

# Leverhulme Trust

Research Fellowship

## Applicant Details

### General Details

Title	Dr	Gender	Male
First Name(s)	Meurig	Date of Birth	26/08/1948
Surname	Beynon		

### Contact Details

Department	Department of Computer Science		
Institution	University of Warwick		
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## Career Details

### Current Employment

Position	Reader in Computer Science		
Are You Self Employed?	<input type="checkbox"/>		
Institution / Organisation	University of Warwick		
Starting Date	01/10/1999		

### Former Employment 1

Position	Senior Lecturer in Computer Science		
Institution / Organisation	University of Warwick		
Date From	10/1991	Date To	09/1999

### Former Employment 2

Position	Lecturer in Computer Science		
Institution / Organisation	University of Warwick		
Date From	10/1975	Date To	09/1991

### Former Employment 3

Position	SRC Postdoctoral Research Fellow (Mathematics)		
Institution / Organisation	University College, Swansea / University of Warwick		
Date From	10/1973	Date To	09/1975

### Former Employment 4

Position	Research Assistant (Mathematics)		
Institution / Organisation	The Open University		
Date From	10/1972	Date To	09/1973

## Degree 1

### General Details

Type	BSc	Class	First class honours
Subject	Mathematics		
Institution	King's College London		
Date From	10/1966	Date To	07/1969

## Doctoral Degree 1

### General Details

Type	PhD		
Institution	King's College London		
Date From	10/1969	Date To	09/1972
Title Of Thesis	Geometric Aspects of the Theory of Partially Ordered Systems		
Supervisor's Name	Professor Philip J. Higgins		

## Research Details

<b>Title Of Research Proposal</b>	Liberating computing as construal
<b>Main Field Of Study</b>	Basic sciences
<b>Sub Field Of Study</b>	Science (various)

## Abstract Of Proposed Research

Computing needs a conceptual account that does justice to its applications to education, humanities and design. Empirical Modelling principles and tools represent a decisive first step towards the essential philosophical and practical reorientation. EM involves crafting artefacts ("construals") that serve a sense-making role. State-of-the-art web technology enables universal access to personal experience of the practical activity of elaborating EM construals. This can generate the critical feedback needed to bring the embryonic framework of EM to maturity, laying the foundation for an enhanced computer science curriculum that acknowledges a far more intimate relationship between computing technology and human imagination and creativity.

## Places Where You Will Carry Out The Proposed Research

I shall be based at my home institution, where I shall dedicate one term in each of two years to building and/or revising models and writing and/or revising associated research publications. This will give me access to essential resources by way of computing platforms and documentation, and enable me to perform teaching duties relating to my research project. I shall make occasional visits to the London Knowledge Lab, the Centre for Computing in the Humanities (King's College London) and the National Centre for Computer Animation (Bournemouth University) to discuss the conception, selection and dissemination of models and publications.

## Relevant Experience / Skills / Training

Teaching experience in computer science includes: foundational mathematics and logic, advanced data structures and algorithms, formal specification and verification, software engineering and programming, databases, computer graphics and a postgraduate module and two international workshops devoted to EM research. Principal author of over 100 refereed publications on mathematics ("the Baker-Beynon duality"), theoretical computer science, computer-aided design, HCI, visualisation, humanities, parallel architectures, educational technology, geographical information systems and databases. Supervisor of 15 successful doctorates and 9 masters-by-research. Creator of a wide range of EM models, including some deployed in administrative and teaching roles. Programming and parsing expertise. Accomplished pianist, organist and accompanist.

## Other Matters Which You Wish To Bring To The Notice Of The Committee

Empirical Modelling does not fit squarely within the remit of a single research council. Its merits have been best appreciated in areas where it is appropriate to consider technology in relation to many disciplines, as was the case for broad initiatives such as the EU Technology Enhanced Learning Kaleidoscope Network of Excellence and the AHRC ICT Methods Network. Without significant external funding, the adoption of EM outside Warwick has been limited to: research on software development at the Moscow Engineering Physics Institute; an online teaching module running under the auspices of the VISCOS distance learning programme in Finland; and a philosophy module devoted to radical empiricism and Empirical Modelling being taught at Potsdam. The most significant practical application of EM principles was that by former EM doctoral student Dr Richard Cartwright who successfully deployed them at the BBC R&D Labs to address the challenge of cross-platform digital broadcasting. The links:  
<http://www2.warwick.ac.uk/fac/sci/dcs/research/em/thinkcomp07>  
<http://www.dcs.warwick.ac.uk/~wmb/sudokuExperience/workshops/>  
<http://empublic.dcs.warwick.ac.uk/projects/kaleidoscopeBeynon2005/posters/>  
may be helpful to reviewers seeking more specific information about the relationship between EM and computer science, the nature of the Web EDEN interpreter, and the scope of EM models respectively. Professor David Gooding (D.C.Gooding@bath.ac.uk) is also willing to act as an additional referee.

## Background and objectives

The aim of this proposal is to disseminate a new vision for the science of computing, potentially broad enough to encompass computing practice in all its richness. This vision is based on an alternative conceptual framework for computing ("Empirical Modelling") developed under my direction over many years [1-10, 18-24]. Empirical Modelling leads to constructions, called "construals", to be interpreted quite differently from conventional programs. Construals (cf. Gooding, 1990) are directly experienced by the modeller as referring to an external situation. Unlike the formal connection associated with a conventional representation (e.g. as explicitly expressed using an abstract data type), the relationship between a construal and the situations to which it refers is established and evolves incrementally through open-ended interaction on the part of the modeller. It is also a matter of "immediate human apprehension, or intuition", in the sense of Naur (1985) and is most appropriately interpreted as what William James (1912) identifies as *a conjunction given in experience*. In keeping with James's radical empiricist stance, EM aspires to trace all knowledge - even inferred knowledge - to its roots in such empirically given conjunctions [5,10].

The extensive literature on EM (cf. the EM website) makes connections with many fields, most topically: education [2,3,9,20,21], humanities [4,8,22,24] and design [6,18,19,23]. Whether or not it can account for all species of computing across these disciplines, it points to a quite decisive shift in perspective on computing. This is apparent from the way in which it puts its primary emphasis on activities that are recognised from a traditional perspective to be the most problematic: observation in the preliminary stages of scientific investigation (Gooding, 1990) [1,7]; synthetic modelling in the imaginative reconstruction of historic artefacts (McCarty, 2005) [4]; domain analysis for complex software systems that takes proper account of the 'incalculable complexity of the real world' (Jackson, 2006) [18,23]. Above all, EM is directly concerned with the negotiation of meaning and wrestling with confusion that is characteristic of creative learning [2,3,9].

Though the idea that computer science must move beyond the rationalistic tradition is well-established (see e.g. Winograd and Flores (1986), Cantwell-Smith (2002) and Naur (1984)), EM is distinguished from alternative proposals through its practical roots in tools and models. EM affords a new approach to software development that allows more effective integration of the formal and the informal aspects (cf. e.g. [8,10]). Specific models feature in most of the more than a hundred refereed papers on EM, and appreciating how these models have been constructed step-by-step and still remain alive to revision as-of-now is vital to full understanding.

The key issue here is that the primitive and fundamental notion of knowing to which James draws our attention cannot be expressed in language; it has to be exhibited through presenting an artefact that is available for open-ended interaction and interpretation. And whilst the computer is beyond doubt an excellent tool for the automation of rational processes, it is also the core technology that has liberated the construction of interactive artefacts of unprecedented flexibility and subtlety.

It is the role that EM can play in the latter use of computers that motivates my proposal: to compile a suite of web-enabled models and associated papers to show how the principles and tools of EM can contribute to a new conceptual framework for computing. This in turn will prepare the ground for projects that require far greater resources, and are only feasible subject to wider dissemination and open source development. There has been great benefit in nurturing EM within a front-rank computer science department, where the practical contribution of student work has been crucial. But full exploitation relies on engaging a wider community, and developing a base of researchers, developers, model-makers and critics across many disciplines.

## Methodology

The basic resources required to develop a suite of illustrative construals and associated research papers or textual accounts already exist. Suitable prototype examples can be selected for instance from the over 200 models that have been archived to date (cf. [19]). To emphasise the interpretation of a model as a *construal*, it is essential to draw explicit attention to the crafting of observables, dependencies and agency in response to an external interpretation. To this end, I shall exploit the recently developed web-enabled variant of the EM interpreter ("Web EDEN"), which enables dynamic annotation of the model that can help to elicit the conjunctions in the mind of the modeller. Many EM publications (including [1-10] below) refer to explicit models, and in many cases it will be sufficient to expose and annotate salient moments in their construction. A very recent paper [1] illustrates how a simple web-enabled model can be integrated with a textual account in this way. The models associated with other papers are typically more ambitious, and none is as yet web-enabled. In some cases, significant re-engineering will be required to ensure that the application of principles and tools is most instructive and follows the best and most up-to-date practice. As one of the principal authors of models

developed in connection with publications, I am well-equipped to carry out work of this nature. The process of web-enabling a model will involve a concentrated effort in comprehension and revision. As a guide to the scale of work, re-engineering a moderately sized model of the perceptions of a human solver of Sudoku puzzles (comprising some 5000 definitions) - cf. [2] - took me approximately one week, and its adaptation for use in an online activity for schools (see references) a further week. Another educational application, based on the characterisation of planar monotone boolean functions described in [12], was developed from scratch in a few days. The revision of certain more complex models is expected to take some weeks to complete.

The choice and treatment of models will reflect the three areas of application targeted in the project: education, design and humanities. I will liaise with the London Institute of Education, the Centre for Computing in the Humanities at KCL, and the National Centre for Computer Animation in selecting themes and models. My aim is to attract external interest in using EM principles and tools from academic staff, students, teachers and pupils, and where feasible I intend to offer support (e.g. via email, online help and short presentations) as necessary. In the area of education, many papers and models have already been developed, and web-enabling will suffice. In relation to design, EM principles have been developed in several papers (cf. Cartwright et al, 2005) but the associated illustrative models, being more complex and older, require more work to adapt and update. There are fewer examples of EM models relating to the humanities, and the full potential of current tools in this area is as yet undetermined. There is however a close affinity between EM and Humanities Computing as characterised by McCarty (2005) (cf. [4]), and elaborating and illustrating the proposal for situating core computing in the humanities set out in [22] will be a priority. Discussions with other leading researchers have also identified relevant themes for collaborative papers and modelling studies in their research; these concern unconventional computing (Susan Stepney), models of space (Nigel Thrift) and systems development (Michael Jackson).

Whilst my main experience of software development is based on model-building using EM tools, I also expect to make some significant but technically modest improvements to the tools themselves. I propose to employ an RA to assist in carrying out essential refinement and maintenance of the EDEN interpreter (building on the existing *Subversion* repository), and to promote and coordinate its open source development. The RA will also be able to advise on the technical aspects the revising key models and organising dissemination activities.

## Outcome

The principal outcome will be a suite of web-enabled models and associated publications, both new and existing, that effectively communicates the idea of a foundation for computing based on construals rather than programs. This will make the EM literature more accessible, enabling readers to trace the modelling process themselves, to appreciate EM principles more fully and potentially become practical modellers. In due course, this will promote a new curriculum for the science of computing, in which the primary emphasis shifts from the formal to the experiential without comprising the integrity of the discipline (cf. the concerns expressed by Lampert (2003)). In practical terms, wider adoption of EM principles and tools will also enable new modes of computer-supported learning, potentially more appropriate for those (e.g. with special needs, in the developing world [21], or in prisons) for whom stereotypical learning schemes and products are ill-suited.

## Bibliographic references

- Brian Cantwell-Smith, The Foundations of Computing. In Scheutz (ed.), *Computationalism: New Directions*, MIT Press, 23-58, 2002.
- Richard Cartwright et al, Web-based Shape Modelling with HyperFun, *IEEE Computer Graphics & Applications*, 60(2), 60-69, 2005.
- David Gooding, *Experiment and the Making of Meaning: Human Agency in Scientific Observation and Experiment*, Kluwer Academic Publishers, 1990
- Michael Jackson, What can we expect of formal verification? *IEEE Computer* 39(10), 65-71, 2006
- William James, *Essays in Radical Empiricism*, Longmans Green, 1912.
- Leslie Lampert, The Future of Computing: Logic or Biology, Talk at Christian Albrechts University, Kiel, 11/07/03 at url: <http://research.microsoft.com/users/lampert/pubs/future-of-computing.pdf> (accessed 05/11/08)
- Willard McCarty, *Humanities Computing*, Palgrave-MacMillan, 2005
- Peter Naur, The role of intuition in software development, *TAPSOFT*, Vol 2, 60-79, 1985
- Terry Winograd and Fernando Flores, *Understanding Computers and Cognition: A New Foundation for Design*, Addison-Wesley, 1986.
- The Empirical Modelling website: <http://www.dcs.warwick.ac.uk/modelling/> (accessed 05/11/08)
- Online activity at <http://www.dcs.warwick.ac.uk/~wmb/sudokuExperience/workshops/> (accessed 05/11/08)

**Major / selected topical publications of which (but for [20]) I am the sole or principal author**

1. \*(with Steve Russ) Experimenting with Computing. In Special Issue of the Journal of Applied Logic devoted to the Philosophy of Computer Science, *Journal of Applied Logic* 6 (2008), pp. 476-489.
  2. \*(with Antony Harfield) Lifelong Learning, Empirical Modelling and the Promises of Constructivism. *Journal of Computers*, Volume 2, Issue 3, 43-55, 2007.
  3. \*Computing technology for learning - in need of a radical new conception. *Journal of Educational Technology & Society*, 10 (1), 94-106, 2007.
  4. \*(with Steve Russ and Willard McCarty) Human Computing: Modelling with Meaning. *Literary and Linguistic Computing* 21(2), 2006, 141-157.
  5. \*Radical Empiricism, Empirical Modelling and the nature of knowing. In (ed. Itiel E Dror) *Cognitive Technologies and the Pragmatics of Cognition: Special Issue of Pragmatics and Cognition*, 13:3, December 2005, 615-646.
  6. \*(with S. Rasmequan and S. Russ) A New Paradigm for Computer-Based Decision Support. *Decision Support Systems*, vol 33 (2002) p127-142.
  7. \*(with J. Rungrattanaubol and J. Sinclair) Formal Specification from an Observation-Oriented Perspective. *Journal of Universal Computer Science*, Vol. 6 (4), 407-421, 2000.
  8. \*Formal and Experiential Perspectives on Music, Consciousness and Computing, *Music and Consciousness* (ed. David Clarke and Eric Clarke) (OUP, to appear)
  9. \*(with Chris Roe) Enriching Computer Support for Constructionism. In Eshaa Alkhalifa (ed.) *Cognitively Informed Systems: Utilizing Practical Approaches to Enrich Information Presentation and Transfer*, Idea Group Publishing, 2006, 209-233.
  10. \*Empirical Modelling and the Foundations of Artificial Intelligence. *Computation for Metaphors, Analogy and Agents*, Lecture Notes in Artificial Intelligence 1562, Springer, 322-364, 1999.
  11. Boolean Function Complexity: a Lattice-Theoretic Perspective. *Boolean Function Complexity*, ed. M. S. Paterson, LMS Lecture Notes Series 169, CUP 1992, 35-56
  12. \*(with John Buckle) On the planar monotone computation of Boolean functions. *Theoretical Computer Science* 53, 1987, 267-279
  13. Replaceability and computational equivalence for monotone boolean functions. *Acta Informatica* 22, 1985, 433-449
  14. Applications of duality in the theory of finitely-generated lattice-ordered Abelian groups. *Can J Math* 29 (2) 1977, 243-254
  15. Vector lattices freely generated by distributive lattices. *Math Proc Camb Phil Soc* 81, 1977, 193-200
  16. Duality theorems for finitely-generated vector lattices. *Proc London Math Soc* (3) 31, 1975, 114-128
  17. Combinatorial aspects of piecewise-linear maps. *Journal London Math Soc* (2) 7, 1974, 719-727
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18. \*(with Russell Boyatt and Zhan En Chan) Intuition in Software Development Revisited. In Proceedings of 20th Annual Psychology of Programming Interest Group Conference, Lancaster University, UK, September 2008 (12pp).
  19. \*Visualisation using Empirical Modelling principles and tools. AHRC ICT Methods Network Expert Workshop "From Abstract Data Mapping to 3D Photorealism: Understanding Emerging Intersections in Visualisation Practices and Techniques", June 19th 2007, Birmingham UK (20pp).
  20. \*Chris Roe and Meurig Beynon. Dependency by definition in Imagine-d Logo: applications and implications. In Ivan Kalas (ed.) Proc. of the 11th European Logo Conference 19-24 August 2007, Bratislava, Slovakia (11pp - published on CD ISBN: 978-80-89186-20-4)
  21. \*Towards Technology for Learning in a Developing World. In Proc. IEEE 4th International Workshop on Technology for Education in Developing Countries, Iringa, Tanzania, July 2006, 88-92.
  22. \*(with Roderick R Klein, Steve Russ) Humanities' Computings (extended abstract only). In Digital Humanities 2006: 1st International Conference of the Alliance of Digital Humanities Organisations, Conference Abstracts, Paris-Sorbonne, France, July 2006, 17-20.
  23. \*(with R.C.Boyatt and S.B.Russ) Rethinking Programming. In Proceedings IEEE Third International Conference on Information Technology: New Generations (ITNG 2006), April 10-12, 2006, Las Vegas, Nevada, USA 2006, 149-154.
  24. \*Liberating the Computer Arts. Proc DALI'2001, First International Conference on Digital and Academic Liberty of Information, University of Aizu, Japan, March 2001 (invited paper, 25pp).

# Duration And Timing

## Duration Of Whole Project

The project will begin on 1st October 2009 and end on September 30th 2011. I will be essentially free of teaching and administrative commitments for the first term of each of the academic years 2009-10 and 2010-11, and will devote this time exclusively to the project. My EM-related teaching commitments in the second and third terms will provide a suitable setting in which to test key aspects of models and tools. The summer periods July-September 2010 and 2011 will be devoted to dissemination activities and to integrating models with associated publications.

Duration Of Fellowship

Proposed Start Date

Percentage Of Working Time To Be Spent On The Project During The Fellowship  %

## Details Of Other Research Projects And Commitments During The Fellowship

My colleague Dr Steve Russ, co-director of the EM project, has study leave in 2009-10. During his leave, in consultation with me, he will edit and organise the publications and lecture notes developed for the advanced module on EM that has been taught at Warwick for some fifteen years to create a research monograph on EM. The development of a suite of models and publications proposed in this project is a natural complement to this activity. My other responsibilities will be supervising research, MSc dissertation and undergraduate project students engaging with EM, and teaching and examining the advanced EM module.

# Referees

## Referee 1

Title	<input type="text" value="Professor"/>	First Name(s)	<input type="text" value="Willard"/>	Surname	<input type="text" value="McCarty"/>
Position	<input type="text" value="Professor of Humanities Computing"/>				
Department	<input type="text" value="Centre for Computing in the Humanities"/>				
Institution	<input type="text" value="King's College London"/>				
Telephone No.	<input type="text" value="020 78482784"/>	Email Address	<input type="text" value="willard.mccarty@kcl.ac.uk"/>		

## Referee 2

Title	<input type="text" value="Professor"/>	First Name(s)	<input type="text" value="Richard"/>	Surname	<input type="text" value="Noss"/>
Position	<input type="text" value="Professor of Mathematics Education / Co-Director of the London Knowledge Lab"/>				
Department	<input type="text" value="The Institute of Education"/>				
Institution	<input type="text" value="University of London"/>				
Telephone No.	<input type="text" value="020 7763 2150"/>	Email Address	<input type="text" value="r.noss@ioe.ac.uk"/>		

## Referee 3

Title	<input type="text" value="Professor"/>	First Name(s)	<input type="text" value="Peter"/>	Surname	<input type="text" value="Comninos"/>
Position	<input type="text" value="Director of the National Centre for Computer Animation"/>				
Department	<input type="text" value="Media School"/>				
Institution	<input type="text" value="Bournemouth University"/>				
Telephone No.	<input type="text" value="01202 965360"/>	Email Address	<input type="text" value="peter.comninos@ntlworld.com"/>		

# Previous and Current Applications

## Previous Leverhulme Awards Or Pending Applications To The Trust

None

## Other Awards Received In The Last 3 Years Related To This Research

AHRC support for the "Thinking Through Computing" international workshop, November 2007 £4.5K  
Warwick University Teaching Quality Enhancement Fund for the development of the Web EDEN interpreter July-September 2008 £3.7K  
AHRC support for attendance and contributions to VisNet Workshops at Birmingham (2007) and Loughborough (2008) - see reference [19]  
Funding to present an international summer school on "Empirical Modelling for Computing and Business" at the University of Rostock, Germany (2006) £2K  
Support from the EU Technology Enhanced Learning Kaleidoscope Network of Excellence for contribution to a Showcase event at Oberhausen, Germany (2005) £2K  
Sponsorship for an international workshop on "Exploiting Dependency in Computer-Assisted Learning" at the ICALT Summer School on Educational Technology at Kaohsiung, Taiwan (2005) \$1K

## Applications You Have Made Or Intend To Make To Other Bodies Related To This Research Proposal

The research proposed in this project will supply a sound basis for broader use of EM principles and tools in a practical educational setting. If my project meets its objectives, it will enable me to promote the use of the Web EDEN interpreter in contexts such as special needs, the developing world or prisons where the flexible and personal character of the learning experience can bring particular benefit. This may be a suitable topic for an application to funding bodies such as the Nuffield Foundation.

## Research assistance

### Type Of Assistance

Technical guidance and support on the refinement and maintenance of the Web EDEN interpreter - the principal tool that will be used to deliver the suite of models being developed in the project. Technical advice and consultation over the re-engineering of complex models, and technical assistance in respect of dissemination activities. Some assistance may also be needed in scanning, photocopying and text-processing tasks associated with the reconstruction of models. For instance, certain older models no longer run on recent versions of the EDEN interpreter, and listings and documentation may no longer be available in electronic form.

### Justification

The EDEN interpreter is a complex piece of software that has been developed, enhanced and maintained as an open source product by graduate students in the EM group. Since I am approaching retirement age, I shall no longer be able to recruit research students to this role, and (though I would like others to engage with EDEN as an open source project) it is important that I develop some basic knowledge and competence in maintaining the interpreter myself. In gaining this, I shall have to rely on recruiting the services of a research assistant with appropriate experience and technical ability.

### Breakdown Of Costs

The estimated level of support required amounts to one week of an RA's time in each year (spine point 24).

### Figures

Total Cost £ 1495

## UK travel

### Travel Destination(s)

I shall make three visits each year to the London Knowledge Lab and the Centre for Computing in the Humanities at King's College London, and to the National Centre for Computer Animation in Bournemouth. I plan to travel off-peak by rail and stay overnight in order to visit both London institutions on a single trip, and to make day trips to Bournemouth. I have estimated costs (with Senior Railcard) on the basis of 3 trips to London (£24.50 return) and 3 to Bournemouth (£74.00 return) by rail per year, and costed subsistence at £60 per day for overnight stays.

### Figures

Total Cost £ 951

## Replacement Costs

### Study Leave

**Your Institution's Policy For Paid Or Unpaid Study Leave**

Warwick University has generous entitlement to study leave, conditionally allowing one year for each six years full service. I have applied for and been granted three years of study leave in my 33 years of service at Warwick to date.

**Amount Of Paid Study Leave In The Last 4 Years**

I was granted paid study leave in 2005-6.

**Amount Of Unpaid Study Leave In The Last 4 Years**

None

**Study Leave Eligibility In The Next 3 Years**

I am next eligible for study leave in 2012-3. If study leave were to be granted at that time, my leave would end just after my 65th birthday.

### Replacement Details

**Justification If Applying For Temporary Replacement**

As the most experienced and long-serving full-time member in my department, I have a full and active administrative and teaching role. I am currently CS Course Manager, First-Year Tutor and assistant First-Year Examinations Secretary, lead the Human Aspects of Computing Research Group and serve on the Steering, Undergraduate Studies and Graduate Studies committees. In this context, it is hard to respond to the external interest in EM research from colleagues such as those I have nominated as referees, as well as to service everything from philosophical to technical requests for help from students applying EM in research and undergraduate projects.

**Type Of Activities To Be Replaced And Arrangements For Cover**

I have requested relief from non-research-related administrative and teaching responsibilities for 2009-10 and 2010-11 (as far as this is realistic). For these two years, I shall be available for research-related consultation, supervision and teaching, but otherwise intend to devote the first term exclusively to my proposed research project. Replacement costs are requested to cover teaching responsibilities and other administrative responsibilities.

**Type Of Cover Requested**

Replacement cover is requested at the hourly rate. This is to cover 10 weeks of my time, corresponding to the first term, in both 2009-10 and 2010-11.

### Figures Section

**Number Of Hours And Hourly Rates**

375 hours in both Years 1 & 2 (hourly paid replacement cost of £28.99).

**Summary Of Hourly Rates**

Total For Hourly Rates £	National Insurance £	Superannuation £	Total £
21743	0	0	21743

**Details Of Replacement Salary**

Annual Salary £ 0      Scale Point/s

**Number Of Months And % If Part-Time**

**Summary Of Salary Costs**

Salary £	London Allowance £	National Insurance £	Superannuation £	Total £
0	0	0	0	0

# Budget Summary

Research Expenses	
Research assistance	£1495
UK travel	£951
<b>Research Expenses Total</b>	<b>£2446</b>

Replacement Costs / Loss Of Earnings	
Replacement Costs	£21743
<b>Replacement Costs / Loss Of Earnings Total</b>	<b>£21743</b>

<b>Grand Total</b>	<b>£24189</b>
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