

Prime Minister
10 Downing Street
London SW1A 2AA

25 June 2020

Dear Prime Minister,

Principles for science and technology moon-shots to achieve by 2030

When you met with the Council for Science and Technology on 4th March, you invited us to offer some advice on moon-shots that could showcase the UK as a science superpower and we discussed some ideas for moon-shots. We are now writing to offer some general advice on formulating and delivering a moon-shot.

Since that meeting, it has become clear that the world is now facing one of the greatest challenges of the post-war era. The focus across government has rightly changed to tackling a global pandemic that has far-reaching ramifications for public health, national economies, and almost every aspect of daily life and society. The SARS-CoV-2 (Covid-19) pandemic has highlighted the importance of science and technology in facing a challenge of such epic proportions, and in building a robust, sustainable, and equitable recovery plan for the UK, post-Covid.

In such a context, moon-shots could be an inspiring and galvanising element of a national research and innovation strategy as part of the overall recovery package: they can instil a sense of direction and ambition, offer concrete goal-oriented solutions to major societal issues, and showcase the UK as a global leader in science and technology.

However, they will not be enough: the wide-ranging issues laid bare by Covid-19 cannot be addressed through moon-shots alone. A resilient recovery from the current pandemic will require a whole-systems approach, including radical and urgent thinking on topics such as our relationship with the environment, global and national economics, and the future of our health and care systems. We will be providing separate advice on how science and technology can help in the UK's post-Covid recovery.

On moon-shots, we have identified seven central principles that we believe are needed to guide their formulation. A moon-shot should:

- i) Excite and inspire the public, academia, and industry

- ii) Help solve an important societal issue
- iii) Be truly disruptive and ground-breaking
- iv) Focus on areas where the underpinning science is at a stage to make a major breakthrough feasible
- v) Be specific and well-defined in what it sets out to achieve, with a clear timeframe for completion
- vi) Take advantage of areas where the UK is, or is poised to be, a world leader
- vii) Generate significant additional benefits.

We provide further detail on these principles in the attachment below, as well as factors to consider in delivering a successful moon-shot programme.

A moon-shot's success will depend on seeking out and maintaining a long-term perspective. We believe that once the themes and funding for moon-shots are decided by government, an independent team of leaders should be established to develop a programme of activity. This operation should be transparent, but it must have maximum autonomy from government. It will also be important to review and build on the significant work done under the Industrial Strategy Grand Challenges to identify and fund research and innovation that can address the greatest industrial and societal challenges of today.

The final decision on which themes to support will rest with you and your government. Whichever decision is taken will send a powerful signal to the academic and industrial research communities, inside and outside the UK, about our nation's priorities and future direction. We hope that you will find our input useful for stimulating further discussion, and for guiding the development of the UK's work on moon-shots. We would be pleased to discuss our recommendations with you or your ministerial colleagues.

We are copying this letter to the Chancellor of the Exchequer, the Secretary of State for Business, Energy and Industrial Strategy, the Chief Secretary to the Treasury, the Parliamentary Under-Secretary of State for Science, Research and Innovation, the Cabinet Secretary, the Permanent Secretary to the Treasury, the acting Permanent Secretary to BEIS and the Chief Executive of UK Research and Innovation.



Sir Patrick Vallance

Co-Chair



Professor Dame Nancy Rothwell

Co-Chair

Prime Minister's Council for Science and Technology:

Principles and general advice for moon-shots

1 Definitions and principles

A 'moon-shot' can be defined as a highly ambitious national or international goal, which, through several scientific, engineering, or technological breakthroughs, delivers a disruptive innovation or solution. It is, by its nature, a multi-disciplinary and multi-stakeholder enterprise, bringing together a range of partners from academia and industry to work towards the overall, single goal.

From this definition, we have identified seven key principles that should guide the process of formulating a moon-shot. A moon-shot should:

- i) **Excite and inspire** the public, academia, and industry, galvanising academic and industrial research and development. A successful moon-shot will engender a sense of motivation, collective achievement, and national pride.
- ii) **Relate to and help solve an important societal issue** which the public can identify with.
- iii) **Be truly disruptive and ground-breaking**, not merely a 'ramping up' of effort in an existing activity or objective.
- iv) Focus on areas where the **underpinning science is at a stage to make a major breakthrough feasible**.
- v) **Be specific and well-defined** in what it sets out to achieve, with a **clear timeframe** for completion, and an explicit, **single measure of overall success**. It will be obvious to everyone, including the public, when the moon-shot has achieved its goal.
- vi) Take advantage of areas **where the UK is, or is poised to be, a world leader**; a moon-shot should demonstrate national capability on the international stage.
- vii) Finally, a moon-shot should offer the prospect of generating **significant additional benefits** from scientific and technological advances which have the potential to be applied in other areas, providing benefits in their own right.

2 Delivering a successful moon-shot

In addition to these seven central principles for formulating and choosing moon-shots, we offer some general advice on delivering them. These can be thought of as fundamental factors in the success of a moon-shot.

Firstly, the **people, processes, and governance structures** put in place to formulate and deliver moon-shots will be critical to success – as important, if not more so, than the moon-shot ideas themselves. A moon-shot team should comprise a wide range of professional skills and specialist knowledge from across disciplines, from researchers to engineers. It should have maximum autonomy from government and from political cycles, while maintaining openness, transparency, and accountability. Further factors will need to be considered, such as the skills required at each stage, how risk will be both embraced and managed, and where ultimate accountability should lie.

Related to such questions, there will need to be an effective way to bring together, coordinate, and direct multiple disciplines and parties, each with their own perspectives, working cultures, and structures. This is especially important considering that a moon-shot team, due to its vast and cross-disciplinary nature, might not be collocated. A dedicated and well-resourced moon-shot research and delivery agency could help ensure direction and coordination across workstreams, disciplines, and locations.

Secondly, **finance** – access to the right financial mechanism at the right time – will be an essential factor, helping those working on a moon-shot meet associated costs and deliver the planned outputs on time. Moon-shots will need the resources to deliver transformative change, including funding for the development and deployment of infrastructure relevant to the moon-shot. There is also a role that government procurement could play, for example by employing procurement criteria that value innovation.

Thirdly, we would highlight the importance of understanding **human perceptions, trust, and behaviour**, and of looking beyond the traditional “hard sciences” for insights. These are essential factors to consider at every stage: identifying relevant issues that a moon-shot should address, ensuring public acceptance of a moon-shot, and helping to maximise a moon-shot’s impact on society.

Fourthly, the UK’s success in moon-shots will depend partly on the **international setting**, and on the UK’s place in the world. The UK should position itself as a thought leader in the development of global norms, regulations, and standards (for example, by leading the international debate on data ethics), seeking out international collaboration and constructive partnerships. Many of the difficult challenges we face today cannot be solved by national technical ingenuity alone.

Fifthly, **evaluation** will be critical. Performance indicators for a moon-shot must be established from the outset, and there should be a sustained monitoring of success, risks, and issues throughout a moon-shot’s life. There should also be recognition that R&D is rarely a straightforward linear process, and that failure in some aspects of work to achieve the moon-shot is a possibility. Monitoring progress and adjusting the approach will help to successfully deliver the goal, and to also learn key lessons for future moon-shots.

Finally, it will be essential to **examine and understand the drivers of the challenges** facing us. An in-depth understanding of the past, present, and possible futures of any challenge will be needed to better design and future-proof the solutions that are pursued. It will thus be constructive to bring together, at the very first planning stage of a moon-shot, historical, sociological, economic, and scientific expertise, as well as insights from horizon-scanning experts. In a similar effort to avoid the well-established pitfalls of short-

term thinking, there should be, from the outset, **a plan to develop the benefits** that a moon-shot is projected to bring. This will help to maximise a moon-shot's impact and the longevity of the benefits it unleashes. In short, a moon-shot's success – defined ultimately as helping to solve a monumental challenge – will depend on seeking out and maintaining a long-term perspective.

3 Limitations of the moon-shot model

There are some issues with the moon-shot model that we should highlight. Moon-shots can sometimes be presented as panaceas to some of modern society's grandest and most complex questions (so-called "wicked problems"). These challenges, such as how to maintain good living standards for a growing population whilst protecting the environment from further damage, pose questions and dilemmas that science alone cannot address. It is therefore imperative that those formulating a moon-shot are unequivocal on the specific problem the moon-shot will seek to address, and that the problem identified *can* be at least partially resolved through science and technology.

Related to this, the crux of the issue in some cases is not one of scientific or technological discovery or innovation alone, but of implementing existing technology, public engagement and public trust, and the enforcement of standards through government regulation (the retrofitting of homes is an apt example here). In some of these areas, a whole-systems approach, rather than a single science and technology moon-shot, would be more appropriate.

Lastly, there are many complex problems facing us that could be addressed through science and technology, but whose potential solutions do not fit the moon-shot of a highly specific, pre-planned outcome. In such cases, other approaches will be more appropriate. For example, government could fund pilot projects to test proposals, and to learn from the pilot's findings. Government also has a role in providing sustained support for science and technology projects that work towards incremental improvements over a long period. There must always be space and funding for speculative, open-ended research whose overall goal may not be evident from the starting point, but whose discoveries may nonetheless prove indispensable to science.

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