



UNIVERSITY of LIMERICK
OLLSCOIL LUIMNIGH

Faculty of
Science + Engineering



THE BERNAL PROJECT

October 2011



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OLLSCOIL LUIMNIGH

The Bernal Project

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INTRODUCTION

The [University of Limerick](#) has adopted a new strategic plan for the period 2011 to 2015. The title of the plan, [Pioneering and Connected](#), reflects both the history of this wonderful institution and our ambition for its future.

The plan commits the University to forging new ways of teaching and learning for our students and to seeking innovations in research that will advance the economic, educational and social development of our region and the world. The plan seeks to create a university that is both locally and globally connected.

A strong sense of local connection to our communities is a defining feature of the University of Limerick, and we fully appreciate our responsibility to promote economic, educational, social and cultural development, particularly in the Shannon region.

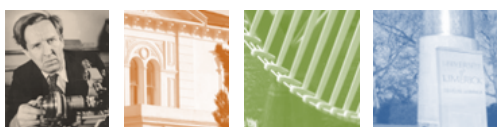
We recognise too that a modern university must be connected to the global research and learning environment to fully realise its ambitions. Internationalisation, both as a way of thinking and in the implementation of specific actions, will form a central component of our strategic activities for the next five years. It will be reflected in both our programme content and our research activities and we will continue to internationalise our student body and staff.

The imperative in growing the University and contributing to the economic development of Ireland is premised on developing a deep knowledge infrastructure and human capital base that will attract investment and stimulate the development of high-end industry and services at the core of a revitalised “smart” economy.

UL has been fortunate to secure private and public support to put in place a world-class knowledge infrastructure that makes our campus the envy of many in the sector. UL has attracted world-class faculty who have international reputations and cutting edge research programmes. But there are human capital gaps that need to be filled in disciplines that are already strategically important or that are emerging as priority areas.

UL wants to recruit leaders in these fields to drive change, pioneer innovation and achieve success that will yield significant benefits for society in the future.

*Professor Don Barry,
President,
University of Limerick*





SCIENCE + ENGINEERING AT THE UNIVERSITY OF LIMERICK



The [Faculty of Science + Engineering](#) at the University of Limerick comprises 200 academics, 150 of whom are research active, namely they actively seek research funding, supervise research students and publish in peer reviewed journals.



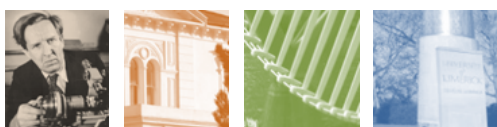
In 2009, as well as supporting the undergraduate education of 3000 students of Science + Engineering, the academic staff secured 27 million Euro of research funding. This funding supported the research of 400 PhD students, 120 Research Masters Students and 150 postdoctoral fellows. In 2009, the Faculty also graduated 66 PhD's, published 290 peer reviewed journal articles and 9 patents.

In the area of technology transfer in 2009 there were 27 invention disclosures, 6 licence agreements and two spin out companies established.

The Faculty is organised internally through 10 academic departments and contributes nearly all the key personnel for the flagship UL Research Institutes, namely the Materials and Surface Science Institute (MSSI), Lero (The Irish Software Engineering RresearchCentre) and The Stokes Institute. It has benefited from a succession of Programmes for Research in Third Level Institutions since 1999.



*Professor Kieran Hodnett
Dean
Faculty of Science + Engineering
University of Limerick*



THE BERNAL PROJECT

The University of Limerick wishes to enhance its research in the Applied Science & Engineering sphere and has made a strategic decision to concentrate its enhancement efforts in areas which are:

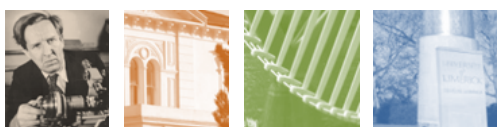
- Capable of Generating a Reputation of Research Excellence for the University
- Suitable for Addressing Technical Problems of Importance to Ireland
- Capable of Generating Excellent Interactions with Industry

The Bernal Project is focussed on the development of the following selected areas:

- Pharmaceutical Science and Engineering,
- Modern Materials, Biomedical Materials and Engineering,
- Energy and Sustainable Environment

These selections are based in part on our current strengths, particularly in the areas of materials and energy, and in many cases a reorientation of existing strengths into new areas. For example, Powder Technology has always been a strength in the Materials and Surface Science Institute (MSSI) as it relates to Ceramics and Catalysts. In this proposal this expertise would be reorientated to Pharmaceutical Powders. Each of the selected areas is already supported by major funding from the Programme for Research in Third Level Institutions (PRTL), Science Foundation Ireland (SFI), Enterprise Ireland (EI) and the EU.

Other key areas of strength in the Applied Science & Engineering sphere will be maintained and developed through state funding and continued success in competitive research funding programmes. These areas include Software, Electronics, Design, and Applied Mathematics.



THE BERNAL PROFESSORSHIPS

The Bernal Project envisages the creation of ten new professorships in the three selected areas. These professorships will be known as the **Bernal Professorships**. The posts will be filled through a competitive process guided by a worldwide professionally directed search. Appointees will be offered full-time permanent contracts.

The ten new professors will be recruited on a phased basis with 4 recruited by September 2012, a further 3 by September 2013 and the final 3 by September 2014. The precise areas for the first 4 new professorships are shown in the following table. The phasing of recruitment has been designed in such a way that the immediate equipment and space needs of the earlier appointees can be met from existing infrastructure.

This project seeks to recruit a cohort of Senior Academic Research Leaders in applied sciences and engineering, and would provide them with the necessary facilities for carrying out their research. We will be appointing Senior Academics with the ability to motivate, attract, mentor and work with a larger cohort of younger academic staff and researchers. Typically, each Research Leader would work with 3 young academic staff (mostly at lecturer level, some of whom are already at UL), and 10-15 researchers at postgraduate and postdoctoral levels, leading to a new research cohort of 140-180 people.

The objective is to generate for UL a world-wide reputation in applied sciences and engineering, with strong outputs in terms of the attractiveness of our research graduates, the citation rates of our scholarly publications and our contributions to the development of industry and wealth in Ireland and the Shannon region. These objectives align with the Research Objectives of the University of Limerick Strategic Plan 2011-2015.

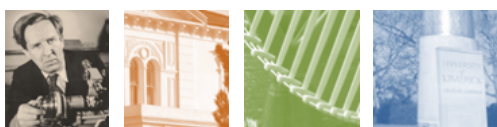
Bernal Science & Engineering Professorships Recruitment Plan 2012

Pharmaceutical Powder Engineering

Biomedical Engineering

Energy

Alternative Energy Engineering





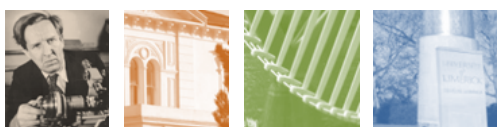
THE BERNAL BUILDING



The Bernal Project also envisages during Phase 1 the provision of a fully equipped laboratory building of the order of 5800m² to enable the research of the ten appointees. A further 6,000m² of laboratory space is envisaged for Phase 2. Typically, each research leader would be provided with laboratory space, offices for academics and administration and open plan write-up areas for researchers. Each laboratory would be equipped in a manner to suit each individual research area.

The building will be designed to support interdisciplinary convergent research with relevance. Distinguishing features will be the infrastructure to support the research teams to translate industry informed research innovations from concept to pre-commercial scale. Incubation units will facilitate and support the development of high potential start-up companies based on the products and processes developed in the Bernal facility. The building itself will be designed and built as a working prototype in energy efficiency.

It is planned to locate the Bernal Research building on the South Campus adjacent to existing science and engineering research facilities. This will further strengthen the University's Science Zone and provide a particularly creative environment for this new research development, an environment that creates close proximity between researchers, students, professors and research facilities across different disciplines. This strategy has sprung from the need to bring together creative minds that interact in an interdisciplinary way as well as sharing specialised facilities and equipment.



COST OF THE BERNAL PROJECT

The total cost of the Bernal Project is estimated at **€52million**.

Start Up Costs

It is envisaged that each professor will be responsible for the provision of ongoing research funding in their own areas through the normal competitive processes, requiring as a minimum the generation of €400,000 per annum in research funding. This would cover salaries of researchers and normal running costs for their research.

However, in order to attract leading researchers to come to Limerick, it will be necessary to put at their disposal a start up package of funding to ensure that the move will not interrupt their research and to give them time to develop proposals aimed at winning competitive external research funding on their own account. The University will make available to each appointee a start up package to the value of €500,000. Expenditure from this package is assumed to start in September of the year of appointment and to be completed two years later.

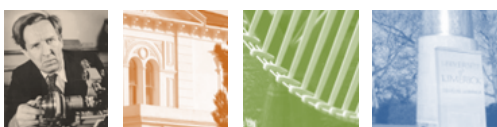
Typical costs charged to faculty start-up funds may include: Postgraduate Students, Post Doc Fellows, Research Assistants, Research Equipment and Computers, Consumables for Research Projects, Professional Travel Costs and Administrative Support. The balance of funding between the items listed above will depend very much on the requirements and circumstances of the new appointee.

Expenditure Plan

The expenditure plan covers the full capital costs of the building and its equipment, the full start up costs and the salary costs of the new professors for a ten year period starting in September of the year of appointment.

The expenditure and associated funding plan is divided into 3 phases as follows:

- **Phase 1** includes the costs associated with 4 professorships and with work on the concept design and design specification for the capital expenditure;
- **Phase 2** includes the costs associated with 3 further professorships and with the construction and fitting out of the building;
- **Phase 3** includes the costs associated with the final 3 professorships.



BERNAL CHAIR IN ENERGY

This Chair is offered in the context of the Bernal Project, a €52 million investment at the [University of Limerick](#) in [Science and Engineering](#), which will involve the appointment of ten Bernal Chairs and the construction of an appropriately equipped 6000m² experimental facility.

This position is focused on energy systems, devices and novel materials for energy conversion, efficiency, storage and management. The subject area includes the development of new components such as electrodes, electrolytes, membranes, sensors, processes and management protocols for energy conversion and storage devices, such as solar cells, batteries or fuel cells. A fundamental and thorough understanding of the relevant physics, chemistry or engineering is essential. The candidate will be expected to lead a major initiative in energy at the University of Limerick with a high national and international impact. The new appointee must demonstrate how their research and teaching would complement existing strengths at the University of Limerick and at our strategic partner, the National University of Ireland, Galway.

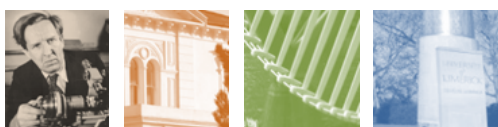
The holder of this chair is expected to have a strong background in the relevant fundamentals, and a sincere interest to develop and apply this competence to promote new technologies and commercial outcomes. The successful candidate, from an academic or industry background, will have a PhD in a relevant discipline, an international research reputation in the discipline as indicated by multiple successes in securing research funding, leading a group of researchers and a significant publication record in high impact international journals or patents. The successful candidate must also demonstrate their interest and experience in teaching at undergraduate and postgraduate levels and become involved in new course developments.

The successful candidate will develop their research with the Department of [Physics and Energy](#), be affiliated with the [Materials & Surface Science Institute](#) or the [Stokes Research Institute](#) and develop a Centre of Excellence in Energy within these structures.

A generous research package including a start-up fund (€500,000) and laboratory space and equipment will be made available to help make the transition from an existing position quickly and efficiently. In their covering letters candidates should indicate how they would use their startup funding and how their research would complement that already underway in UL.

The closing date for applications is 30 January 2012. Screening and Short listing will take place prior to 13 February 2012' and candidates informed thereafter of the results. The interviews will take place at the University of Limerick on the 5-6 March 2012.

Recruitment Dates Bernal Chair in Energy				
Position	Presentation and Interview Dates	Date by which Shortlisting is Completed and Applicants informed	Date by which Screening is Completed	Dead-Line For applications
Bernal Chair in Energy	5-6/3/2012	13/2/2012	31/1/2012	30/1/2012



BERNAL CHAIR IN BIOMEDICAL ENGINEERING.

This Chair is offered in the context of the Bernal Project, a €52 million investment at the [University of Limerick](#) in [Science and Engineering](#), which will involve the appointment of ten Bernal Chairs and the construction of an appropriately equipped 6000m² experimental facility.

This position will focus on any of the main areas of Biomedical Engineering including Biomechanics, Biofluidics, Biomedical Computation and Modelling, Mechanobiology, Biomedical Devices and Materials, Biomechatronics, Neurotechnology, Biomaterials, Implants and Regenerative Medicine. A thorough knowledge of tissue behaviour, tissue chemistry, and/or molecular and stem cell biology will be required of the successful candidate. An interest in the biocompatibility of materials would be highly desirable. The new appointee must demonstrate how their research and teaching would complement existing strengths at the University of Limerick and at our strategic partner, the National University of Ireland, Galway.

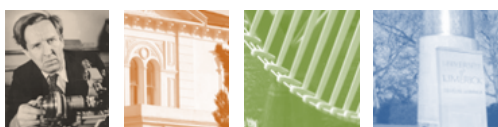
The holder of this chair is expected to have a strong background in the relevant fundamentals, and a sincere interest to develop and apply this competence to promote new technologies and commercial outcomes. The successful candidate, from an academic or industry background, will have a PhD in a relevant discipline, an international research reputation in the discipline as indicated by multiple successes in securing research funding, leading a group of researchers and a significant publication record in high impact international journals or patents. The successful candidate must also demonstrate their interest and experience in teaching at undergraduate and postgraduate levels and become involved in new course developments.

The successful candidate will develop their research with the [Materials and Surface Science Institute](#) or [The Stokes Research Institute](#) and the Department of [Mechanical, Aeronautical and Biomedical Engineering](#).

A generous research package including a start-up fund (€500,000) and laboratory space and equipment will be made available to help make the transition from an existing position quickly and efficiently. In their covering letters candidates should indicate how they would use their start-up funding and how their research would complement that already underway in UL.

The closing date for applications is 30/1/2012. Screening and Shortlisting will be completed by 13/2/2012 and candidates informed thereafter of the results. The interviews will take place at the University of Limerick on the 8-9/3/2012.

Recruitment Dates Bernal Chairs				
Position	Presentation and Interview Dates	Date by which Shortlisting is Completed and Applicants informed	Date by which Screening is Completed	Dead-Line For applications
Bernal Chair in Biomedical Engineering	8-9/3/2012	13/2/2012	31/1/2012	30/1/2012



BERNAL CHAIR IN PHARMACEUTICAL POWDER ENGINEERING

This Chair is offered in the context of the Bernal Project, a €52 million investment at the University of Limerick (www.ul.ie) in Science and Engineering (www.scieng.ul.ie), which will involve the appointment of ten Bernal Chairs and the construction of an appropriately equipped 6000m² experimental facility.

This position is a chair focused on physical properties and processing of pharmaceutical powders. The subject area includes the relationship between molecular properties, crystal structure, macroscopic particle and powder properties of pharmaceutical solids including powder flow ability, adhesion and agglomeration, behaviour in milling and granulation, compressibility, the mechanical shear, stress and deformation characteristics in compacted powders and how these relate in turn to technological aspects of the manufacturing of solid dosage forms. This position will approach the area of secondary manufacturing of pharmaceuticals, from a solid state chemistry or physics / mechanical engineering / chemical engineering point of view. The new appointee must demonstrate how their research and teaching would complement existing strengths at the University of Limerick and at our strategic partner, the National University of Ireland, Galway.

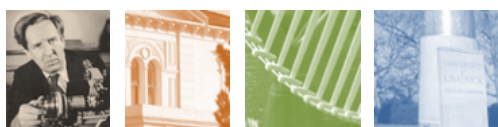
The holder of this chair is expected to have a strong background in the relevant fundamentals, and a sincere interest to develop and apply this competence to promote new technologies and commercial outcomes. The successful candidate, from an academic or industry background, will have a PhD in a relevant discipline, an international research reputation in the discipline as indicated by multiple successes in securing research funding, leading a group of researchers and a significant publication record in high impact international journals or patents. The successful candidate must also demonstrate their interest and experience in teaching at undergraduate and postgraduate levels and become involved in new course developments.

The successful candidate will develop their research with the [Solid State Pharmaceutical Cluster](#), the [Materials and Surface Science Institute](#) and the Department of [Chemical and Environmental Sciences](#).

A generous research package including a start-up fund (€500,000) and laboratory space and equipment will be made available to help make the transition from an existing position quickly and efficiently. In their covering letters candidates should indicate how they would use their start-up funding and how their research would complement that already underway in UL.

The closing date for applications is 6/2/2012. Screening and Shortlisting will be completed by 20/2/2012 and candidates informed thereafter of the results. The interviews will take place at the University of Limerick 12-13/3/2012.

Recruitment Dates Bernal Chairs				
Position	Presentation and Interview Dates	Date by which Shortlisting is Completed and Applicants informed	Date by which Screening is Completed	Dead-Line For applications
Bernal Chair in Pharmaceutical Powder Engineering	12-13/3/2012	20/2/2012	7/2/2012	6/2/2012



BERNAL CHAIR IN ALTERNATIVE ENERGY ENGINEERING.

This Chair is offered in the context of the Bernal Project, a €52 million investment at the University of Limerick (www.ul.ie) in Science and Engineering (www.scieng.ul.ie), which will involve the appointment of ten Bernal Chairs and the construction of an appropriately equipped 6000m² experimental facility.

The position will focus on any of the major areas of Alternative Energy Engineering including Chemical, Biochemical or Green Technologies for applications to Pharmaceutical, Biofuels, Combustion or Hydrogen Generation and Storage. This position will approach the area of Alternative Energy Engineering from an engineering point of view, but candidates must demonstrate a thorough molecular level understanding of their discipline as appropriate. The new appointee must demonstrate how their research and teaching would complement existing strengths at the University of Limerick and at our strategic partner, the National University of Ireland, Galway.

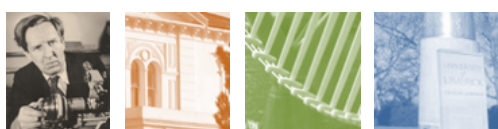
The holder of this chair is expected to have a strong background in the relevant fundamentals, and a sincere interest to develop and apply this competence to promote new technologies and commercial outcomes. The successful candidate, from an academic or industry background, will have a PhD in a relevant discipline, an international research reputation in the discipline as indicated by multiple successes in securing research funding, leading a group of researchers and a significant publication record in high impact international journals or patents. The successful candidate must also demonstrate their interest and experience in teaching at undergraduate and postgraduate levels and become involved in new course developments.

The successful candidate will develop their research in the Department of [Chemical & Environmental Sciences](#), be affiliated with the [Materials & Surface Science Institute](#) or the [Stokes Research Institute](#) and develop a Centre of Excellence in Alternative Energy Engineering within these structures.

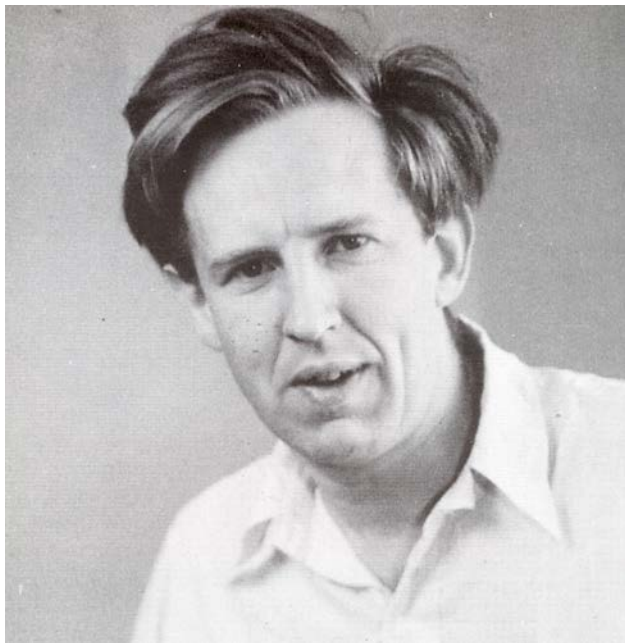
A generous research package including a start-up fund (€500,000) and laboratory space and equipment will be made available to help make the transition from an existing position quickly and efficiently. In their covering letters candidates should indicate how they would use their start-up funding and how their research would complement that already underway in UL.

The closing date for applications is 6/2/2012. Screening and Shortlisting will be completed by 20/3/2012 and candidates informed thereafter of the results. The interviews will take place at the University of Limerick on the 15-16/3/2012.

Recruitment Dates Bernal Chairs				
Position	Presentation and Interview Dates	Date by which Shortlisting is Completed and Applicants informed	Date by which Screening is Completed	Dead-Line For applications
Alternative Energy Engineering	15-16/3/2012	20/3/2012	7/2/2012	6/2/2012



BIOGRAPHY - JOHN DESMOND BERNAL, 1901 (NENAGH, CO. TIPPERARY) - 1973 (LONDON)



J. D. Bernal was born in Brookwatson, Nenagh, Co. Tipperary on the 10th May 1901, the first son of Samuel and Elizabeth Bernal. He was encouraged academically by his mother from a young age and by two and half could speak English and French. His scientific interests were supported and would frequently undertake experiments around the family home. At the age of seven, he persuaded his mother to buy zinc and sulphuric acid to prepare hydrogen gas after noting the experiment in a volume of Faraday's lectures. Initially disappointed by the apparent failure of the experiment, he returned later before bed to check on the progress and due to the darkness, lit a match to observe more closely. The subsequent explosion of the built up hydrogen more than made up for the previous disappointment.

His education began at the local school before transferring to Hodder School then Sandhurst College in England, where he worked his way through the school library each Sunday after Mass. He was accepted into Emmanuel College, Cambridge in 1919 for an undergraduate degree in Natural Science where he developed a strong interest in the developing science of X-ray crystallography. Only in 1913 did the father and son pair W.H. Bragg and W.L. Bragg demonstrate that the diffraction of X-rays from a crystal could be used to determine the inner chemical structure of the material and in 1923 Bernal joined the elder Bragg in his group at the Royal Institution (RI). There he worked on a range of topics within the burgeoning field including both technical and theoretical developments. He built a new cylindrical detector using a goniometer to rotate the crystal in the X-ray beam built from an old alarm clock and a nail, which was the basis for all subsequent designs, while his tables for interpreting the resulting diffraction patterns were in continuous use until the 1970s.

Bernal left the RI in 1927 to become the first lecturer in structural crystallography at Cambridge and remained there until 1937 when he obtained a chair in Physics at Birkbeck College, University of London and was the head of the newly established department of crystallography. His research moved from the technical development to the applications of crystallographic methods to new fields of science especially biologically important materials. Initially, he and his collaborator William Astbury at the University of Leeds, with whom he'd worked at the RI, separated the field of biochemistry between them with Bernal studying the smaller crystalline components such as amino acids and steroids, while Astbury focused on fibrous materials and proteins. However, as time passed the scope of his group expanded and ground breaking work on the structure of viruses and proteins led to the foundation of protein crystallography. This development fundamentally changed the focus of biochemical research and the understanding of biological activity as it allowed for the 3-D chemical structure of the component species to be examined often as the processes occurred.



Bernal specialised in the identification of new fields to explore but rarely stayed long enough to fully civilise the area, which he left to trusted colleagues. Indeed two of his former students (Dorothy Hodgkin and Max Perutz) were awarded Nobel prizes for pioneering work in protein crystallography for the first structural determination of vitamin B12 and haemoglobin respectively.

Away from the field of biological structures, Bernal founded yet more fields of study. He pioneered investigations into the structure of liquid water by diffraction methods. Liquids unlike crystals have no regularly repeating structure and so do not give well-ordered diffraction but a diffuse undulating diffraction from which only the distances between pairs of atoms can be determined. Thus the construction of large models that fit these distances is required. Work on water stretched over Bernal's career, in 1933 he proposed the structure of H₂O as a bent molecule with a O-H bond length of 0.96 Å (current value is 0.958 Å) and the presence of hydrogen bonding between the molecules to construct regions of microcrystalline water resembling that of ice with disordered regions connecting these pockets. He returned to the problem of liquid structure in 1957, when he constructed a ball-and-spoke model of water with the lengths of the spokes derived from the diffraction pattern. To ensure randomness the model was constructed in his office where the regular interruptions would ensure he would not remember which sections he had previously been working on. From this model he was able to identify that irregular polyhedra within the structure frequently formed with five sides. Conventional crystallography states that such figures are unable to pack in a regular fashion; thus significant restructuring is required to convert a crystal to a liquid; this Bernal proposed was the source of the large latent heat observed on melting.

During the Second World War, Bernal worked on operational research, contributing to the planning of the D-day landings and was awarded the U.S. Medal of Freedom in 1945. Subsequently he became interested in the rebuilding of Britain and initiated research into the structure and properties of metal hydroxides and the silicate components of cements. As often was the case the final determinations and discoveries were carried out by other groups but the impudence and emphasis of importance of these problems was driven by Bernal.

J. D. Bernal was nicknamed Sage by his undergraduate peers because he knew everything. It was a title he retained throughout his life. He was driven by a belief that science and technology would improve the living standards of humanity if properly focused and was a frequent campaigner for peace and demilitarisation in the years after the Second World War. He suffered a series of cerebral haemorrhages from 1963 until his death in 1971. His legacy was the development of crystallography as a central tool across the sciences³.

References

1. A. Brown, J. D. Bernal: The Sage of Science, **2005**, Oxford University Press, Oxford, UK.
2. H. F. W. Taylor, *Acta Crystallographica Section A*, **1972**, *28*, 359.
3. Vincent Casey 2007 *J. Phys.: Conf. Ser.* **57** [doi:10.1088/1742-6596/57/1/E01](https://doi.org/10.1088/1742-6596/57/1/E01)
dedicated to "John Desmond Bernal: Science and Society"

*Prepared by
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Research Fellow
University of Limerick
October 2011.*

