsibility in the Scottish Prison Service population, bringing prisoners as ‘marginalised learners’ an educational opportunity they rarely receive. Tapping into the unique experience that prisoners have of confinement, this programme has given them the capacity to co-create plans for the design of stations in the confined environments of other planets.</p> <p>Reach: Approximately 160 prisoners from across Scotland have been directly engaged in this programme. In addition, two books (<i>Life Beyond – From Prison to Mars</i>, <i>Life Beyond – From Prison to the Moon</i>) have been published and have been distributed to NASA and ESA, including trainee European astronauts at the European Astronaut Centre. The project has led directly to new initiatives in English prisons and the writing of Personal Development booklets for developing similar initiatives in other prisons in the UK and internationally.</p>		
2. Underpinning research <p>Charles Cockell has been Director of the UK Centre for Astrobiology at the University of Edinburgh since 2010. His involvement in space research, and his reflection on the confinement that space exploration implies, led him to the idea that the subject might be used as a basis to involve prisoners in considering the human future beyond the Earth and provide a vehicle for science education in which the participants had direct and immediate experience.</p> <p>The research underpinning this impact was carried out by the UK Centre for Astrobiology in the School of Physics and Astronomy, University of Edinburgh (UoE), on space exploration and life in extreme environments [R1, R2]. The Centre is involved in the study of life (including microbial life) in the space environment. For example, it has developed technology (bioreactors for growing microbes) in 2016 that eventually flew to the International Space Station in 2019 to gather fundamental data on the growth of microbes in space and their use in space exploration [R3, R4]. As part of its wider astrobiology activity, the Centre is interested in the human exploration of space.</p> <p>The link with prisons and the incarcerated population emerged from the notion that prisoners have experience of long-term confinement and isolation, not dissimilar to that required for space exploration, giving them unique insights into how to build a sustained presence on other planetary bodies. In this project, prisoners have used their experience to consider the designs,</p>		

both technical and social, of extra-terrestrial stations. The Centre's research has provided prisoners with the expertise and knowledge.

The Centre's interest in Mars and lunar exploration [R5] has provided technical underpinning to this project. Specifically, the centre has been involved with the science team designing the instruments planned for the European Space Agency's ExoMars rover, due to launch to Mars in 2022. Centre members are on the science teams for the Raman spectroscopy instrument, the CLUPI (Close-Up Imager) and the HABIT instrument designed to study the habitability of the Martian surface.

3. References to the research (indicative maximum of six references)

Synthesis summary of underpinning research on astrobiology at Edinburgh:

[R1] **Cockell CS, Biller B**, Bryce C, Cousins C, **Direito S**, Forgan D, Fox-Powell M, Harrison J, Landenmark H, Nixon S, Payler SJ, **Rice K**, Samuels T, Schwendner P, Stevens A, Nicholson N, Wadsworth J. The UK Centre for Astrobiology: A Virtual Astrobiology Centre. Accomplishments and Lessons Learned, 2011-2016. *Astrobiology* 18, 224-243 (2018). DOI: <https://doi.org/10.1089/ast.2017.1713>

Papers:

[R2] Lowery CM, Bralower TJ, Owens JD, Rodríguez-Tovar FJ, Jones H, et al. (including **Cockell CS**) Rapid recovery of life at ground zero of the end-Cretaceous mass extinction. *Nature* 558, 288-291 (2018). DOI: <https://doi.org/10.1038/s41586-018-0163-6> [36 citations, WoK]

[R3] Loudon C-M, Nicholson N, Finster K, Leys N, Byloos B, Van Houdt R, Rettberg P, Moeller R, Fuchs FM, Demets R, Krause J, Vukich M, Mariani A, **Cockell CS**. BioRock: new experiments and hardware to investigate microbe–mineral interactions in space. *International Journal of Astrobiology* 17, 303-313 (2018). DOI: <https://doi.org/10.1017/S1473550417000234> [5 citations, WoK]

[R4] Westall F, Foucher F, Bost N, Bertrand M, Loizeau D, Vago JL, Kminek G, Gaboyer F, Campbell KA, Breheret JG, Gautret P, **Cockell CS**. Biosignatures on Mars: What, Where, and how? Implications for the Search for Martian Life. *Astrobiology* 15, 998-1029 (2015). DOI: <https://doi.org/10.1089/ast.2015.1374> [89 citations, WoK]

[R5] Martin-Torres FJ, Zorzano MP, Valentin-Serrano P, Harri AM, Genzer M, Kemppinen O, et al. (including **Cockell CS**) Transient liquid water and water activity at Gale crater on Mars. *Nature Geoscience* 8, 357–361 (2015). DOI: <https://doi.org/10.1038/ngeo2412> [188 citations, WoK]

4. Details of the impact

The exploration of space is one of the great human adventures. New commercial organisations and governments are travelling into space, making this aspiration very real. One question that arises from this activity is how people will live in these extreme environments. This is a compelling challenge that contains within it a range of technical and cultural dimensions that have the potential to inspire people, and will require the involvement of wider society. In this project we used this question to inspire the prison population to imagine, and directly contribute towards, the human future beyond Earth.

Developing stimulating education programmes in prisons is not only beneficial for enhancing learning opportunities for participants, it has also been shown to reduce the percentage of individuals returning to prison and enhances social integration after release. Science is an important instrument for achieving these ends. It can be used to improve learning skills, enhance the ability to think critically, and develop numeracy and literacy skills. Linked to writing and arts and wider societal issues, science provides a vehicle for encouraging creativity and civic skills.

To assess the potential use of astrobiology in prisons as a form of science education, a pilot program was implemented in 2016, with visits to four prisons in Scotland: HMP (Her Majesty's

Prison) Shotts, Edinburgh, Glenochil and Lowmoss. Building on the success of the pilot scheme, a programme was developed and the first full course was run in 2017.

The *Life Beyond* programme is a four-week course. The course has been structured to lead prisoners through the process of thinking about space exploration to designing their own extraterrestrial stations. It has been designed to use the Centre's knowledge of extreme environments and space exploration to inform the prisoners [R1-R5]. The material provided to the prisoners to start their own station designs include books and articles from the Centre's own research work. To date, the course has involved approximately 160 prisoners [I1] – roughly 2% of the Scottish prison population.

In the *Life Beyond* course, groups of four or five prisoners consider what scientific and technical challenges there are to living in space, transitioning into designing their own space station, incorporating challenges such as oxygen and food production. Movement between groups is encouraged to share ideas and knowledge throughout the course. Participants then work on their designs, either as a group or individually within their cells. They work on engineering diagrams, concept drawings or calculations on food, fuel, oxygen and other requirements to develop their writing, numerical and drawing skills. They then consider what the occupants at the station would do, such as planning expeditions or conducting science. This is the week in which ancillary activities take place, including creative writing, art, and model making. Finally, they consider how a society would be run in space and what challenges in governance, civic responsibilities and management confront a group of people living in a station, contributing to their knowledge and ideas about these important areas of personal development. They are encouraged to use their own experiences in prison to think about these issues, stimulating discussion on interdependence of societies, democracy and active citizenship.

Impact

The project has had a major impact on the prisoners involved, proven by their own personal testimonials [I2] that illustrates the effect of the course on their sense of engagement with education, their well-being and the educational attainment. One participant stated that the course:

“helped me with better perseverance, patience and the value of mutual cooperation. ... This project is a great motivator and it has a very positive psychological effect which may help other people in prison with mental health issues, enhance their mood, improve motivation, and generate optimism as it provides people with a great activity to look forward to.” [I2]

Beyond merely gaining new knowledge, the project provides an opportunity for prisoners to contribute to entirely original research on designs for space stations, which are then collated and published as books by the British Interplanetary Society [I3]. This demonstrates the effect of the project on prisoner educational attainment. Two books have been published so far: *Life Beyond: From Prison to Mars* and *Life Beyond: From Prison to the Moon* [I3]. They have been distributed to major space exploration organisations, such as NASA, ESA, and trainee astronauts at the European Astronaut Centre, to disseminate the efforts of the prisoners. Since publication, *Life Beyond: From Prison to Mars* has sold 328 copies [I4].

The originality of the prisoners' work and the effort they put into the project has been recognised by the Koestler Arts, a UK prison arts charity. In 2018, one of the groups at HMP Glenochil won a Silver Koestler Award for their work on the Terra Nova Mars station in *Life Beyond* [I5]. Their winning entry to these annual awards ('arts by offenders') is shown below in Figure 1.

In addition to impact among the prison population, the project has become a benchmark of educational good practice in prisons across Europe. A 2019 report from EuroPris, an EU-wide network of prisons and prison education establishments that considered new plans for education in European prisons, cited the *Life Beyond* course as an example of good practice.

The report highlighted that the project has provided “an enriched curriculum” for prisoners and “promot[es] scientific knowledge as well as developing key skills in leadership, citizenship, design and creativity” [16].

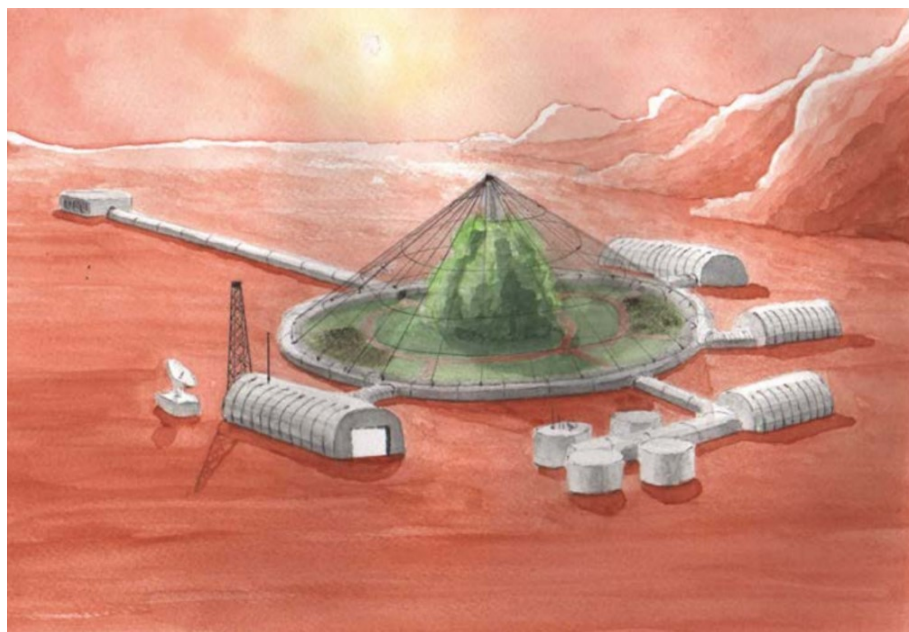


Figure 1: Winner of a Silver Koestler award in 2018 — the design of a station on Mars, the Terra Nova Base by prisoners at HMP Glenochil.

The *Life Beyond* project has directly inspired a new initiative in an English prison. For example, the ‘Think like a scientist’ course in HMP Low Newton uses the methods developed in our course to write a letter home from Mars to engage prisoners in developing science and writing skills [17].

The project has led to new educational evaluation materials in prisons. Prisoners complete Personal Development (PD) plans, which provides evidence of their progress in a variety of ways, such as group work, public speaking and interpersonal behaviour. In 2018, prisoners on our course in HMP Glenochil wrote a completely new development plan based on the project, which is available in HMP Glenochil and more widely [11]. This new *Life Beyond* development plan is used by prisoners to show progress in the following Scottish Credit and Qualifications Framework (SCQF) units: Self in Community Unit (SCQF level 3 and 4), Self and Work (SCQF level 3 and 4), and the Practical Abilities Unit (SCQF level 3 and 4), which are segments of wider qualifications across several subjects within the Scottish prison education system [11]. The course also used peer-to-peer teaching. For example, the prisoners who wrote the 2018 development plan aided their fellow prisoners to complete the plans in 2019. This increases the confidence of prisoners. Those teaching their fellow prisoners gain teaching and mentoring experience. Participants have greater engagement since they are being taught by their fellow prisoners. The Edinburgh project organisers have also written papers, published in the *Journal of Correctional Education and Astronomy and Geophysics*, to explain the impact of the project, its structure, and how to implement this project in other prisons [18].

Ultimately, society benefits from this work. Research has shown that educational activities in prisoners reduces the rate of reoffending (e.g., Vacca, J.S., *Journal of Correctional Education* 55, 297-305, 2004). Thus, although difficult to quantify directly, we expect that our work contributes to an overall educational strength and quality in prisons that can reduce reoffending.

The Scottish Prison Service (SPS) has been radical in its objective of distancing prison education from a fairly universal and uniform curriculum that is currently focused on remedial literacy/numeracy and low employability courses. In rejecting such ‘correctional’ pedagogy, SPS were both breaking with longstanding custodial conventions and realigning education to

meet the individual needs and aspirations of prisoners. This project has directly contributed to this objective by providing a powerful way for prisoners to learn a variety of skills and knowledge and in the process contribute to original research [I1], as the Head of Learning and Skills at the SPS has observed:

“... the subject matter not only engaged learners but enabled them to imagine other entities and other realities and other possibilities. This helps learners to think more critically, furnishing them with skills to re-imagine their own lives, appreciate the necessity and benefits of cooperation, citizenship and human endeavour and how they, as marginalised and often disaffected learners, could and should embrace the opportunities to contribute to the unfolding and flourishing of new knowledge and understanding.” [I9]

The *Life Beyond* programme has also been commended by the Prisoners' Education Trust (PET), the UK's leading prison education charity:

“Education can provide the means to enable prisoners to transform their lives both within custody and on release. The materials generated for the project offer an excitingly new and significant way for prisoners to engage in education and produce original work, particularly in science education. The subject matter is big and bold enough to encourage engagement with the science of astro-biology (even for those without any science background or training), imagination and creativity. The books that the prisoners have produced are a testament to that.” [I10]

Cockell is now working with the organisation to create “in-cell” (reflective of the current COVID-19 restrictions) packs of *Life Beyond* project materials to be distributed within prisons across England and Wales. This will allow a whole new group of prisoners to take part in the project in the coming years.

5. Sources to corroborate the impact

[I1] Corroborating contact: Head of Learning & Skills at SPS. Can verify the number of prisoners that took part, the new personal development plans, that the project helped prisoners progress with SCQF units, and the project's contribution to SPS educational objectives.

[I2] Quotes taken from prisoners' feedback on the course

[I3] Books (hard copies retained by the university): *Life Beyond: From Prison to Mars* (ISBN: 978-1983289088) and *Life Beyond: From Prison to the Moon* (979-8642193419).

[I4] Sales numbers of *Life Beyond: From Prison to Mars* (provided by The British Interplanetary Society)

[I5] 2018 Koestler Trust Silver Award (HMP Glenochil; *Terra Nova – Life Beyond*) won by prisoners (page 24): <https://www.koestlerarts.org.uk/wp-content/uploads/2015/11/2018-Koestler-Awards-Results.pdf>

[I6] Example of impact of project on Europe-wide good prison practices. A EuroPris report cited the project as an example of good practice in European prisons (page 3 of tabulated best practice collection): <https://www.europris.org/file/report-review-of-european-prison-education-policy-and-council-of-europe-recommendation-89-12-on-education-in-prison/>

[I7] Article describing the 'Think Like A Scientist' course running at HMP Low Newton near Durham: <https://www.neechamber.co.uk/our-members/news/first-for-england-as-science-course-taught-in-prison>

[I8] a) Cockell CS, Fosado YAG, Hitchen J, Landenmark H, Perera L, Vissers T (2018) *Life Beyond – A program to use astrobiology to teach science and advance space exploration through prisons. Journal of Correctional Education* 69, 30-43 <https://www.jstor.org/stable/26508039>; b) Cockell CS (2018) *Life Beyond – planning for Mars in prisons. Astronomy and Geophysics* 59, 4.32-4.35 <https://doi.org/10.1093/astrogeo/aty193>

[I9] SPS statement outlined in the foreword to *Life Beyond: From Prison to Mars* (ISBN: 978-1983289088) published in June 2018 (PDF scan available for reference)

[I10] Support letter from the Chief Executive of the Prisoners' Education Trust