APPLICATION FOR A PROJECT GRANT

wellcome trust

Trust reference number:
eGrants reference number: 9313
Joint application: No

Q1 Applicants	Principal Applicant	Coapplicant (1)
Surname	Bowman	Waddington
Forenames	Adrian William	John
Title (Dr etc.)	Prof	Prof

	Coapplicant (2)	Coapplicant (3)	Coapplicant (4)
Surname	Ayoub	Hayes	Siebert
Forenames	Ashraf Farouk	Kevin	J. Paul
Title (Dr etc.)	Prof	Dr	Dr

Q2 **Title of project**

The analysis of three-dimensional facial dysmorphology

Q3 **Department name and address of administering institution where different from principal applicant's address:**

Q4 **Period for which support is sought:** (state in months) 36

Q5 **Proposed start date:** 01/07/2009

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Q6 TIME SPENT BY APPLICANTS ON RESEARCH

Adrian William Bowman

How many hours per week does the Principal Applicant spend on research?	20
How many hours per week will be spent on this project by the Principal Applicant?	4

John Waddington

How many hours per week does the Coapplicant spend on research?	20
How many hours per week will be spent on this project by the Coapplicant?	2

Ashraf Farouk Ayoub

How many hours per week does the Coapplicant spend on research?	20
How many hours per week will be spent on this project by the Coapplicant?	2

Kevin Hayes

How many hours per week does the Coapplicant spend on research?	20
How many hours per week will be spent on this project by the Coapplicant?	2

J. Paul Siebert

How many hours per week does the Coapplicant spend on research?	20
How many hours per week will be spent on this project by the Coapplicant?	2

Brendan Guilfoyle

How many hours per week does the Coapplicant spend on research?	20
How many hours per week will be spent on this project by the Coapplicant?	2

Paul Whelan

How many hours per week does the Coapplicant spend on research?	20
How many hours per week will be spent on this project by the Coapplicant?	2

Q7 RELATED APPLICATIONS (Please ensure that you read the guidance notes before completing this section, and that you comply with all the stated requirements while your Wellcome Trust application is being considered.)

(a)	Is this or a related application currently being submitted elsewhere?	No
	If yes, to which organisation?	
	By what date is a decision expected?	
(b)	Has this, or a similar, application been submitted elsewhere over the past year?	No
	If yes, to which organisation?	
	What was the result?	
(c)	Is this application a resubmission or has it been previously considered under another Wellcome Trust scheme?	Yes
	If yes, when was it originally considered?	06/05/2008
	Please give the Wellcome Trust's reference number:	085062

State how this application differs from the original (no more than 500 words).

The following changes have been made in response to comments raised by Referee 1.

1. Detailed information on the resolution of the captured images has been provided.

2. The specific landmarks which we plan to extract automatically have been identified. In making this selection, we aim to achieve a satisfactory compromise between landmarks which are important anatomically and are also able to be extracted in a robust and reliable manner.

3. An illustration of a facial image with the relevant landmarks has been included.

4. Further details of the landmark extraction algorithm has been provided. In broad terms, we plan to characterise locations through the nature of the surrounding surface curvature, classified as peak or cap, ridge, saddle, valley or rut, pit or cup, and plane. Standard methods are described in Koenderink, J. J. (1990, Solid Shape, MIT Press) and an adaptive algorithm will be constructed to match these characterisations to each landmark of interest. This will extend to the face work which has proved to be successful in other anatomical regions such as the colon.

5. We have provided further information on the differences between the facial shapes of schizophrenic patients and controls which existing work, such as Hennessy et al. (2007), has been able to identify. This includes large scale facial characteristics as well as differences in more detailed facial features. Interestingly, while differences were found in patients of both sexes, these appeared to be more prominent in females. The challenge which we plan to tackle in the new proposal is to build on these initial findings in order to resolve the topography of facial dysmorphogenesis in greater detail and extend the analysis to new characteristics of shape such as asymmetry.

Responses to the comments of Referee 2 have been made in the covering letter. These

responses are reflected in the new case for support through more careful and clear wording in the description of the statistical methods.

The following changes have been made in response to comments raised by Referee 3.

6. We fully recognise the importance of sample size and its effect on power and precision. We are encouraged by the fact that the earlier work of Hennessy et al. (2007) was able to identify differences between schizophrenic patients and controls with sample sizes close to 30. However, we accept that larger sample size would be preferable and this has been increased to 100, split evenly between males and females.

7. We have clarified the benefits of identifying differences between control and schizophrenic patients. Such ﬁndings could potentially guide future molecular genetic and neuropathological studies. Furthermore, the ability to make comparisons of facial shape across diagnoses, for example between schizophrenia and bipolar disorder (formerly known as manic-depressive psychosis) will allow us to address directly the long-standing conundrum of whether these disorders involve similar, distinct or overlapping dysmorphogenic processes.

In addition, we have added further information on how our proposal links to the work of other research groups.

Q8 RESEARCH QUESTION

(a) What is your research question? (no more than 100 words)

Three-dimensional surface imaging systems, such as those based on laser-scanning or stereo-photogrammetry, are now widely available and in increasing use in medical applications. The principal aims of this project are to identify whether:

(a) key anatomical information can be extracted from three-dimensional facial images in an effective, reliable and largely automatic manner;

(b) statistical methods can be developed to analyze the extracted anatomical information across samples of patients, to provide valuable insight;

(c) these tools can provide increased quantitative insight into medical conditions involving facial dysmorphology, such as schizophrenia, and the characterisation of surgical outcomes, such as in orthognathic procedures.

(b) Why is it important? (no more than 250 words)

Three-dimensional imaging has created the ability to display objects and to explore these visually in a potentially informative manner. In medical applications the shape of relevant anatomical features can give insights into basic biological mechanisms as well as providing a basis for diagnosis, treatment planning and the evaluation of outcomes. Facial applications are very important because of the primary role played by the face in human interactions.

The proposed research is important because it seeks to make significant advances in the methods and tools available to analyze facial data. Scientific investigations of the face require reliable quantitative measures of shape. Existing approaches are based on the manual identification of anatomical landmarks, which is a laborious and expensive process. A primary aim is therefore to allow this information to be extracted in a more automatic manner. In addition, we aim to improve existing methods of representing the full facial surface. A second main aim of the research is to provide tools for the construction of statistical models based on this information. This is of critical importance because of the need to provide quantitative insight into the information carried by samples of patients, with the resulting ability to draw carefully constructed and supported conclusions on patient populations.

These tools will be applied to two important application areas. One concerns the biology of schizophrenia and the other will assess the surgical outcomes of orthognathic procedures. These investigations will also exemplify the potential applications of the methods for facial analysis developed by the project.

Q9 SUMMARY OF PROPOSED RESEARCH INCLUDING KEY GOALS

(a) For scientifically qualified assessors (no more than 200 words):

This research aims to provide tools to extract important and potentially useful quantitative information on facial shape from three-dimensional images. We plan to identify anatomical landmarks in a more automatic manner than is currently possible, by using techniques of differential geometry to characterize local surface shape and match this with the definitions of landmarks of interest. This will be extended into a quantitative characterization of anatomical curves, and of the entire facial surface, again using differential geometry and template matching on the image data at its highest resolution.

Appropriate statistical models will then be constructed to allow this information to be used to weigh the evidence for effects of interest. Important special cases will be the use of functional data analysis for anatomical curves and the construction of measures of asymmetry.

These computational and statistical tools will be applied to two important application areas in the characterization of the facial shape of schizophrenia patients and of patients undergoing orthognathic surgery. The first of these will involve cognitive assessment and will provide valuable information on the biological processes which underlie schizophrenia. The second will enable surgical outcomes to be assessed in a quantitative and highly informative manner.

(b) For lay readers (no more than 200 words):

Facial shape is significant in a variety of medical contexts. One example is where children are born with a cleft lip and/or palate, requiring urgent treatment. However, surprisingly, there is a wider variety of medical conditions which have an associated characteristic facial shape. This happens because, as a fetus develops in the womb, the cells which develop into the face are closely associated with the processes which are involved in the development of other parts of the body, including the brain.

This kind of issue can be investigated by taking pictures of the face in three dimensions and characterising its shape. However, while three-dimensional imaging is readily available, methods for extracting relevant information from these images, and analyzing it properly, are much less well developed. Methods for analyzing complex data, in the form of curves and surfaces, are becoming available and the aim of the project is to explore the potential for this in the context of the face. One application to the development of schizophrenia, and another to the outcome of surgery on the jaw, will be studied. However, the more general analytical tools developed will be available for other scientists to use for wider applications.

Q10 DETAILS OF RESEARCH PROJECT

Detail (a) Aims of the project, (b).Work which has led up to the project, (c) Experimental design and methods to be used in investigating this problem. Full details of the study design for experiments (humans & animals) must be provided. This should include power calculations, sample size justification and, where appropriate, case definition & inclusion/exclusion criteria. Please refer to guidelines. (d) Timetable and milestones, if appropriate. **For clinical trials, refer to guidelines**.

No more than 3,500 words should be used to describe the research project.

Graphs, figures and supporting unpublished data may be embedded in the text or included as an appendix or appendices. These additional data must not exceed the equivalent of 5 A4 pages in length.

Research details

(a) Medical rationale and aims

The face is one of the primary characteristics by which humans present themselves to the external world. From a medical perspective, the shape of the face plays a very important role in a number of settings. One is in facial disfigurement, either through congenital abnormality or trauma, with the possible subsequent need for surgical correction. A second important context arises through the remarkable fact that facial shape can inform on an individual's underlying biology. Cellular associations at the stage of embryological development can lead to links between genetic or early developmental disorders and specific facial characteristics. For these and other reasons, the ability to image, quantify and analyse facial shape has very important medical applications.

A specific example of surgical intervention arises in the treatment of cleft lip or cleft palate or both. Every year in the UK and Ireland, around 1 in every 700 babies is born with this condition which therefore represents the second most frequently occurring congenital deformity. The ultimate goal of surgical repair is to improve facial appearance without leaving identifiable stigmata of the cleft deformity. Similar issues arise in adult orthognathic surgery. The ability to characterize and quantify the magnitude and form of residual dysmorphology therefore has immense potential value.

Craniofacial shape can also inform on the pathobiology of adult disorders, particularly neurological and psychiatric disorders of early developmental origin. For example, craniofacial dysmorphology occurs not only in chromosomal abnormalities such as Down's syndrome but also, quantitatively, in schizophrenia. Over early fetal life the anterior brain, neuroepithelium, neural crest and facial ectoderm constitute a unitary, 3D developmental process and so disruption of brain morphogenesis is accompanied by facial dysmorphogenesis. The analysis of facial shape is therefore a very important tool for assessing the developmental pathobiology of craniofacial dysmorphogenesis.

Three-dimensional image capture technologies now allow facial surfaces to be recorded at very high resolution. Members of the research team have considerable experience in using both portable, hand-held laser scanners and stereophotogrammetry for three-dimensional image capture. The number of surface points collected for each face is approximately 80,000 for the former and at least three times that for the latter, corresponding to resolution below 0.5mm on each axis and of the order of 0.2mm in depth. These technologies are becoming increasingly common and accessible. However, the tools available for extracting and analysing the key information from the resulting images are much less well developed. Morphometrics and statistical shape analysis are well established for landmark data in the form of individual points but models and methods for the richer structures expressed in curve and surface data are much less well developed.

The principal aim of this project is to bring together an interdisciplinary research team to construct reliable and accessible tools for the analysis of facial data from medical applications. This involves the automatic identification of key information such as well-

defined anatomical landmarks and curves, as well as the investigation of convenient representations of the facial surface itself. It also involves the construction of methods of statistical analysis for these extracted data. The effectiveness of these methods will be evaluated on existing data. However, they will also be used in two new investigations. One will involve schizophrenia patients, where potential relationships between anatomical shape, psychotic symptoms and cognitive impairment will be investigated. A second study aims to quantify the change in facial shape resulting from orthognathic procedures, as a means of assessing surgical outcome.

Investigation of these biological and surgical issues are of considerable interest in their own right. However, the tools which result from the project will also enable other projects and researchers to pursue effective quantitative investigation of a much wider variety of important medical questions associated with facial data.

(b) Previous work

Computing Science

The research team based at the Computer Vision & Graphics Group (in the Department of Computing Science, Glasgow University) and the Glasgow Dental Hospital and School has pioneered the use of 3D imaging, based on stereo-photography [65, 6, 7, 8, 70, 59, 5, 9, 11, 12], for the clinical assessment of 3D surface anatomy [10, 34, 35, 62, 33]. This collaboration, initiated in 1992, has developed systems which are now in daily use at four Glasgow Hospitals and has established tools for assessing facial anatomy [58, 59, 66] before and after surgical intervention. Our key developments include methods for conforming 3D models to captured data such that subsequent measurements can be fully automatic and in standardised form to support comparisons between different images [60, 47, 61, 50, 51].

The Vision Systems Group (VSG) in Dublin City University acts as a focus for Image Processing & Quantitative Image Analysis research. It is part of the Centre for Image Processing & Analysis, one of the three nodes of RINCE, a national centre of excellence in information and communications technology, formed in 1999. The VSG's research programmes include issues involved in the acquisition, processing, quantitative analysis, classification, visualization and systems engineering for a wide range of computer vision applications. Specifically the group focuses on the issues involved in the automation or semi automation of image feature segmentation, and its associated quantitative analysis, at both a micro and macro level. The core expertise provided by the VSG is in its ability to develop and design novel computer based solutions that will allow the automatic extraction of key image features [specifically from 2D, video, 3D and 4D data sources] with a view to a robust and reliable quantitative analysis, classification or tracking of key information/data within the scene.

Statistical and mathematical modelling

A classical approach to statistical shape analysis, or morphometrics, is to regard shape as 'the geometrical properties of an object that remain when location, translation and

scale are filtered out' [25]. This powerful idea has led to the development of very effective tools for data in the form of collections of landmarks. However, modern image capture technologies now allow facial surfaces to be recorded at very high resolution and, with this much richer form of data, models and methods to represent and analyze data in the form of curves and surfaces, rather than simply key points, are required. Functional data analysis [69] provides models and methods for data in the form of curves and [14, 17] have made use of the underlying concepts to develop methods of exploring change, variation and asymmetry in a three-dimensional facial setting. Members of the research team have been very active in adapting the concept of 'mixed effects' [68] models to the functional data analysis setting, including explicit work on facial shape curves [22, 13]. Other recent approaches to curve analysis, arising from different contexts, are also described by [26, 3].

A rather separate development of shape analysis, such as in the modelling of brain surface data, is making considerable use of differential geometry; see [73], for example. Guilfoyle has extensive experience in the relevant mathematical techniques, in particular in the application of low-dimensional geometric techniques to real world problems [31]. At one level, this can provide essential information to guide the construction of the point-based representations described above, using geometrical properties to identify pseudo-landmarks. However, at a deeper level this approach offers the prospect of characterising facial shape in a manner which genuinely respects the nature of the information as curves and surfaces.

Medical applications

Early work at the Royal College of Surgeons in Ireland was based on the analysis of 3D landmarks to investigate sexual dimorphism in normal subjects [40] and then extended to schizophrenia-control comparisons, including the comparisons of directional asymmetry [41]. The methodology was further extended to examine the relationship of facial shape to cognitive measures in normal subjects, using correlation models [42]. The relationship of sexual dimorphism in normal human facial shape to sexual dimorphism in cognitive function, using interpolated landmarks over the entire facial surface, has also been investigated [42]; this is a critical validator for the application of facial shape analysis as an index of brain function as well as structure. Graphical visualisation has also been a key tool in all these investigations. There are many other important applications of the analysis of facial data; for example, see [39].

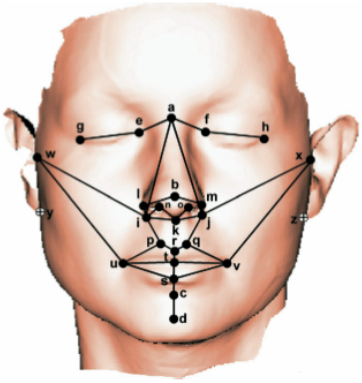
At Glasgow Dental School, three-dimensional surface data has been collected on cleft-lip and palate patients for around ten years in a variety of different clinical projects. A substantial longitudinal database has been constructed and different methods of shape analysis [12, 45, 46, 71, 2, 23] applied. This includes the use of traditional linear and angular measurements, as well as more advanced techniques for assessing asymmetry and shape change. In addition, a wide variety of other surgical operations are carried out on the face. This therefore provides a rich test bed of information on which new methods of data extraction and analysis can be assessed.

(c) Research strategy and methods

1. *The automatic identification of anatomical features*

   The standard starting point for the extraction of information from raw facial data, is the identification of key anatomical landmarks. This is currently done manually by trained and experienced clinicians and scientists and it is a laborious process. It is proposed to develop methods of automating as much of this process as possible. The Vision Systems Group (VSG) at Dublin City University has already developed 2D and 3D shape extraction techniques. The aim will be to combine these with available methods for matching local surfaces to identify the relevant landmarks. This will build on relevant work in the literature, such as [27, 21, 72, 64, 18, 74].

   The figure opposite shows 24 (a-x) landmarks which are commonly used in facial analysis and which have careful anatomical definitions. We will investigate the extent to which some or all of these can be identified automatically. A further stage of the process will involve the automatic, or semi-automatic, extraction of key anatomical curves, such as the mid-line profile, nasal ridge, nasal base, upper lip, etc.



   We propose to build on ongoing work at Glasgow to extend the SIFT [52] algorithm for point-matching between images by adapting Lowe's concept of a keypoint descriptor to include information about range surface local topology [50, 51]. We have based this new keypoint descriptor on a combination of the local surface orientation histogram and a histogram of the local surface shape index [53]. Locations are characterised through the nature of the surrounding surface curvature, classified as peak or cap, ridge, saddle, valley or rut, pit or cup, and plane. We anticipate that a subset of clinical landmarks will be amenable to automated extraction, particularly where landmarks are associated with high curvature in at least two dimensions, such as the corners of the eyes and mouth and distinctive parts of the nose. Standard methods are described in [49] and an adaptive algorithm will be constructed to match these characterisations to each landmark of interest. This will extend to the face work which has proved to be successful in other anatomical regions such as the colon [19]. By utilising range images we propose to achieve a greater degree of invariance to illumination and 3D pose changes than could otherwise be achieved using 2D images alone.

2. *The representation of facial surfaces*

   The Computer Vision & Graphics Laboratory (CVGL) at the University of Glasgow has a long history in the development of algorithms to construct three-dimensional models from stereo-camera systems. In addition, methods have been developed to fit a generic facial shape to each model, using key anatomical landmarks as anchor points and warping the generic shape to fit the surface between these.

The resulting point-by-point correspondence in the fitted generic shapes then allows a variety of quantitative methods of analysis to be applied, including principal components, measurements of facial asymmetry and facial growth, and the comparison of facial shape across different groups of patients.

Existing algorithms represent captured anatomical surfaces as polygonal meshes. This approach has the merit of simplicity but it does not properly represent the very high resolution which is now provided by modern digital capture systems and this inefficiency is a significant drawback in both the quantification and visualisation of surface data. It is therefore proposed to refine the techniques for model construction and generic shape fitting to work directly with the raw data of the range map produced by the capture systems, rather than its polygonal representation. This proposed approach would involve fitting an appropriate face representation (mesh, grid or parametric) directly to the range map. In order to provide a more automatic solution we propose to develop a robust initial range map-to-face model registration mechanism by drawing upon techniques developed by the VSG at Dublin City University, described above, and also at CVGL, based on a range-surface formulation of the SIFT algoritm.

3. *Statistical models for anatomical data*

   Standard methods for the analysis of landmark data are now well established and the ideas involved have been extended to the pseudo-landmark data which is often used to represent surface data in a more complete form. However, modern methods of statistical analysis also allow data to be represented not only in traditional point form but also in much richer structures. For example, anatomical curves represent an attractive compromise between the complexity of surface data and the simplicity of landmarks. The representation of facial shape through a set of well chosen curves allows relatively simple models to be constructed for each curve while, if the set of curves is large enough, the resulting description of the face remains rich. In addition, anatomical curves have clear and helpful interpretations.

   A specific aim of the project is to connect the modelling of facial shape with the recently developed and highly active area of statistics known as functional data analysis (fda), as described by [69]. The key idea of fda is to construct models and methods which properly represent the collected information in curve form. Suitable parametrisations, such as those based on splines, allow curves to be represented in a relatively economical, low-dimensional manner, while retaining considerable flexibility of shape. Information on local curvature and discontinuities can be calculated easily and modern advances in differential geometry brought to bear. A wide variety of statistical methods such as principal components, regression and analysis of variance now have their counterparts in the fda paradigm. We therefore aim to bring together the functional nature of facial scan data and these exciting tools of modern statistical methods. The extent to which this brings additional insight into facial analysis will be investigated by careful comparison with more standard landmark approaches.

4. *The quantification and analysis of asymmetry*

Asymmetry is a familiar and important quantity in medical and biological applications yet its numerical and visual characterisation is not easy to construct. The classical decomposition of total asymmetry into directional (mean) and fluctuating (variance) components of [67] was brought into the geometric morphometrics paradigm by [63]. The definition of symmetry as the coincidence of the shape of an object and its mirror image leads to a measure of asymmetry as the degree of mismatch between the the original and its reflection. This can be implemented for anatomical positions by identifying paired landmarks, associated with corresponding features on each side of the face, and unpaired landmarks corresponding to features on the 'midline'. This approach has been applied to the human face [41] and has been extended to curves [14]. The latter paper, and [15], also discuss a method of decomposition which identifies the relative contributions of different features and types of asymmetry to the overall score.

However, much remains to be done to develop general methods for the quantification and analysis of asymmetry. The methods of surface representation described above immediately provide a means of fitting a facial template, which in turn provides sets of paired and unpaired pseudo-landmarks from which surface asymmetry can be derived. Tests for different degrees of asymmetry across populations, and to identify the principal sources and natures of asymmetry, also need to be constructed. There is also considerable scope for using visualisation to display the results of these analyses informatively, using three-dimensional graphics and colour coding to highlight deviations from a symmetric form.

5. *Facial shape and schizophrenia*

Recent work has shown that the face exhibits a characteristic topography of dysmorphology in schizophrenia [43, 1, 44]. This includes overall widening and vertical shortening of the face; increased width of the skull base and upper face; lateral displacement of the cheeks, eyes and orbits, with the superior margins of the orbits displaced anteriorly; narrowing and reduction of the mid/lower face and frontonasal prominences, including reduced width of the mouth, upper and lower lips and chin, which are displaced posteriorly; widening of the mandible. While differences were found in patients of both sexes, these appeared more prominent in females. We propose to build on this work by investigating possible functional correlates of facial dysmorphology. Specifically, we will investigate the extent to which psychopathology, particularly negative symptoms and cognitive impairment, are related to facial dysmorphology and thus, for the first time, offer insight into the underlying developmental pathobiology of schizophrenia.

Novel procedures and algorithms generated during this project will be applied to a new dataset comprising three-dimensional laser surface images of patients with schizophrenia in comparison with control subjects. Thirty patients will be drawn from attendees of Cavan-Monaghan Mental Health Service who are under the age of 65; each will satisfy DSM-IV criteria (American Psychiatric Association, 1994) for schizophrenia or schizoaffective disorder as described previously [43, 1, 44]. One hundred control subjects under the age of 65 will be drawn from individual and community group volunteers in Cavan-Monaghan; those who have a personal

or family history of psychotic illness or suicide in a first degree relative will be excluded. To ensure ethnic homogeneity, all subjects, their parents and grandparents will originate from and be born in Ireland, Scotland, Wales or England; all will be white. Subjects will be questioned about any craniofacial trauma or surgery and individuals who report such events will be excluded. Subjects will be assessed for psychopathology using the Positive and Negative Syndrome Scale and a neuropsychological test battery.

The principal aim is to understand the nature of brain dysmorphogenesis. Because the developmental biology of facial morphogenesis is considerably better understood than is brain morphogenesis, abnormalities in facial shape therefore have the potential to inform incisively on this. Such findings could potentially guide future molecular genetic and neuropathological studies. Furthermore, the ability to make comparisons of facial shape across diagnoses, for example between schizophrenia and bipolar disorder (formerly known as manic-depressive psychosis) will allow us to address directly the long-standing conundrum of whether these disorders involve similar, distinct or overlapping dysmorphogenic processes.

6. *Assessing the outcome of orthognathic surgery*

   A common facial procedure in adults is orthognathic surgery, which involves the correction of the position, shape and size of the upper (maxilla) and/or lower (mandible) jaw, to improve facial alignment. While the success of this type of operation can be judged visually in a subjective manner, quantitative measures of change and improvement would be of considerable value. We propose to recruit a cohort of thirty orthognathic patients. Consent will be sought using standard protocols, to be approved by the South Glasgow & Clyde ethics committee. The project will sponsored by Greater Glasgow Hospital Health board through the Research & Development Department at the South General Hospital. Facial shape will be recorded by stereophotogrammetry before and after surgery, using existing local facilities for image capture.

   Linear and angular measurements have traditionally been used to describe the change in the size and shape of areas of interest [34, 35, 37] but the new methods to be developed in the project have the potential for significantly improved assessment. In particular, curve analysis will be applied to describe shape change of the upper and lower vermilion borders to measure changes in response to surgery. There are currently no well established objective methods to measure change in this important anatomical region. Asymmetry will also be measured to check that this is not inadvertently increased by the surgery.

   While investigation of facial change in this setting is of interest in its own right, this study will prepare the way for future investigations of the relationship between changes in underlying bone position and soft tissue facial shape [48, 4], using the information from cone-beam CT scans, as this becomes more routinely available.

(d) Timetable and milestones

The scientists involved in the research team span a wide variety of discplines, including

medicine, computing science, statistics and mathematics. The team has arisen out of three invited meetings (two in Dublin in 2006 and one in Glasgow in 2007) on the theme 'Morphometrics in Medicine'. These meetings identified common interests and have ensured that genuine interdisciplinary working is feasible. All types of expertise will be involved, although to differing degrees, in each of the main development stages of the project. It is anticipated that one RA will have a computing science background and one a statistics background. Regular meetings of the full team, plus regular site visits by the RAs and the additional use of videoconference facilities will ensure close co-ordination of the research effort.

<table>
<tr><th>Year 1</th><th>Year 2</th><th>Year 3</th></tr>
</table>

RA1

<table>
<tr><td>Automatic identification
of anatomical features</td><td>Representation of
facial surfaces</td><td rowspan="2">Final
analysis
and write-up</td></tr>
<tr><td colspan="2">Facial shape and schizophrenia</td></tr>
</table>

RA2

<table>
<tr><td>Statistical models
for anatomical data</td><td>Quantification and analysis
of asymmetry</td><td rowspan="2">Final
analysis
and write-up</td></tr>
<tr><td colspan="2">Assessing the outcome of orthognathic surgery</td></tr>
</table>

Q11 **REFERENCES** (Research project)
Please give citation in full, including title of paper and all authors.

References

[1] Agartz IK, Hennessy RJ, McNeil T, et al. (2007). Dysmorphology of face and brain in male schizophrenia via MRI imaging and 3D morphometrics - Total shape and directional asymmetry *Schizophrenia Bulletin* **33**, 327–327.

[2] Al-Omari I, Millett DT, Ayoub AF. (2005). Methods of assessment of cleft related facial deformity: a review. *Cleft Palate Craniofac J.* **42**, 145–156.

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Q12 **DATA MANAGEMENT & DATA SHARING** (no more than 1500 words)

Where appropriate, detail (a) your plans for data management, curation and storage; (b) your policy for sharing data with others, including the management and prioritisation of access to data; (c) your strategy for current and future communication with user communities; and (d) any ethical considerations.

Q13 **OUTLINE OF PUBLIC ENGAGEMENT PLANS** (no more than 250 words)

Please note that we provide support for researchers in the UK and Republic of Ireland to engage with the lay public. Do you wish to receive information about training, funding and other public engagement opportunities?

Yes

Q14 CURRICULUM VITAE OF APPLICANT

(a) Surname: Bowman Forenames: Adrian William

Date of birth: 03/01/1955

(b) Title of current post: Professor of Statistics

Date of appointment: 01/10/1995

Expected date of termination: 30/09/2020

(c) With whom do you have your contract of employment?

University of Glasgow

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

HEFC

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/Institution
1981	1986	Lecturer in Mathematical Statistics	Mathematics	University of Manchester
1986	1990	Lecturer in Statistics	Statistics	University of Glasgow
1990	1992	Senior Lecturer in Statistics	Statistics	University of Glasgow
1992	1995	Reader in Statistics	Statistics	University of Glasgow
1995	present	Professor of Statistics	Statistics	University of Glasgow

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
1973	1977	Mathematics B.Sc.	University of Glasgow
1977	1978	Diploma in Mathematical Statistics	University of Cambridge
1978	1981	Ph.D. in Statistics	University of Glasgow

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

A principal research area throughout my career has been the topic of statistical smoothing techniques. In this approach to the modelling of data, no particular parametric shapes of distribution or regression functions are assumed. Instead, the information in the data is condensed into the form of a smooth curve or surface. This

approach to modelling data has a very wide range of applications.

Early technical work included a method of controlling the amount of smoothing applied to the data in some specific settings, known as least-squares cross-validation, which proved to mark a significant step forward in the area through its theoretical and practical success. This method was described in Bowman (1984; Biometrika, 71, 353-60). Later work concentrated on the use of smoothing techniques in inferential methods, designed to assess the evidence for the presence of particular effects of interest. Techniques were developed for widely occurring models and data structures, including the detection of non-linearity in regression, analysis of covariance, repeated measurements analysis, survival data, non-monotonicity and the detection of spatial auto-correlation. In all of these areas, effort was directed towards the development of appropriate graphical methods as well as more formal methods of inference.

Research in this general area culminated in the publication of an OUP monograph, jointly with Prof. Adelchi Azzalini of the University of Padua. (Bowman, A. and Azzalini, A., 1997, Applied smoothing techniques for data analysis. Oxford University Press.) An extensive library of S-Plus/R software was also developed in conjunction with the book. This software which has since been repeatedly developed further and released in new versions. (www.stats.gla.ac.uk/~adrian/sm)

Most recently, work has focussed on the important class of tools known as additive models, with the aim of developing methods of inference which place the use of these tools on a firmer footing. In this area, work on environmental applications has been extensive, with particular connections to issues of environmental monitoring, in conjunction with the Scottish Environment Protection Agency and the Centre for Ecology and Hydrology.

I have also had extensive experience of more general statistical applications, from a wide variety of areas but most commonly in the environmental, biological and medical sciences. A recent example is involvement in an interdisciplinary research group of dental anaesthesia. (See, www.stats.gla.ac.uk/~adrian for details.)

A major theme of current research is the statistical modelling of the shape of three-dimensional objects. The applications revolve principally around the stereo-photogrammetric reconstruction of faces, using a camera system developed by colleagues in Computing Science. An interdisciplinary team in Glasgow has collected longitudinal data on the growth of children's faces, with particular application to the identification of residual dysmorphology in children who have undergone repair for cleft lip and/or palate conditions. Major statistical challenges arise in the extraction and analysis of relevant information on shape. One approach has focussed on one-dimensional measures, such as asymmetry, and recent work has produced measures of asymmetry which can be decomposed into regional components and which has associated characteristic types associated with position, orientation or intrinsic asymmetry. (Bock, M.T. and Bowman, A.W., 2006, On the measurement and analysis of object asymmetry with applications to facial modelling. Applied Statistics, 55, 77-91.) Other work has focussed on the graphical display of both systematic and variational components in shape data across samples of patients. (Bowman, A.W. and Bock, M., 2006, Exploring variation in three-dimensional shape data. J.Comp.Graph.Stat., 15, 524-541.) A third area of current activity is the development of longitudinal models which reflect the particular characteristics of individuals across time, as in classical repeated measurements models, but are extended to allow a description of the highly multivariate information present in shape data (paper under invited revision).

Professional and leadership roles (selected):

Joint Editor of the journal Applied Statistics (J.Roy.Stat.Soc.Series C), 1999-2002.

Associate editor of JRSSB (1986--92), Biometrika (1996—1998), Biometrics (1996-1998), Biostatistics (2006-present), Journal of Statistical Software (2007-present)
Head of the Department of Statistics at the University of Glasgow (1999-2005).
External examiner at the Universities of Cambridge, Newcastle, Wales (Aberystwyth) and St. Andrews.
Director, Higher Education Academy network for Mathematics, Statistics and OR (Glasgow site).
Chair of the UK Committee of Professors of Statistics (2001-2004).
A wide variety of responsibilities have been held within the Royal Statistical Society.
Elected a Fellow of the International Statistical Institute, 1994.
Elected a Fellow of the Royal Society of Edinburgh, 2000.

(h) Publications.
Applicants should list **all publications from previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave or Principal Applicants seeking their own salary, must provide a complete list of their scholarly publications.

Prof. Adrian Bowman

Publications since 2005

Bowman, A.W., Crawford, E., Currall, J.C. & Young, S.G. (2005). Entry on *The Internet* in the *Encyclopedia of Biostatistics*, 2nd edition, pp. 2085-2088. Wiley: London.

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Downie, J., Mao, J., Lo, R., Barry, S., Bock, M., Siebert, P., McConnachie, A., Yap, C., Bowman, A.W., Ayoub, A. (2007). A double-blind, clinical evaluation of facial augmentation treatments: a comparison of PR 1, PR 2, Zyplast and Perlane. *Plastic and Reconstructive Surgery*, to appear.

Significant earlier publications

Hood, C.A., Bock, M., Hosey, M.T., Bowman, A.W. & Ayoub, A.F. (2003) Facial asymmetry - 3D assessment of infants with cleft lip and palate. *International Journal of Pediatric Dentistry*, **13**, 404–410.

Bowman, A.W. and Azzalini, A. (2003). Computational aspects of nonparametric smoothing with illustrations from the `sm` library. *Computational Statistics and Data Analysis*, **42**, 545–560.

Diblasi, A. & Bowman, A.W. (2001). On the use of the variogram for checking independence in a Gaussian spatial process. *Biometrics*, **57**, 211–218.

Bowman, A.W. & Wright, E. (2000). Graphical exploration of covariate effects on survival data through nonparametric quantile curves. *Biometrics*, **56**, 563–570.

Bowman, A. & Azzalini, A. (2000). The sm library, version 2. A library of S-Plus functions published on the internet to accompany the book *Applied smoothing techniques for data analysis*.

Bowman, A.W. (1999). The Birds and the Bees. In *Statistics and Problem Solving*, Bowman, A.W. & McColl, J.H. (editors), 1999, pp. 11–22. Arnold, London.

Bowman, A.W., Hall, P.& Prvan, T. (1998). Bandwidth selection for the smoothing of distribution functions. *Biometrika* **85**, 799–808.

Bowman, A.W., Jones, M.C. and Gijbels, I. (1998). Testing monotonicity of regression. *J.Comp.Graph.Stat.* **7**, 489–500.

Bowman, A. & Azzalini, A. (1997). *Applied smoothing techniques for data analysis*. Oxford University Press.

Bowman, A.W. & Young, S.G. (1996). Graphical comparison of nonparametric curves. *Applied Statistics* 45, 83–98.

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

Current grants:

EPSRC. Academy for PhD Training in Statistics (APTS). 362,158 pounds. 2007-1012. (with W.Kendall, Warwick and 8 other UK colleagues). 1 hour per week.

EPSRC. Scottish Mathematical Training Centre - a taught course centre for UK PhD students. 377,909 pounds. 2007-2012. (with A.Carberry and 10 other Scottish-based colleagues). 1 hour per week.

Chief Scientist's Office, Scottish Executive. Randomised clinical trial of the effects of total intravenous anaesthesia versus volatile anaesthesia on children's postoperative cognition, behaviour and physical morbidity. 214,075 pounds. 2007-2010. (with K.Millar, R.Welbury, M.T.Hosey and A.J.Asbury). 2 hours per week.

Strathclyde Police. Reduction of alcohol abuse, aggression and facial injury - a randomised trial of brief intervention strategies in patients with alcohol abuse. 100,000 pounds. 2006-2008. (with A.Ayoub and C.Goodall). 1 hour per week.

Joint Funding Councils. Funding for the Glasgow component of the LTSN Centre for MSOR. 100,494 pounds. 2006-2007. 2 hours per week.

SHEFC CPD funds to the University of Glasgow. Development of short courses on statistics for environmental studies. 34,410 pounds. 2006-2007. (with E.M.Scott). 1 hour per week.

NERC. Provision of training courses for environmental scientists. 57,000 pounds. 2006-2009. (with E.M.Scott). 1 hour per week.

Chief Scientist's Office, Scottish Executive. A multidisciplinary assessment of residual deformities following surgical repair of cleft lip and palate. 149,289 pounds. 2005-2008. (with A.Ayoub, A.Bell, R.Welbury, K.Millar, P.Siebert, D.Millett). 2 hours per week.

Highlights of previous grants:

Tissue Science Laboratories. Assessment of Permacol in facial reconstruction. 212,000 pounds. 2003-2005. (with A.Ayoub and P.Siebert).

Chief Scientist's Office, Scottish Executive. Cleft lip and palate study in babies. 150,000 pounds. 1999-2002. (with A.Ayoub, P.Siebert).

National Lotteries Fund. Cleft lip and palate study in infants. 200,000 pounds. 1999-2002. (with A.Ayoub and P.Siebert).

UFC. A consortium to develop computer based teaching materials in statistics. 659,000 pounds. 1992-1995. (with Lancaster, Sheffield, Leeds, Reading, UMIST).

Q14 CURRICULUM VITAE OF COAPPLICANT

(a) Surname: Waddington Forenames: John

Date of birth: 30/10/1952

(b) Title of current post: Professor of Neuroscience and Head of Molecular & Cellular Therapeutics

Date of appointment: 01/10/1999

Expected date of termination: 30/09/2017

(c) With whom do you have your contract of employment?

Royal College of Surgeons in Ireland

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

No other source other than Royal College of Surgeons in Ireland

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/ Institution
1999	Present	Professor of Neuroscience and Head of Department	Molecular & Cellular Therapeutics	Royal College of Surgeons in Ireland
1991	1998	Associate Professor of Neuroscience	Department of Clinical Pharmacology	Royal College of Surgeons in Ireland
1988	1991	Reader	Department of Clinical Pharmacology	Royal College of Surgeons in Ireland
1985	1988	Senior Lecturer	Department of Clinical Pharmacology	Royal College of Surgeons in Ireland
1981	1984	Lecturer	Department of Clinical Pharmacology	Royal College of Surgeons in Ireland
1978	1981	Scientific Staff, Division of Psychiatry	MRC Clinical Research Centre	Northwick Park Hospital, Harrow, UK
1975	1978	Medical Research Council Scholar & Demonstrator in Pharmacology	Division of Psychiatry /School of Pharmacy	MRC Clinical Research Center, Northwick Park Hospital, Harrow /University of London UK
1974	1975	Medical Research Council Student & Demonstrator in Physiology	Department of Physiology	University of Bradford UK

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
1971-1974	BA (Hons)	Class 11 (i) in Natural Sciences	University of Cambridge
1978	MA	Natural Sciences	University of Cambridge
1974-1975	MSc	Experimental Pharmacology	University of Bradford
1975-1978	PhD	Psychopharmacology	University of Bradford
1991	DSc	Psychopharmacology	University of Bradford

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

Prof. John Waddington
Prof. Waddington is Professor of Neuroscience at the Royal College of Surgeons in Ireland. Educated at University of Cambridge, BA [Hons] II(i) Natural Sciences [1974], MA [1978]; University of Bradford, MSc Experimental Pharmacology [1976]; University of London, PhD Psychopharmacology [1981]; University of London, DSc Neuroscience [1991]. Post-doctoral research at the Division of Psychiatry, MRC Clinical Research Centre [1978-1981]. Scientific honours include: Conway Medalist, Royal Academy of Medicine in Ireland [1987]; Research Prize, British Association for Psychopharmacolog [1988]; Graves Medalist, Royal Academy of Medicine in Ireland and Health Research Board [1991]; Organising Committee, International Nobel Prizewinners Forum-Festival of Discovery, Dublin: European City of Culture [1991]; Award of Merit for Pharmacology & Toxicology, Royal Irish Academy [1996]; Elected to Foreign Corresponding Fellowship, American College of Neuropsychopharmacology [1997]; John Cade Lecturer, University of Melbourne [1999]; Visiting Professor, Nihon University, Tokyo [2000]; Elected to Membership, Royal Irish Academy [2003]; Lilly Neuroscience Award 2004.

(h) Publications.
Applicants should list **all publications from the previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave must provide a complete list of their scholarly publications.

Prof. John Waddington
Publications since 2005

O'Sullivan, G.J., Kinsella, A., Sibley, D.R., Tighe, O., Croke, D.T. & Waddington. J.L. Ethological resolution of behavioural topography and D_1-like vs D_2-like agonist responses in congenic D_5 dopamine receptor mutants: identification of D5:D2-like interactions. Synapse 55, 201-211, 2005.

Hennessy, R.J., McLearie, S., Kinsella, A. & Waddington J.L. Facial surface analysis by 3D laser scanning and geometric morphometrics in relation to sexual dimorphism, cerebral-craniofacial morphogenesis and cognitive function. J. Anatomy 207, 283-296, 2005.

McGhee, K.A., Morris, D.W., Schwaiger, S., Nangle, J.-M., Donohue, G., Meagher, D., Quinn, J., Scully, P., Waddington, J.L., Gill, M. & Corvin, A. Investigation of the apolipoprotein-L (APOL) gene family and schizophrenia usng a novel DNA pooling strategy for public database SNPs. Schizophr. Res. 76, 231-238, 2005.

Waddington, J.L., O'Tuathaigh, C., O'Sullivan, G., Tomiyama, K., Koshikawa, N., Croke, D.T. Phenotypic studies on dopamine receptor subtype and associated signal transduction mutants: insights and challenges from 10 years at the psychopharmacology-molecular biology interface. Psychopharmacology 181, 611-38, 2005.

Parish, C.L., Nunan, J., Finkelstein, D.I., McNamara, F., Wong, J.Y., Waddington, J.L., Brown, R.M., Lawrence, A.J., Horne, M.K., Drago, J. Mice lacking the alpha 4 nicotinic receptor subunit fail to modulate dopaminergic neuronal arbors and possess impaired dopamine transporter function. Mol. Pharmacol. 68, 1376-1386, 2005.

Waddington, J.L. What have we learned from the new generation of prospective studies on first episode psychosis? Schizophrenia Bulletin 31, 623, 2005.

Baldwin, P., Browne, D., Scully, P.J., Quinn, J.F., Morgan, M.G., Kinsella, A., Owens, J.M., Russell, V., O'Callaghan, E., Waddington, J.L.. Epidemiology of first-episode psychosis: illustrating the challenges across diagnostic boundaries through the Cavan-Monaghan study at 8 years. Schizophr. Bull. 31, 624-38, 2005.

Hennessy, R.J., McLearie, S., Kinsella, A. & Waddington, J.L. Facial shape and asymmetry by 3D laser surface scanning covary with cognition in a sexually dimorphic manner. J. Neuropsychiat. Clin Neurosci. 18, 73-80, 2006.

Tomiyama, K., Makihara, Y., Yamamoto, H., O'Sullivan, G., Nally, R.E., Tighe, O., Kinsella, A., Fienberg, A.A., Grandy, D.K., Sibley, D.R., Croke, D.T., Koshikawa, N. & Waddington J.L. Disruption of orofacial movement topographies in congenic mutants with dopamine D_5 but not D_4 receptor or DARPP-32 transduction 'knockout'. Eur. Neuropsychopharmacol.16, 437-445, 2006.

O'Sullivan, G., Kinsella, A., Grandy, D.K., Low, M.J., Tighe, O., Croke, D.T. & Waddington, J.L. Ethological resolution of behavioural topography and D2-like vs D1-like

agonist responses in congenic D4 dopamine receptor 'knockouts': identification of D4:D1-like interactions. Synapse 59, 107-118, 2006.

Norton, N., Moskvina, V., Morris, D., Bray, N., Zammit, S., Williams, N., Williams, H.J., Preece, A., Dwyer, S., Wilkinson, J.C., Spurlock, G., Kirov, G., Buckland, P., Waddington, J.L., Gill, M., Corvin, A.P., Owen, M.J., O'Donovan, M.C. Evidence that interaction between Neuregulin 1 and its receptor erbB4 increases susceptibility to schizophrenia. Am. J. Med. Genet. [Neuropsychiat. Genet.] 141, 96-101, 2006.

O'Tuathaigh, C.M.P., O'Sullivan, G.S., Kinsella, A., Tighe, O., Croke, D.T., Harvey, R., Waddington, J.L. Topographical evaluation of behavioural phenotype in neuregulin-1 mutant mice. NeuroReport 17, 79-83, 2006.

O'Sullivan, G., O'Tuathaigh, C., Clifford, J., O'Meara, G.F., Croke, D.T., Waddington, J.L. Possibilities and limitations of genetic manipulation in animals. Drug Discovery Today: Technologies 3, 173-180, 2006.

Fujita, S., Lee, J., Kiguchi, M., Uchida, T., Cools, A.R., Waddington, J.L., Koshikawa, N. Topographical resolution of jaw movements mediated by cyclase- vs. non-cyclase-coupled dopamine D1-like receptors: studies with SK&F 83822. Eur. J. Pharmacol. 538, 94-100, 2006.

Vaddadi, K., Hakansson, K., Clifford, J. & Waddington, J. Tardive dyskinesia and essential fatty acids. Int. Rev. Psychiatry 18, 133-143, 2006.

Whitty, P., Clarke, M., McTigue, O., Browne, S., Gervin, M., Kamali, M., Lane, A., Kinsella, A., Waddington, J., Larkin, C. & O'Callaghan, E. Diagnostic specificity of neurological soft signs in schizophrenia, bipolar disorder and other psychoses over the first four years of illness. Schizophr. Res. 86, 110-117, 2006.

Clarke, M., Whitty, P., Browne, S., McTigue, O., Kamali, M., Gervin, M., Kinsella, A., Waddington, J.L., Larkin, C. & O'Callaghan, E. Untreated illness and outcome of psychosis. Br. J. Psychiatry 189, 235-240, 2006.

Clarke, M., Whitty, P., Browne, S., McTigue, O., Kinsella, A., Waddington, J.L., Larkin, C., & O'Callaghan E. Suicidality in first episode psychosis. Schizophr Res. 86, 221-5, 2006.

Tomiyama, K., Waddington, J.L.& Koshikawa, N. Observation and recording of mouse jaw movements with a novel restrictor system and a behavioural check list. Nippon Yakurigaku Zasshi 128, 244-9, 2006.

Cryan, J.F., Driscoll P. & Waddington J.L. Neurogenetics and behaviour: from basic processes to neuropsychiatric disorders. Neurosci. Biobehav. Rev. 31, 1-2, 2007.

O'Tuathaigh, C.M.P, Babovic, D., Croke, D.T. & Waddington, J.L. Susceptibility genes for schizophrenia: phenotypic characterisation of mutant models. Neurosci. Biobehav. Rev. 31, 60-78, 2007.

Gantois, I., Fang, K., Jiang, L., Babovic, D., Lawrence, A.J., Ferreri, V., Teper, Y., Jupp, B., Ziebell, J., Morganti-Kossman, C.M., O'Brien, T.J., Nally, R., Schutz, G., Waddington

J., Egan, G. & Drago, J. Targeted ablation of D1 dopamine receptor expressing cells generates mice with seizures, hind limb dystonia, hyperactivity and impaired oral behaviour. Proc. Natl. Acad. Sci. USA 104, 4182-4187, 2007.

Hennessy, R.J., Baldwin, P.A., Browne, D.J., Kinsella, A. & Waddington, J.L. 3D laser surface imaging and geometric morphometrics resolve frontonasal dysmorphology in schizophrenia. Biol. Psychiatry 61,1187-1194, 2007.

Waddington, J.L., Kingston, T. & O'Tuathaigh, C.M.P. Longitudinal studies on course of illness in schizophrenia: a lifetime trajectory perspective. In: The Year in Schizophrenia, Volume 1, (eds W.T. Carpenter & G. Thaker), Oxford Clinical Publishing, pp 77-99, 2007.

Makihara, Y., Okuda, Y., Kawada, C., Matsumoto, M., Waddington J.L., Koshikawa N. & Tomiyama, K. Differential involvement of cyclise–versus non-cyclase-coupled D1-like dopamine receptors in orofacial movement topography in mice: studies with SKF 83822. Neurosci. Lett. 415, 6-10, 2007.

Waddington, J.L., Neuroimaging and other neurobiological indices in schizophrenia: relationship to measurement of functional outcome. Br. J. Psychiatry (in press).
Ishige, K., Takagi, N., Imai, T., Rausch, W.D., Kosuge, Y., Kihara, T., Kusama-Eguchi, K., Ikeda, H., Cools, A.R., Waddington, J.L., Koshikawa N. & Ito Y. Role of Caspase-12 in amyloid beta-peptide-induced toxicity in organotypic hippocampal slices cultured for long periods. J. Pharmacol. Sci. 104, 46-55, 2007.

Clarke, M., Browne, S., McTighue, O., Gervin, M., Kinsella, A., Waddington, J.L., Larkin, C., & O'Callaghan, E. Determinants of duration of untreated psychosis in an Irish catchment area sample. Ir. J. Psychol. Med. (in press).

Corvin, A., McGhee, K.A., Murphy, K., Donohoe, G., Nangle, J.M., Schwaiger, S., Kenny, N., Clarke, S., Meagher, D., Quinn, J., Scully, P., Baldwin, P., Brown, D., Walsh, C., Waddington, J.L., Morris, D.W. & Gill M. Evidence for association and epistasis at the DAOA/G30 and D-amino acid oxidase loci in an Irish schizophrenia sample. Am. J. Med. Genet. [Neuropsychiat. Genet.]. (in press).

Aono, Y., Saigusa, T., Watanabe, S., Iwakami, T., Mizoguchi, N., Ikeda, H., Ishige, K., Tomiyama, K., Oi, Y., Ueda, K., Rausch, W.D., Waddington, J.L., Ito, Y., Koshikawa, N. & Cools, A.R. Role of alpha adrenoceptors in the nucleus accumbens in the control of accumbal noradrenaline efflux: a microdialysis study with freely moving rats. J. Neural Transm. (in press).

Waddington, J.L., Corvin, A.P., Danohue, G., O'Tuathaigh, C.M.P., Mitchell, K.J., & Gill, M. Functional genonics and schizophrenia: endophenotypes and mutant models. Psychiat. Clin. N. Amer. (in press).

O'Tuathaigh, C.M.P., Babavic, D., O'Sullivan, G.J., Clifford, J.J., Croke, D.T., Harvey, R. & Waddington, J.L. Phenotypic characterisation of spatial cognition and social behaviours in mice with 'knockout' of the schizophrenia risk gene neuregulin 1. Neuroscience (in press).

Morris, D.W., Murphy, K., Kenny, N., Purcell, S.M., McGhee, K.A., Schwaiger, S., Nangle, J.-M., Donohoe, G., Clarke, S., Scully, P., Quinn, J., Meagher, D., Baldwin, P., Crumlish, N., O'Callaghan, E., Waddington, J.L., Gill, M. & Corvin, A. Dysbindin (DTNBP1) and the biogenesis of lysosome-related organelles complex 1 (BLOC-1): main and epistatic gene effects are potential contributors to schizophrenia susceptibility. Biol. Psychiatry (in press).

Babovic, D., O'Tuathaigh, C.M., O'Sullivan, G.J., Clifford, J.J., Tighe, O., Croke, D.T., Karayiorgou, M., Gogos, J.A., Cotter, D. & Waddington, J.L. Exploratory and habituation phenotype of heterozygous and homozygous COMT knockout mice. Behav. Brain Res. (in press).

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

2003 - 2007 Science Foundation Ireland
Investigator Grant [PI] € 954,363
2001 - 2004 Enterprise Ireland
Basic Science Research Grant [PI] € 82,076
2000 - 2004 Higher Education Authority € 64,154
PRTLI Biopharmaceutical Sciences Network
[Project PI]
2000 - 2003 Irish Brian Research Foundation
Galen Fellowship [PI] € 31,743
1999 - 2003 HEA Institute for
Biopharmaceutical Sciences [Project PI] €236,044
1999 - 2001 Nihon University Japan € 45,482
International Coollaboration Research Grant [PI]
1998 - 2000 HEA PRTLI Preliminary € 44,441
Biopharmaceutical Sciences Reseaarch
Resource [Project PI]
1998 - 2001 Royal College of Surgeons in Ireland
Research Grant € 45,095
1996 -1998 Irish Brain Research Foundation & RCSI
Clinical Research Grant [Co-PI] € 79,683
1995 - 2004 Stanley Research Institute €1,530,612
USA, Clinical Research Centre Grant [Co-Director]
1991 - 1996 Health Research Board of Ireland
Schizophrenia Research Unit € 506,289
1988 - 1991 St. John of God Order € 95,230
Clinical Research Grant [Co-PI]
1984-1989 Medical Research Council of Ireland
Drugs & the Elderly Research Unit [Co-PI] €412,664

Q14 CURRICULUM VITAE OF COAPPLICANT

(a) Surname: Ayoub Forenames: Ashraf Farouk

Date of birth: 24/03/1961

(b) Title of current post: Professor/Honorary Consultant

Date of appointment: 01/01/1998

Expected date of termination: 01/03/2026

(c) With whom do you have your contract of employment?

Glasgow University

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

HEFC

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/ Institution
1990	1993	PhD Student	Faculty of Medicine	University of Glasgow
1992	1993	Part-time Instructor	Glasgow Dental Hospital, Faculty of Medicine	University of Glasgow
1993	1998	Lecturer in Oral and Maxillofacial Surgery	Faculty of Medicine	University of Glasgow
1993	1998	Specialist Registrar	Oral and Maxillofacial Surgery	Canniesburn Hospital, Glasgow
1998	2003	Senior Lecturer/Honorary Consultant	Glasgow Dental Hospital and School	University of Glasgow
2003	present	Professor in Oral and Maxillofacial Surgery	Glasgow Dental Hospital and School	University of Glasgow

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
1982	BDS	Dental Surgery	Cairo University
1989	MDS	Oral Surgery and Anaesthesiology	Cairo University
1992	FDS RCS	Oral Surgery and Medicine	Royal College of Surgeons, Edinburgh
1993	PhD	Oral and Maxillofacial Surgery	University of Glasgow

1994	ANB I and II	Dentistry	American National Board
1994	Full Reg GDC	Statutory Examination	General Dental Council
1997	FDS RCS (OS)	Intercollegiate Specialty Assessment	Royal College of Surgeons
1998	CCST	Completion of Surgical Training	Royal College of Surgeons

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

1990 -1993 PhD Student in the Faculty of Medicine, University of Glasgow.

1992 -1993 Part-time Instructor, Glasgow Dental Hospital and School, University of Glasgow.

1993 -1998 Lecturer in Oral & Maxillofacial Surgery, The University of Glasgow, Specialist registrar in academic Oral & Maxillofacial Surgery, Canniesburn Hospital, West of Scotland Regional Plastic & Maxillofacial Unit

1998-2003 Senior Lecturer/ Honorary Consultant in Oral & Maxillofacial Surgery, Glasgow Dental Hospital & School

2003 Professor in Oral & Maxillofacial Surgery

Key Achievements
1) Established the West of Scotland as a centre of excellence for research in three dimensional imaging.
2) Obtained more than one million pounds to promote research in the analysis of craniofacial deformities.
3) Structured and co-ordinated a successful post-graduate programme in oral and maxillofacial surgery.
4) Supervised five PhD degrees on the analysis of facial deformities using 3D imaging; all were successfully completed.
5) Appointed as Glasgow Dental Hospital and School Research Director in 2005.

Awards and Honours
1) The Tom Gibson Memorial Award from the Royal College of Physicians and Surgeons of Glasgow for research in bone bio-engineering, 1999

2) Poster Prize (1st place) Gunter Russell Prize, British Orthodontic Conference 2001. Three dimensional soft tissue changes following orthognathic surgery – a preliminary report (M. Hajeer, D Millett, A Ayoub)

3) Poster Prize (3rd place) British Orthodontic Conference, Sept. 2001 on Clinical and three-dimensional assessment of cleft deformity (Al-Omari, D Millett, A Ayoub)

4) Best Young Researcher presentation at the International Meeting of the International Association of Paediatric Dentistry, Sept, 2002 on Facial Asymmetry-3D assessment in infants with cleft lip and palate (C Hood, M Bock, MT Hosey, A Ayoub)

(h) Publications.
Applicants should list **all publications from the previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave must provide a complete list of their scholarly publications.

Prof. Ashraf Ayoub
Publications since 2005

Bone Biology/Healing:

M Abu Serriah, A Ayoub, A Knotaxis, A Ayoub, J Harrison, E Odell, J Barbenel. Mechanical evaluation of mandibular defects reconstructed using osteogenic protein-1 (rhOP-1) in a sheep model: a critical analysis. *Int J Oral Maxillofac Surg 34:287-293, 2005*

A F Ayoub, W. Richardson, JC Barbenel. Mandibular elongation by automatic distraction osteogenesis: The first application in humans. *Brit J Oral Maxillofac Surg 43:324-328, 2005.*

M Abu Serriah, A Ayoub, D Wray, N. Milne, S Carmicheal, J Boyd. Contour and volume assessment of repairing mandibular osteopriosteal continuity defects in sheep suing recombinant human osteogenic protein 1. J Carnio Maxillofac Surg 34:162-167, 2006

Three Dimensional Imaging

Ayoub A F, Moos K F, Siebert P, Wray D. A three-dimensional modelling for modern

M Hajeer, D Millett, A Ayoub. The application of 3D imaging in orthodontics. Part II *Brit J Orthod* 31:154-162, 2004

M Hajeer, D Millett, P Siebert, A Ayoub. A new three-dimensional method of assessing facial volumetric changes following craniofacial surgery. *Cleft Palate Craniofac J* 42:145-156, 2005

Al-Omari I, Millett DT, Ayoub AF. Methods of assessment of cleft related facial deformity: a review. *Cleft Palate Craniofac J. 42*:145-156, 2005

A Garrahy, DT Millett, A F Ayoub. Early assessment of dental arch development in repaired unilateral cleft and unilateral cleft lip and palate versus control. *Cleft Palate Craniofac J 42:385-391, 2005*

Mao Zhili, Xiangyang Ju, Paul Siebert J, Paul Cockshot W, Ayoub A. Constructing dense correspondences for the analysis of 3D facial morphology. Pattern Recognition Letters , 27(6)2006, 597-628

Rachel Lo TW, Siebert P, Ayoub A. Robust feature extraction for range images interpretations using local topology statistics. Medical Imagaing Compter Assisted Intervention 2006.DK

A Ayoub , Y. Xiao, B Khambay, P siebert, D Hadley. Toward building a virtual human face. Int J Oral Maxillofac Surg 2007;36:423-428

Devlin, M.F., Ayoub A. Ray, A., Raine, P., Bowman A. Assessment of alar base asymmetry using stereophotogrammetry . *Cleft Palate Craniofac J* (in press)

B Khambay, A Bell, N Nana, A Ayoub. Validation and reproducibility of a high resolution 3D facial imaging system. Brit J Oral Maxillofac Surg (in press)

J Nunu, A Bell, S Mchugh, A Ayoub. Assessmend of the morbidity associate woth blepheroplasty incisions using 3D imaging. Int J Oral Maxillofac Surg (in oress)

Clinical Studies:

Primrose AC, Broadfoot E, Diner PA, Molina F, Moos KF, Ayoub AF. Patients' response to distraction osteogenesis: a multi-centre study. *Int J Oral Maxillofac Surg 34:238-242, 2005*

Fry NK, Duncan J, Malnick H, Warner M, Smith AJ, Jackson MS, Ayoub A. Bordetella pertii Clinical isolation. *Emerging Infectious Diseases 11:1131-1133, 2005.*

Ghandi D, Ayoub A, Moos KF, Pogrel T. Ameloblastoma the surgeon's dilemma. J Oral Maxillofac Surg 64:1010-1014, 2006

Jayade V, Ayoub AF, Khambay BS, Walker FS, Gopalakrishnan K, Mailk NA, Srivastava DS, Prdhan DR. Skeletal stability after correction of maxillary hypoplasia by Glasgow extra-oral distraction device. Brit J Oral Maxillofac Surg 44:301-307, 2006

A Saddique, A Ayoub, K F Moos, J McMahon. Single versus two plates for fixation of fracture of the angle of the mandible. Brit J Oral Maxillofac Surg 45:223-225, 2007

R Johns, B Khambay, A Youb. The accuracy of using CASSOS for prediction planning in Orathognathic Surgery. Int J Oral Maxilloafac Surg (in press)

Selected earlier publications

M Abu Serriah, A Ayoub, A Knotaxis, A Ayoub, J Harrison, E Odell, J Barbenel. Mechanical evaluation of mandibular defects reconstructed using osteogenic protein-1 (rhOP-1) in a sheep model: a critical analysis. *Int J Oral Maxillofac Surg 34:287-293, 2005*

A F Ayoub, W. Richardson, JC Barbenel. Mandibular elongation by automatic distraction osteogenesis: The first application in humans. *Brit J Oral Maxillofac Surg 43:324-328, 2005.*

M Abu Serriah, A Ayoub, D Wray, N. Milne, S Carmicheal, J Boyd. Contour and volume assessment of repairing mandibular osteopriosteal continuity defects in sheep suing recombinant human osteogenic protein 1. J Carnio Maxillofac Surg 34:162-167, 2006

Ayoub A F, Moos K F, Siebert P, Wray D. A three-dimensional modelling for modern diagnosis and planning in maxillofacial Surgery. *Int J Adult Orthod Orthognath Surg* 11:225-233, 1996.

B. Khambay, J C Nebel, F Walker, J Bowman, D Hadley, A Ayoub. A pilot study: 3D photogrammetric image superimposition on to 3D CT scan images- The future of orthognathic surgery. *Int J Adult Orthod Orthognath Surg* 17:331-341, 2002

A Ayoub, A Garrahy, C Hood, J White, M Bock, J P Siebert, R Spencer, A Ray. Validation of a vision based three-dimensional facial imaging system. *Cleft Palate Craniofac J* 40:523-529, 2003

M Hajeer, D Millett, A Ayoub. The application of 3D imaging in orthodontics. Par I *Brit J Orthod* 31:62-70, 2004

M Hajeer, D Millett, A Ayoub. The application of 3D imaging in orthodontics. Part II *Brit J Orthod* 31:154-162, 2004

Mao Z, Siebert J.P, Cockshott W.P., Ayoub A.F. Constructing Dense Correspondences to Analyze 3D Facial Change. The 17th International Conference on Pattern Recognition, UK, vol. 3, 2004:144-148.

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

Multidisciplinary longitudinal assessment of cleft lip
facial impairment £200,000
National Lottery Charities Board
A. Ayoub, P Siebert, A Bowman
Nov.1999-Nov.2002

Analysis of Facial deformities in infants
The Chief Scientist Office
A. Ayoub
Oct 2002-March 2003
£30,000

Assessment of facial changes following alveolar
bone grafts using 3D stereophotogrammetry
Scottish Council for Postgraduate Medical and
Dental Education (SCPMDE)
M Devlin, A Ayoub, A Ray
May2002- May2004
£70,000

Predictors of outcome following brief intervention
in patients with alcohol related facial injuries
Alcohol Education and Research Council
A Ayoub, G Gailchrist, A Crawford, I Smith
Jan. 2003-Jan. 2005
£50,000

Three dimensional assessments of long-term stability following collagen injection in the face
Tissue Science Laboratory
A. Ayoub, P.Siebert, A Bowman
May 2003-2005
£249,688

Outcome assessment of alar base augmentation with bone grafting - a 3D prospective study on the secondary nasal deformity following cleft lip and palate repair.
Scottish Executive Health Department
M. Devlin, A Ayoub
Oct. 2003-2004
£15,000

Building virtual face by superimposing 3D soft
Tissue imaging on 3D CT scan
Wellcome Trust Value in people (VIP) Award
A Ayoub, P Siebert
March 2005
£18.5000

A multidisciplinary assessment of residual
deformities following surgical repair of cleft lip & palate

Chief Scientist Office
A Ayoub, A Bell, A Ray, B Siebert, A Bowman
May 2005
£150,665

Development of a new curriculum for the diagnosis
and management of facial deformities in EGYPT.
A European grant “TEMPUS”
A. Ayoub (the UK)
D. Millett (Republic of Ireland)
M. Lotfy (Egypt)
April 2005
£375,000

Control of alcohol abuse and physical aggression
to reduce facial injuries
Strathclyde Police
A Ayoub, A Crowford, A Bowman, C Goodall, I Smith
Oct. 2006
£100,000

Q14 CURRICULUM VITAE OF COAPPLICANT

(a) Surname: Hayes Forenames: Kevin

Date of birth: 09/05/1969

(b) Title of current post: Lecturer (Statistics)

Date of appointment: 01/09/1995

Expected date of termination: 01/09/2034

(c) With whom do you have your contract of employment?

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

Higher Education Authority

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/ Institution
1995	present	Lecturer (Statistics)	Mathematics and Statistics	University of Limerick

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
Sept 1996	PhD	Statistics	University of Dublin, Trinity College
June 1991	BSc	Applied Sciences (Chemistry and Mathematics)	University of Dublin, Trinity College

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

I have 15 peer reviewed research journal publications in statistics and applied statistics.

I have graduated 3 postgraduate students (2 PhD, 2006, 2008, and 1 MSc 2007), 1 PhD student awaiting examination and 2 more PhD students under my supervision.

In 2007 year I received my first large funding award, €188,000 from Science Foundation Ireland, investigating the statistical methodology behind method comparison studies.

(h) Publications.
Applicants should list **all publications from the previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave must provide a complete list of their scholarly publications.

Dr. Kevin Hayes
Department of Mathematics and Statistics,
University of Limerick, Ireland.
Telephone: +353-(0)61-202388
Email: kevin.hayes@ul.ie

Publications since 2005 plus previous highlights

1. Haslett, J., and **Hayes, K.** (1998) Residuals for the linear model with general covariance structure. *Journal of the Royal Statistical Society, Series B: Statistical Methodology*, Vol. 60, Part 1, pp.201–215.

2. **Hayes, K.**, and Haslett, J. (1999) Simplifying general least squares. *The American Statistician*, Vol. 53, No. 4, pp.376–381.

3. Lyons, E., Leahy, J.J., and **Hayes, K.** (2001) A study of ageing in acrylics adhesives. *International Journal of Adhesion & Adhesives*, Vol. 21, pp.35–40.

4. Moles, R., and **Hayes, K.** (2002) Evaluating biodiversity through functional groups: a comparison of functional groups and biodiversity measures. *Journal of Biology and Environment*, Vol. 102B, No. 2, pp.113–117.

5. Moles, R., **Hayes, K.**, O'Regan, B., and Moles, N. (2003) The impact of environmental factors on the distribution of plant species in a Burren grassland patch: implications for conservation. *Journal of Biology and Environment*, Vol. 103B, No. 3, pp.139–145.

6. **Hayes, K.**, and Kinsella, A. (2003) Spurious and non-spurious power in performance criteria for tests of discordancy. *Journal of the Royal Statistical Society, Series D: The Statistician*, Vol. 52, Part 1, pp.69–82.

7. **Hayes, K.** (2004) A lower bound for the most deviant Z score. *Teaching Statistics*, Vol. 26, No. 3, pp.89–91.

8. Gath, E.G. and **Hayes, K.** (2006) Bounds for the largest Mahalanobis distance. *Linear Algebra and its Applications*, Vol. 419, Issue 1, pp.93–106.

9. Ryan, W., Harrison, A.J., and **Hayes, K.** (2006) Functional data analysis of knee joint kinematics in the vertical jump. *Sports Biomechanics*, Vol. 5, No. 1, pp.121–138.

10. Harrison, A.J., Ryan, W., and **Hayes, K.** (2007) Functional data analysis of joint coordination in the development of vertical jump performance. *Sports Biomechanics*, Vol. 6, No. 2, pp.199–214.

11. **Hayes, K.**, Kinsella, A., and Coffey, N. (2007) A note on the use of outlier criteria in Ontario laboratory quality control schemes. *Clinical Biochemistry*, Vol. 40, Issue 3, pp.147–152.

12. Shiely, F., Kelleher, C.C., and **Hayes, K.** (2007) Contraceptive patterns across the lifecourse in the SLAN populations. *Irish Medical Journal*, Vol. 100, No. 4, pp.435–439.

13. Donoghue, O., Harrison, A.J., Coffey, N., and **Hayes, K.** (2008) Functional data analysis of the kinematics of running gait in subjects with chronic Achilles tendon injury. *Medicine and Science in Sports and Exercise*, Vol. ??, Part ??, pp???–???.

14. Coffey, N., and **Hayes, K.** (2008) Functional principal component analysis in a linear mixed effect modelling framework. *Journal of the Royal Statistical Society, Series B: Statistical Methodology*, Vol. ??, Part ??, pp.???–???.

15. **Hayes, K.**, Barry, D., Coffey, N., and Breen, J.P. (2008) Bayesian wavelet regression of correlated near infared spectra. *Journal of the Royal Statistical Society, Series C: Applied Statistics*, Vol. ??, Part ?, pp.???–???.

16. **Hayes, K.**, and Barry, D. (2007) Optimization methods for statistical inference with lifetime distributions. In *Wiley Encyclopedia of Statistics in Quality and Reliability* (ed. Wilson, S.P.), pp.???–???. John Wiley & Sons. (Scheduled for September 2007. Awaiting page numbers.)

17. **Hayes, K.**, and Hannigan, A. (2006) Trading coupons: completing the World Cup football sticker album. *Significance: Magazine of the Royal Statistical Society*, Vol. 3, Issue 3, pp.142–143.

18. **Hayes, K.**, and Hannigan, A. (2006) Estimating the cost of filling the 2006 GAA players stickers album using Euler's approximation for harmonic sums. *Irish Mathematics Teachers Association Newsletter*, No. 106, pp.35–39.

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

The problem of comparing the precision of two measurement methods is ubiquitous in scientific research. In 1986 the Lancet described a simple graphical procedure for comparing two measurement methods, now often referred to as an Altman-Bland method. This method has become the expected (often obligatory) approach for presenting determinations of method reliability in many scientific journals. This method is statistically flawed and should not be used for outlier detection, establishing limits of agreement, or determining non-conforming analytical observations. This proposal, supported by SFI 2006 Frontiers programme €118k, aims to develop an alternative procedure to replace the misleading Altman-Bland method. This research builds on previous work concerning discordant observations: Hayes et al. (2007) discuss the pitfalls of using informal outlier criteria in (clinical) laboratory settings; Gath and Hayes (2006) extend the univariate bounds of Hayes (2004) to a multivariate setting, specifically in the context of the Mahalanobsis distance which is a linear transformation of Hotelling's T-squared; Hayes and Kinsella (2003) consider suitable performance criteria for outlier test; Haslett and Hayes (1998) and Hayes and Haslett (1999) consider outlying observations in linear mixed models.

Q14 CURRICULUM VITAE OF COAPPLICANT

(a) Surname: Siebert Forenames: J. Paul

Date of birth: 27/12/1956

(b) Title of current post: Senior Research Fellow

Date of appointment: 01/10/1997

Expected date of termination: 01/01/2021

(c) With whom do you have your contract of employment?

University of Glasgow

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

SHECF

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/ Institution
1/1/1983	1/1/1988	Reserach Engineer	Electronics Laboratories	Barr & Stroud
1/1/1988	1/1/1991	Scientist	Edinburgh	BBN Laboratories
1/1/1991	1/1/1994	Senior Consultant	Vision Group	Turing Institute
1/1/1994	1/1/1997	Chief Executive	(Greenagate Ltd.)	Turing Institute
1/1/1997	1/1/2001	Senior Lecturer	Computing Science	University of Glasgow
1/1/2001	1/1/2007	Senior Research Fellow	Computing Science	University of Glasgow

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
1/1/1979	BSc	Electronics & Electrical Engineering	University of Glasgow
1/1/1985	PhD	Electronics Electronics & Electrical Engineering	University of Glasgow

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

Dr Siebert's research, developing stereo-photgrammetry based 3D imaging in combination with non-rigid registration techniques and statistical shape description methods, has produced capture-to-analysis pipelines for 3D surface anatomy assessment in humans and animals, tackling fundamental issues in 3D shape interpretation and analysis. Working closely for over a decade with Glasgow Dental School and the Canniesburn Plastic Surgery Unit, the work has resulted in 3D imaging and surface anatomy systems being deployed in four Glasgow

hospitals. These systems support clinical research in the assessment of maxillo-facial surgery for facial cleft repair, facial trauma and ostiotomy correction and also breast reconstruction for mastectomy patients. His interest in biologically motivated computer vision has produced a functional basic model of the human visual system front-end based on a randomly sampled artificial retina analogue and represents one of the most sophisticated space-variant vision systems ever developed. He has co-authored 80 International journal and conference papers in these areas.

(h) Publications.
Applicants should list **all publications from the previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave must provide a complete list of their scholarly publications.

J.P. Siebert

Selected Publications for 2005-2007

2007

Ham Volume Measurement of Live Pigs Using 3D Stereo Photogrammetry
Ju,X. Siebert,J.P. McFarlane,N.J.B. Tillett,R.D. Journal of Experimental Mechanics, Vol. 22, No. 4, August 2007.

Iconic Object-based Saccade Generation using a Biologically Inspired Self-organized Retina
Balasuriya,L.S. Siebert,J.P. 2007 International Joint Conference on Neural Networks, August 12-17, 2007, Orlando, Florida, USA.

An Implementation of the Scale Invariant Feature Transform in the 2.5D Domain
Lo,T.W.R. Siebert,J.P. Ayoub,A.F. 10th International Conference on Medical Image Computing and Computer Assisted Intervention, Brisbane, Australia, Workshop on Content-based Image Retrieval for Biomedical Image Archives: Achievements, Problems, and Prospects, October 29th, 2007.

Towards building a photo-realistic virtual human face for craniomaxillofacial diagnosis and treatment planning
Ayoub,A.F. Xiao,Y. Khambay,B. Siebert,J.P. Hadley,D. International Journal of Oral and Maxillofacial Surgery, Issue 5, May 2007. pp 423-428.

The Role of Geodesics in Human-Computer Interfaces for 3D Surface Anatomy Assessment
Oehler,S.B. Siebert,J.P. Mao,Z. Khambay,B.S. Ayoub,A.F. 10th International Conference on Medical Image Computing and Computer Assisted Intervention, Brisbane, Australia, Workshop on Interaction in medical image analysis and visualization, 2 November, 2007.

2006

A Resolution-Independent Image Representation for Digital Cinema
Brugnot,S. Ju,X. Cockshott,P. Siebert,P. WSCG'2006 conference proceedings, 2006.

Hierarchical Feature Extraction using a Self-organised Retinal Receptive Field Sampling Tessellation
Balasuriya,L.S. Siebert,J.P. Neural Information Processing - Letters & Reviews, 2006.

An Architecture for Object-based Saccade Generation using a Biologically Inspired Self-organised Retina
Balasuriya,L.S. Siebert,J.P. Proceedings of the International Joint Conference on Neural Networks, Vancouver, 2006.

A functional-based segmentation of human body scans in arbitrary postures

Werghi,N. Xiao,Y. Siebert,J.P. IEEE Transactions on Systems, Man and Cybernetics: Part B, Vol. 36, No. 1 pp 153-165 IEEE., 2006.

Constructing Dense Correspondences for the Analysis of 3D Facial Morphology
Mao,Z. Ju,X. Siebert,J.P. Cockshott,W.P. Ayoub,A.F. Pattern Recognition Letters, Volume 27, Issue 6 (15 April 2006) pp 597-608 Elsevier Science.

Robust Feature Extraction for Range Images Interpretation using Local Topology Statistics
Lo,T.W.R. Siebert,J.P. Ayoub,A.F. Proceedings of MICCAI 2006 Workshop on Craniofacial Image Analysis for Biology, Clinical Genetics, Diagnostics and Treatment pp 75-82, 2006.

2005

Building Superquadric Men from 3D Whole-Body Scan Data
Xiao,Y. Siebert,J.P. 4th IEEE Chapter Conference on Applied Cybernetics, 2005.

Shape measurements of live pigs using 3D image capture
McFarlane,N.J.B. Wu,J. Tillett,R.D. Schofield,C.P. Siebert,J.P. Ju,X. Journal of Animal Science, 2005.

A Biologically Inspired Computational Vision Front-end based on a Self-Organised Pseudo-Randomly Tessellated Artificial Retina
Balasuriya,L.S. Siebert,J.P. International Joint Conference on Neural Networks 2005, Montreal IEEE.

Space-Variant Vision using an Irregularly Tessellated Artificial Retina
Balasuriya,L.S. Siebert,J.P. Workshop on Biologically-Inspired Models and Hardware for Human-like Intelligent Functions, Montreal, 2005.

Key Prior Publications

1. **A Stereo Imaging System for the Metric 3D Recovery of Porcine Surface Anatomy**
   Ju,X. Siebert,J.P. McFarlane,N. Wu,J. Tillett,R. Schofield,P. Sensor Review 24(3) 2004 pp 298-307, 2004

2. **Applying Mesh Conformation on Shape Analysis with Missing Data**
   Ju,X. Mao,Z. Siebert,J.P. McFarlane,N. Wu,J. Tillett,R. 2nd International Symposium on 3D Data Processing, Visualization, and Transmission, 3DPVT 2004 pp 696 - 702 IEEE Computer Society Press, 2004.

3. **A coordinate-free method for the analysis of 3D facial change**
   Mao,Z. Siebert,J.P. Cockshott,W.P. Ayoub,A.F. In Proceedings of SPIE on Medical Imaging, Town and Country Hotel San Diego, California USA, 14-19 Feb. 2004 SPIE, 2004.

4. **Individualising Human Animation Models**
   Ju,X. Siebert,J.P. Eurographics 2001, Manchester, UK, 2001.

5. **Development of 3D measuring techniques for the analysis of facial soft tissue change**
   Mao,Z. Ayoub,A. Siebert,J.P. Proceedings of the Medical Image Computing and Computer-Assisted Intervention 2000 (MICCAI 2000), Pittsburgh, USA, 2000. pp 1051-1061 Springer, 2000.

6. **Human Body 3D imaging by speckle texture projection photogrammetry**
   Siebert,J.P. Marshall,S.J. Sensor Review. Volume 20, No 3 pp 218-226, 2000.

7. **A vision-based three dimensional capture system for maxillofacial assessment and surgical planning**
   Ayoub,A.F. Siebert,J.P. Moos,K.F. Wray,D. British Journal of Oral Maxillofacial Surgery pp 353-357, 1998.

8. **Active Animate Stereo Vision**
   Urquhart,C.W. McDonald,J.P. Siebert,J.P. Fryer,R.J. Proceedings of the 4th British Machine Vision Conference, University of Surrey, Guildford, UK, 21-23 September,1993. pp 75-84

9. **Visualisation and Model Building in Medical Imaging**
   McDonald,J.P. Fryer,R.J. Siebert,J.P. Journal of Medical Informatics 19 (1), 1993.

10. **Foveated Vergence and Stereo**
    Siebert,J.P. Wilson,D.F. Proceedings of the Third International Conference on Visual Search (TICVS), Nottingham, UK, August 1992.

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

TBA: approximately £1M in research income in the last RAE period

Q14 CURRICULUM VITAE OF COAPPLICANT

(a) Surname: Guilfoyle Forenames: Brendan

Date of birth: 07/12/1966

(b) Title of current post: Lecturer

Date of appointment: 01/09/1996

Expected date of termination: 01/09/2032

(c) With whom do you have your contract of employment?

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

IT Tralee

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/ Institution
01/09/1996	present	Lecturer	Mathematics	IT Tralee
01/09/1993	01/09/1996	Assistant Instructer	Marthematics	UT Austin, Texas

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
1997	PhD	Mathematics	UT Austin, Texas
1991	MSc	Mathematics	Trinity College Dublin
1988	BA	Mathematics	Trinity College Dublin

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

After completing his PhD in the University of Texas, Austin, Dr. Guilfoyle returned to Ireland to take up the position of Lecturer in Mathematics at the Institute of Technology Tralee in 1996. Since then he has developed strong links with other third level Institutions in Europe, particularly Durham University, England and Humboldt University, Berlin. Dr. Guilfoyle is a mathematical consultant for the Hamilton Mathematics Institute, TCD, and was recently elected to the committee of the Irish Mathematics Society.

His area of specialization is differential geometry, and, in particular, the application of low-dimensional geometric techniques to real world problems.

(h) Publications.
Applicants should list **all publications from the previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave must provide a complete list of their scholarly publications.

DR. BRENDAN GUILFOYLE

1. PUBLICATIONS

(1) B. Guilfoyle and B. Nolan, *Yang's gravitational theory*, Gen. Rel. and Grav. **30** (1998) 473–495.
(2) B. Guilfoyle, *Interior Weyl-type solutions to the Einstein-Maxwell field equations*, Gen. Rel. and Grav. **31** (1999) 1645–1674.
(3) B. Guilfoyle, *Weyl-type fields with geodesic lines of force*, J. Math. Phys. **40** (2000) 2032–2045.
(4) B. Guilfoyle, *The local moduli of Sasakian 3-manifolds*, Int. J. Math. Sci. **32** (2002) 117–127.
(5) B. Guilfoyle and W. Klingenberg, *On the space of oriented affine lines in* $\mathbb{R}3$, Archiv der Math. **82** (2004) 81–84.
(6) B. Guilfoyle and W. Klingenberg, *Generalised surfaces in* $\mathbb{R}3$, Math. Proc. R. Ir. Acad. **104A(2)** (2004) 199–209.
(7) B. Guilfoyle and W. Klingenberg, *An indefinite Kähler metric on the space of oriented lines*, J. London Math. Soc. **72** (2005) 497–509.
(8) B. Guilfoyle, W. Klingenberg and S. Sen, *The Casimir effect between nonparallel plates by geometric optics*, Reviews in Math. Phys. **17** (2005) 859–880.
(9) B. Guilfoyle, *A structure theorem for stationary perfect fluids*, Class. Quantum Grav. **22** (2005) 1599–1606.
(10) A. Diatta, P. Giblin, B. Guilfoyle and W. Klingenberg, *Level sets of functions and symmetry sets of surface sections*, in Mathematics of Surfaces. Lecture Notes in Computer Science **3604** (2005).
(11) B. Guilfoyle and W. Klingenberg, *Isolated umbilical points on surfaces in* $\mathbb{R}3$, Bull. Greek Math. Soc. **51** (2006) 23–30.
(12) B. Guilfoyle and W. Klingenberg, *Reflection of a wave off a surface*, J. Geom. **84** (2006) 55–72.
(13) B. Guilfoyle and W. Klingenberg, *On Hamilton's characteristic functions for reflection*, Irish Math. Soc. Bulletin **57** (2006) 29–40.
(14) B. Guilfoyle and W. Klingenberg, *Reflection in a translation invariant surface*, Math. Phys. Anal. Geom. **9** (2006) 225–231.
(15) B. Guilfoyle and W. Klingenberg, *Geodesic flow on global holomorphic sections of TS*2, Bull. Belg. Math. Soc. **13** (2006) 1–9.
(16) B. Guilfoyle and W. Klingenberg, *Geodesic flow on the normal congruence of a minimal surface*, Progr. Math. **265** (2007) 427–436.
(17) B. Guilfoyle and W. Klingenberg, *A neutral Kähler surface with applications in geometric optics*, Recent developments in pseudo-Riemannian Geometry, European Mathematical Society Publishing House (to appear).

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

2007 Research Frontiers Programme, Science Foundation Ireland €150,000.
2006/7 Research in Pairs Programme, MFO, Germany €10,000.
2006 IRCSET Postdoctoral Fellowship €80,000.
2005 - Governing Body Scholarship (IT Tralee) €75,000.
2004 - GR17 Conference Support, Science Foundation Ireland €40,000
2003/2004/2005 - International Collaboration Grant, Enterprise Ireland €13,000

Q14 CURRICULUM VITAE OF COAPPLICANT

(a) Surname: Whelan Forenames: Paul

Date of birth: 21/06/1963

(b) Title of current post: Professor of Computer Vision

Date of appointment: 14/04/2005

Expected date of termination: 14/04/2028

(c) With whom do you have your contract of employment?

Dublin City University

(d) Source of personal salary support (If 'Other', please specify):

Please also be specific if salary is funded from more than one source.

University Faculty post since 16 July 1990

(e) Previous posts held: (most recent first)

Date from	Date to	Position	Department	University/ Institution
1990	present	Contract Lecturer / Lecturer / Senior Lecturer / Associate Professor / Full Professor	Electronic Engineering	Dublin City University
1989	1990	Senior Design Engineer	Vision Engineering	Westinghouse Electric Systems & Logistics (WESL) Ltd., Shannon
1985	1989	Development Engineer / Senior Development Engineer / Manager of Advanced Vision Programmes	Vision Engineering	Industrial and Scientific Imaging (ISI) Ltd., Limerick

(f) Education/training:

Date (mm/yyyy)	Degree	Subject	University/Institution
1994	Ph.D.	Computing Mathematics / Computer Vision	University of Wales, Cardiff, UK
1990	M.Eng.	Computer Vision	University of Limerick, Ireland
1985	B.Eng. (first)	Electronic Engineering	NIHE Dublin (now Dublin City University)

(g) Summary of scientific career to date, including key achievements (no more than 700 words).

Prof. Paul F. Whelan
B.Eng. (Hons), M.Eng. (Limerick), Ph.D. (Cardiff), C.Eng., MIEE, SMIEEE, MIPRCS, MIAPR
Professor of Computer Vision
School of Electronic Engineering, Faculty of Engineering & Computing

Prof. Paul F Whelan received his B.Eng. (Hons) degree from the National Institute for Higher Education Dublin, a M.Eng. degree from the University of Limerick, and his Ph.D. (Computer Vision) from the University of Wales, Cardiff, UK (Cardiff University). During the period 1985-1990 he was employed by Industrial and Scientific Imaging Ltd and later Westinghouse (WESL), where he was involved in the research and development of high speed computer vision systems. He was appointed to the School of Electronic Engineering, Dublin City University (DCU) in 1990 and is currently Professor of Computer Vision (Personal Chair). Prof. Whelan setup the Vision Systems Laboratory and its associated Vision Systems Group in 1990 and the Centre for Image Processing & Analysis is in 2006 and currently serves as its director. He also serves on the steering committee of the PRTLI national centre for excellence in information and communications technology: RINCE - Research Institute for Networks and Communications Engineering and is a PI in the National Biophotonics & Imaging Platform [NBIP] (HEA-PRTLI IV). Prof. Whelan was also responsible for the establishment and on-going management (1995-2000) of the World Wide Web based Remote Access to Continuing Engineering Education (RACeE) initiative for the School. Prof. Whelan is also responsible for the VSG's NeatVision Project (NeatVision 2.1, a freely distributed java based image analysis and software environment for computer vision and computer aided diagnostic application development). Prof. Whelan is the research convenor for the School of Electronic Engineering and a member of the Faculty of Engineering and Computing Research board. He is also a member of the DCU Governing Authority (2006-2011) [Professor/Associate Professor Constituency].

As well as publishing over 150 peer reviewed papers, Prof. Whelan has co-authored 2 monographs namely "Intelligent Vision Systems for Industry" (1997-Springer) and "Machine Vision Algorithms in Java: Techniques and Implementation" (2000-Springer, reprinted in 2001). He has also co-edited 3 books including "Selected Papers on Industrial Machine Vision Systems" (1994-SPIE). His research interests include image segmentation, and its associated quantitative analysis (specifically mathematical morphology, colour-texture analysis) with applications in computer/machine vision and medical imaging (specifically computer aided detection and diagnosis focusing on translational research).
He is a Senior Member of the IEEE, a Chartered Engineer and a member of the IET and IAPR. He is also a member of a range of computer vision related conference program committees and acts as a reviewer for a number of the main computer/machine vision journals. He served on the IEE Irish centre committee (1999-2002) and is the national representative and member of the governing board of the International Association for Pattern Recognition (IAPR), a member of the International Federation of Classification Societies (IFCS) council and the current President of the Irish Pattern Recognition and Classification Society. Prof. Whelan has been funded by the HEA-PRTLI, Enterprise Ireland (EI) and Science Foundation Ireland (SFI) as a principal investigator.

Prof. Whelan has earned over €5.6 million (as PI) in competitive grant income. Prof. Whelan's machine/computer vision programmes have been funded by Motorola, Hewlett-Packard, Amdahl, Technology Systems International Ltd., Enterprise Ireland (Forbairt), European Commission: Framework IV, EOLAS/British Council, DCU Research Committee, Private Donors, DCU Educational Trust, Martin Ryan Marine Science Institute (NUIG), HEA/PRTLI1 (RINCE) and SFI. Prof. Whelan's biomedical computer-aided image analysis/diagnostic programmes have been funded by ICS, HRB, HEA/PRTLI1 (RINCE), EU and SFI. He was also one of the founding PIs involved in the development of the Schools successful Higher Education Authority's PRTLI-1 proposal. This resulted in the founding in 1999 of the Research Institute for Networks and Communications Engineering (RINCE) - a national centre for excellence in Information and Communications Technology (ICT). Total value of RINCE

PRTLI funding to DCU: €10.4 million. Prof. Whelan is also a PI and coordinator of the Imaging Technology core in the newly formed National Biophotonics & Imaging Platform [NBIP] (a €30 million HEA-PRTLI IV initiative). Total value of NBIP PRTLI funding to DCU: €7 million.

See for http://www.eeng.dcu.ie/~whelanp/home.html details

(h) Publications.
Applicants should list **all publications from the previous three years** and up to **ten** key prior publications. Please list only your original research publications and other scholarly contributions that you consider to be significant. Publications should be in chronological order with the most recent first.

Please give citation in full, including title of paper and all authors.

Applicants requesting a period of Research Leave must provide a complete list of their scholarly publications.

Prof Paul F Whelan
Professor of Computer Vision
Dublin City University
Ireland

All Publications 2005-2007

1. Tarik A. Chowdhury, Paul F. Whelan and Ovidiu Ghita (2007), "A Fully Automatic CAD-CTC System Based on Curvature Analysis for Standard and Low Dose CT Data", IEEE Transactions on Biomedical Engineering (accepted - in press)
2. Michael Lynch, Ovidiu Ghita and Paul F. Whelan (2007), "Segmentation of the Left Ventricle in 3D+t MRI Data Using an Optimised Non-Rigid Temporal Model", IEEE Transactions on Medical Imaging (accepted - in press)
3. John Mallon and Paul F. Whelan (2007), "Calibration and removal of lateral chromatic aberration in images" Pattern Recognition Letters 28(1):125-135, Jan 2007
4. Tarik A. Chowdhury, Paul F. Whelan, Ovidiu Ghita, Nicolas Sezille and Shane Foley (2007), "Development of a synthetic phantom for the selection of optimal scanning parameters in CAD-CT colonography", Medical Engineering & Physics 29(8):858-867, Oct 2007
5. John Mallon and Paul F. Whelan (2007), "Which Pattern? Biasing Aspects of Planar Calibration Patterns and Detection Methods", Pattern Recognition Letters, 28(8):921-930, June 2007.
6. Michael Lynch, D. Ilea, K. Robinson, O. Ghita and Paul F. Whelan (2007), "Automatic seed initialisation for the expectation-maximisation algorithm and its application in 3D medical imaging", Journal of Medical Engineering & Technology, 31:5, 332 - 340
7. O. Ghita, P.F. Whelan, D. Vernon and J. Mallon (2007) "Pose estimation for objects with planar surfaces using eigenimage and range data analysis", Machine Vision and Applications, 18(6):355-365, December 2007
8. Ovidiu Ghita and Paul F Whelan (2007), "Ultra-Compact Aperture Controlled Depth From Defocus Range Sensor", U.S. Patent 60/953,339
9. John Mallon and Paul F Whelan (2007), "A Method For High Precision Lens Distortion Calibration And Removal", U.S. Patent 60/946,268
10. Ovidiu Ghita, Michael Lynch, Paul F. Whelan (2007), "Analysis of Cardiac Function in Multi-Dimensional MRI Data", "Hands-on Image Processing" Seminar, ROBOTIKER-Tecnalia, Zamudio-Bizkaia (Spain), 27th-28th November 2007. [Invited Talk]
11. Aubrey K. Dunne, John Mallon, Paul F. Whelan (2007), "Efficient Generic Calibration Method for General Cameras with Single Centre of Projection", Eleventh IEEE International Conference on Computer Vision, ICCV 2007, Rio de Janeiro, Brazil, October 14-20, 2007
12. Kevin Robinson, Paul F. Whelan, Padraic Mac Mathuna and Helen Fenlon (2007), "Integrated approach to CTC review and report with assistive CAD", The 8th International Symposium on Virtual Colonoscopy, October 15 - 17, 2007 Westin Copley Place, Boston, MA [Poster Presentation]
13. Dahai Yu, Ovidiu Ghita, Alistair Sutherland, Paul Whelan (2007), "A New Manifold Representation for Visual Speech Recognition", Proceedings of the International Machine Vision & Image Processing Conference 2007 (IMVIP 2007), 5th-7th September, National University of Ireland, Maynooth (NUIM), IEEE Computer Society Press. [Best Poster Award]
14. Dana Elena Ilea and Paul F. Whelan (2007), "Adaptive Pre-Filtering Techniques for Colour Image Analysis", Proceedings of the International Machine Vision &

Image Processing Conference 2007 (IMVIP 2007), 5th-7th September, National University of Ireland, Maynooth (NUIM), IEEE Computer Society Press.

15. Dahai Yu, Ovidiu Ghita, Alistair Sutherland, Paul Whelan (2007), "A New Manifold Representation for Visual Speech Recognition", 12th International Conference on Computer Analysis of Images and Patterns (CAIP 2007), Vienna, Austria. August 27th - 29th, 2007.
16. Dahai Yu, Ovidiu Ghita, Alistair Sutherland, Paul Whelan (2007), "A PCA based Manifold Representation for Visual Speech Recognition", China-Ireland International Conference on Information and Communications Technologies (CIICT2007), August 28th - 29th, 2007 [Microsoft Best Paper Award]
17. Aubrey K. Dunne, John Mallon, Paul F. Whelan (2007), "A comparison of new generic camera calibration with the standard parametric approach", MVA2007 IAPR Conference on Machine Vision Applications, 3-22:114-117, May 16-18, 2007, Tokyo, JAPAN
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19. O. Ghita, P.F. Whelan and T. Carew (2006), "A vision-based system for inspecting painted slates", Sensor Review, 26(2): 108-115.
20. Julie O'Brien, Darren Brennan, Paul F. Whelan, Kevin Robinson, Ovidu Ghita, Stephen Eustace (2006), "The use of whole body mri for body fat assessment and comparison with serum leptin concentrations", Skeletal Radiology, 35(6), 461, 2006 [Abstract]
21. Michael Lynch, Ovidiu Ghita, Paul F. Whelan (2006), "Left-Ventricle myocardium segmentation using a Coupled Level-Set with A-Priori knowledge", Computerized Medical Imaging and Graphics, 30:255-262, 2006
22. Lynch M, Ghita O, Whelan PF "Automatic segmentation of the left ventricle cavity and myocardium in MRI data" Computers in Biology and Medicine 36 (4): 389-407 APR 2006
23. Julie O'Brien, Darren Brennan, Paul Whelan, Kevin Robinson, Ovidu Ghita, Stephen Eustace (2006), "The use of Whole Body MRI for Body Fat Assessment and Comparison With Serum Leptin Concentration", European Society of Skeletal Radiology (ESSR 2006), Bruges, Belgium, 9-10 June 2006.
24. Paul F Whelan (2006), "Application of Image Processing & Analysis to the Computer Aided Detection of Polyps", China-Ireland International Conference on Information and Communications Technologies (CIICT06), October 18th-19th, 2006, Hangzhou, China [Invited Plenary Talk]
25. V. Luaute, R.J.T. Sadleir, H.M. Fenlon and P.F. Whelan (2006) "A reader training system for CTC" Irish Machine Vision & Image Processing Conference 2006 (IMVIP 2006), Dublin, Ireland, August 30th - September 1st.
26. V. Luaute, R.J.T. Sadleir and P.F. Whelan (2006) "A remote access web based tutor system for reader training at CT colonography" RSNA 2006 - 92nd Scientific Assembly and Annual Meeting of the Radiological Society of North America, McCormick Place, Chicago, USA, November 26th - December 1st (inforad exhibit) to be published in: Radiology 241 (Suppl)
27. V. Luaute, R.J.T. Sadleir and P.F. Whelan (2006) "A Remote Access Training System for the Detection of Colorectal Polyps at Computed Tomography Colonography" ECR 2006 - European Congress of Radiology, Vienna, Austria, March 3rd - 7th.
28. R.J.T. Sadleir and P.F. Whelan (2006) "A Novel Technique for Reducing False Positive Detections in CAD-CTC" China-Ireland International Conference on Information and Communications Technologies (CIICT06): 352-355, October 18th-19th, 2006, Hangzhou, China.

29. Dana Elena Ilea and Paul F. Whelan (2006), "Color Image Segmentation using a Self-initializing EM Algorithm", International Conference on Visualization, Imaging and Image Processing (VIIP 2006), 28-30 August, Spain.
30. Dana Elena Ilea and Paul F. Whelan (2006), "Automatic Segmentation of Skin Cancer Images using Adaptive Color Clustering", China-Ireland International Conference on Information and Communications Technologies (CIICT06): 348-351, October 18th-19th, 2006, Hangzhou, China.
31. Dahai Yu, Ovidiu Ghita, Alistair Sutherland, Paul F Whelan (2006), "Dictionary Based Lip Reading Classification", China-Ireland International Conference on Information and Communications Technologies (CIICT06): 226-229, October 18th-19th, 2006, Hangzhou, China.
32. Tarik A. Chowdhury, Ovidiu Ghita, Paul F. Whelan and Abhilash Miranda, "A Note on Feature Selection for Polyp Detection in CT Colonography", The 18th International Conference on Pattern Recognition (ICPR 06): 1017-1021, Hong Kong, 20-24 August, 2006.
33. Dana Elena Ilea and Paul F. Whelan (2006), "Color Image Segmentation Using a Spatial K-Means Clustering Algorithm", Proceedings of the Irish Machine Vision & Image Processing Conference 2006 (IMVIP 2006): 146-153, 30th August - 1st September 2006, Dublin City University.
34. J. Le Colloec, R.J.T. Sadleir and Paul F. Whelan (2006), "Remote Access CT Colonography using a Java Enabled Mobile Device", Proceedings of the Irish Machine Vision & Image Processing Conference 2006 (IMVIP 2006), 30th August - 1st September 2006, Dublin City University (Poster)
35. Tarik A. Chowdhury, Ovidiu Ghita and Paul F. Whelan (2006), "Evaluation of 3D gradient filters for estimation of the surface orientation in CTC", Proceedings of the Irish Machine Vision & Image Processing Conference 2006 (IMVIP 2006): 34-41, 30th August - 1st September 2006, Dublin City University [Best Student Paper Award]
36. Paul F. Whelan (2006), "Computer Aided Detection of Polyps: A Medical Application of Image Processing & Analysis", IET Irish Signals and Systems Conference, Dublin, June 28-30, 2006 [Invited Plenary Talk]
37. Abhilash Miranda, Tarik Chowdhury, Ovidiu Ghita, Paul Whelan (2006), "Shape Filtering for False Positive Reduction at Computed Tomography Colonography", MICCAI 2006 - 9th International Conference on Medical Image Computing and Computer Assisted Intervention, LECTURE NOTES IN COMPUTER SCIENCE 4191: 84-92 2006, Copenhagen, Denmark.
38. Paul F Whelan, Helen M. Fenlon and Padraic Mac Mathuna, "A Virtual ID of possible bowel cancers - A fully automatic (Computer aided detection at CT colonography) CAD-CTC system based on curvature analysis for standard and low dose CT data", HRB Conference - Todays Health Research is Tomorrows Health Care, June 2006 [Invited Poster]
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41. D. Molloy, O. Ghita and R. Sadleir (Eds.) (2006) IMVIP 2006 - Proceedings of the Irish Machine Vision and Image Processing Conferences 2006, Dublin City University, 216 pages, ISBN-10: 0-9553885-0-3, ISBN-13: 978-0-9553885-0-7 2005

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43. Robert J. T. Sadleir, Paul F. Whelan (2005), "Fast Colon Centreline Calculation using Optimised 3D Topological Thinning", Computerized Medical Imaging and Graphics; 29(4):251-258 (June)
44. D Brennan, P.F. Whelan, K Robinson, O Ghita, R Sadleir J O Brien and S Eustace (2005), "Rapid Automated Measurement of Body Fat Tissue Distribution from Whole Body MRI", American Journal of Roentgenology; 185(2):418-423 (Aug).
45. J. Mallon and P.F. Whelan (2005), "Projective rectification from the fundamental matrix", Image and Vision Computing, Volume 23, Issue 7 , 1 July 2005, Pages 643-650
46. O Ghita, K Robinson, M Lynch and P.F. Whelan (2005), "MRI diffusion-based filtering: A note on performance characterisation", Computerized Medical Imaging and Graphics; 29(4):267-277
47. Ovidiu Ghita, Paul F. Whelan and John Mallon (2005), "Computational approach for depth from focus", Journal of Electronic Imaging 14(2), April 2005, 023021 (1-8)
48. Eamonn Boyle, D. Molloy, "Adaptive Active Human Model Reconstruction", Journal of Advanced Technology on Imaging and Graphics, Volume 1, Number 1, September 2005, pp. 16-18, ISSN 1885-6411.
49. Michael Lynch, Ovidiu Ghita and Paul F. Whelan (2005), "Automatic Seed Picking Algorithm for Region-Based Segmentation of Cardiac MRI Images", European Society for Cardiac Radiology - ESCR 2005, Zurich
50. Paul F. Whelan (2005), "NeatVision - Visual Programming for Computer Aided Diagnostic Applications", Medical Visionday, IMM - Danmarks Tekniske Universitet (DTU), Denmark, June 2005 [Invited Plenary Talk]
51. Paul F. Whelan (2005), "Quality Grading of Painted Slates Using Texture Analysis", Industrial Visionday, IMM - Danmarks Tekniske Universitet (DTU), Denmark, June 2005 [Invited Plenary Talk]
52. T.A. Chowdhury, P.F. Whelan, H. Fenlon, P. MacMathuna, Evaluation of radiation dose on automatic polyp detection at CT colonography: Experiments with a synthetic phantom, Association of Physical Scientists in Medicine, 2005 Annual Scientific Meeting, Galway, Ireland, 2005. (poster presentation)
53. John Mallon, "Modelling and Removal of Distortions in Images", Ph.D. thesis, Dublin City University, 2005:1-194.
54. Michael Lynch, Tarik Chowdhury, Ovidiu Ghita and Paul F. Whelan (2005), Determining Candidate Polyp Morphology from CT Colonography using a Level-Set Method, 3rd European Medical and Biological Engineering Conference EMBEC 2005, November 2005, Prague, Czech Republic.
55. Abhilash A. Miranda and Paul F. Whelan (2005), "Fukunaga-Koontz Transform for Small Sample Size Problems", Irish Signals and Systems Conference (ISSC 2005), 1-2 September 2005
56. Tarik A. Chowdhury, Paul F. Whelan and Ovidiu Ghita (2005), "A Method for Automatic Segmentation of Collapsed Colons at CT Colonography", Indian International Conference on Artificial Intelligence (December) IICAI-05:3517-3532
57. Ovidiu Ghita, Rene Gapert, Laura Monks, Jason Last and Paul F. Whelan (2005), "A machine vision system for forensic analysis", Proceedings of the Irish Machine Vision & Image Processing Conference 2005 (IMVIP 2005), 30th - 31st Aug 2005, Queen's University Belfast (QUB) Northern Ireland
58. Tarik A. Chowdhury, Ovidiu Ghita and Paul F. Whelan (2005), "A statistical approach for robust polyp detection in CT colonography", 27th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 1-4 September 2005, Shanghai, China.

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60. P. Moore, E. Boyle, D. Molloy (2005), "Automatic Construction of 3D Human Models from Only Two Orthographic Projections", In Proc. Eurographics Workshop (Ireland), Institute of Technology Blanchardstown (ITB), Dublin, pp. 33-40, 3rd June 2005.
61. E. Boyle, D. Molloy (2005), "Definition of B-Spline Templates for the Automatic Extraction of Human Shape Information", IADAT-micv2005, Madrid, Spain, March 30 - April 1 2005.
62. K Robinson, P.F. Whelan (2005), "Analysis of the Pancreato-biliary System from MRCP", IEEE CMBS 2005 - The 18th IEEE International Symposium on Computer-Based Medical Systems: 253-258 (June) [SFI Best Student Paper Award]
63. K Robinson, O Ghita, P.F. Whelan (2005) "Intensity non-uniformity correction in multi-section whole body MRI", OPTO-Ireland 2005: Imaging and Vision, Proceedings of SPIE; 5823:164-174 (April 2005)
64. E. Boyle,B. Uscilowski, D. Molloy and N. Murphy (2005), "Using Facial Feature Extraction to Enhance the Creation of 3D Human Models", WIAMIS 2005 - 6th International Workshop on Image Analysis for Multimedia Interactive Services, Montreux, Switzerland, 13-15 April 2005.
65. D. Ilea, O. Ghita, K. Robinson, M. Lynch, P.F. Whelan (2005) "A 3D CAD tool for body fat identification", Proceedings of 17th European Congress of Radiology, ECR 2005, March 4-8 2005, Vienna, Austria.
66. P.F. Whelan (2005), "Computer Assisted Diagnosis (CAD) For The Rapid Automated Measurement of Body Fat Tissue From Whole Body MRI" in Imaging Beyond the Pin-hole Camera. 12th Seminar on Theoretical Foundations of Computer Vision (04251), Eds. Konstantinos Daniilidis and Reinhard Klette and Ales Leonardis, Internationales Begegnungs- und Forschungszentrum (IBFI), Schloss Dagstuhl, Germany [Abstract]

Ten key prior publications (upto 2005)

1. Paul F. Whelan, Robert J. T. Sadleir, and Ovidiu Ghita, (2004) "Informatics in Radiology (infoRAD): NeatVision: Visual Programming for Computer-aided Diagnostic Applications" Radiographics; 24(6):1779-1789
2. K. Robinson and P.F. Whelan (2004), "Efficient Morphological Reconstruction: A Downhill Filter", Pattern Recognition Letters, 25(15), November 2004, pp: 1759-1767
3. Robert J. T. Sadleir, Paul F. Whelan, Padraic MacMathuna, and Helen M. Fenlon (2004) "Informatics in Radiology (infoRAD): Portable Toolkit for Providing Straightforward Access to Medical Image Data" Radiographics. 2004 Jul-Aug:24(4):1193-1202
4. O. Ghita and P.F. Whelan (2002), “A computationally efficient method for edge thinning and linking using endpoints”, Journal of Electronic Imaging, 11(4), Oct. 2002, pp 479-485.
5. A. Drimbarean and P.F. Whelan (2001), “Experiments in colour texture analysis”, Pattern Recognition Letters, 22(10), pp 1161-1167
6. P.F. Whelan, P. Soille and A. Drimbarean (2001), “Real-time registration of paper watermarks”, Real-Time Imaging, 7(4), pp 367-380
7. P.F. Whelan and D. Molloy (2000), Machine Vision Algorithms in Java: Techniques and Implementation, Springer (London), 298 Pages. ISBN 1-85233-218-2. (Reprinted Aug. 2001)
8. D. Molloy and P.F. Whelan (2000), “Active-Meshes”, Pattern Recognition Letters, 21(12), pp 1071-1080.

9. B.G. Batchelor and P.F. Whelan (1997), Intelligent Vision Systems for Industry, Springer-Verlag (London), 457 pages, ISBN 3-540-19969-1.
10. P.F. Whelan and B.G. Batchelor (1996), "Automated packing systems - A systems engineering approach", IEEE Trans. on Systems, Man and Cybernetics - Part A [Systems and Humans]; 26(5):533-544.

(i) Research grants from other funding agencies.
Please list all held in the last five years and any key prior grants (list the most recent first).
Please state the name of the awarding body, title of project, amounts awarded and start and end dates of support. For all current grants, indicate the number of hours per week that are spent on each project.

2007-2011
€ 1.8 Million Higher Education Authority (HEA) - Programme for Research in Third Level Institutions (PRTLI) IV
Image Processing & Analysis facility for the new National Biophotonics & Imaging Platform [NBIP].
10 Hours per week

2006-2007
€ 126,000 Enterprise Ireland - Commercialisation Plus Award
Computer Aided Detection and Diagnosis for CT Colonography
5 Hours per week

2006-2007
€ 92,000 Enterprise Ireland - Proof of Concept
Correction of Lateral Chromatic Aberration through Calibrated Demosaicing of Digital Images
1 Hour per week

2005-2008
€ 140,000 SFI - Research Frontiers Programme
Adaptive colour-texture discriminators for robust image segmentation
2 Hour per week

2005-2008
€ 145,000 SFI - Research Frontiers Programme in conjunction with NUI Maynooth
Development of a computational model for the description of the shape, texture and dynamics of facial expression.
1 Hour per week

2005-2010
€ 180,000 Supervisor of 3 successful IRCSET Scholarship students - Embark Initiative, 3 years starting: Oct 2005, Oct 2006 & Oct 2007.
3 Hour per week

2002-2006
€ 560,000 SFI - Principal Investigator Programme Grant
Automated computer analysis of Computed Tomography (CT) Colonography image data sets for the detection of colorectal cancer using standard and low-dose radiation CT acquisition.
Successfully completed.

Q15 PREVIOUS APPLICATIONS TO THE WELLCOME TRUST

(a) Is this the Principal Applicant's first application to the Wellcome Trust? Yes

(b) Give details of all previous applications to the Wellcome Trust over the last five years. This information should be provided for the Principal Applicant and all Coapplicant(s). Please include name of grant holder, grant number (if known), title of project, and if application was successful, the amount and period of award.

Principal Applicant

Coapplicant
John Waddington
1989 - 1992 Wellcome Trust; Project Grant [PI]

Coapplicant
Ashraf Farouk Ayoub

Coapplicant
Kevin Hayes

Coapplicant
J. Paul Siebert
none within previous 5 years

Coapplicant
Brendan Guilfoyle

Coapplicant
Paul Whelan

Q17 **INFLATION** The costs requested will be increased for inflation by the Wellcome Trust. However, the Trust would like to monitor the current inflation rate(s) that the institution would normally use when costing applications.

Salary inflation rate (% per annum):	4
Non-salary inflation rate (% per annum):	0

Q18 **SUMMARY OF FINANCIAL SUPPORT REQUESTED**

Please specify currency used:	UK£ Sterling
Duration of grant (state in months):	36

		TOTAL COST
(a)	Salaries	257106
(b)	Materials and consumables	0
(c)	Animals	0
(d)	Equipment	5000
(e)	Miscellaneous	36000
	GRAND TOTAL	**298106**

Q19 DETAILS OF FINANCIAL SUPPORT AND RESOURCES REQUESTED

(a) Salaries (including the applicant's salary)

Post no.	Name (if known)	Staff category	Salary grade/ scale	Start date (dd/mm/yy)	Period on project (months)	% of full time	Basic starting salary	Total cost on grant
Post 1	Unnamed	Research	9/RCSI	01/07/2009	36	100	38106	134496
Post 2	Unnamed	Research	7/34	01/07/2009	36	100	32636	122610

Q19 DETAILS OF FINANCIAL SUPPORT AND RESOURCES REQUESTED (cont.)

(b) Materials and consumables (description)	**Costs**
Subtotal	**0**

(c) Animals	
Total purchase cost Total maintenance cost Total procedures cost Total associated cost	
Subtotal	

(vi)	**Associated costs**	
	Staff training costs	
	Total staff training costs	
	Animal environment, training and enrichment costs	
	Total animal environment, training and enrichment costs	
	Animal licence costs	
	Total animal licence costs	
	Total associated cost	

Q19 DETAILS OF FINANCIAL SUPPORT AND RESOURCES REQUESTED (cont.)

(d) Equipment

Contact details for the Institution's Director of Procurement/Head of Purchasing (or equivalent).

Name:	Mr T. McAra	Tel:	014 1330 4415
Address:	Finance Office University of Glasgow Glasgow G12 8QQ Scotland	E-mail:	t.mcara@admin.gla.ac.uk

(i) Request for equipment

Type of equipment	Equipment specification	Preferred manufacturer/ supplier (if known)	Maintenance contract duration (months)	Cost of maintenance contract	Number of items	Cost per item	**Total cost**	**Contribution from other sources**	**Amount requested**
Desktop computer	Processor, monitor, keyboard, mouse	Macintosh or Dell			2	1000	**2000**		**2000**
Laptop computer		Macintosh or Dell			2	1500	**3000**		**3000**
							0		**0**
						Total:	**5000**		**5000**

Q 19 DETAILS OF FINANCIAL SUPPORT AND RESOURCES REQUESTED (cont.)
(d) Equipment (cont.)

(ii) Request for equipment maintenance.

Maintenance of existing Wellcome Trust-funded equipment

The Wellcome Trust will only consider providing maintenance funds for equipment more than five years old if the applicant can demonstrate it is cost-effective to do so.

Details of equipment/facility	Wellcome Trust grant reference number	Award start date of original award	Award end date of original award	Date of purchase	Start/end dates of any current maintenance contract & length	Total cost of maintenance contract	% of time of use for this project	**Total cost for project**
								0
							Total	**0**

(iii) Request for access charges.

Access Charges

Details of equipment/facility	Original source of funding	Wellcome Trust grant reference number, if applicable	Standard access charge per hour/day	Specify "hourly" or "daily"	Hours/days of use for this project	**Total cost for project**
						0
					Total	**0**

Q19 DETAILS OF FINANCIAL SUPPORT AND RESOURCES REQUESTED (cont.)

(e) Miscellaneous (description)	**Costs**
Travel, accommodation and subsistence (project team)	18000
Travel, accommodation and subsistence (RAs)	8000
Relocation assistance for RAs	4000
Administrative support	6000
Subtotal	**36000**

Q20 ACCESS TO RADIATION SOURCES

(a) Synchrotron Radiation Sources

(i) Will the proposed research require access to a synchrotron radiation source (SRS)? No

(ii) Please specify to which source(s) you will be applying

(b) Neutron Sources

(i) Will the proposed research require access to a neutron source? No

(ii) Are you requesting costs from the Wellcome Trust?

(iii) If yes, complete table below (anticipated usage must be specified in whole days) and Q19 (d)(iii) Access Charges, detailing the costs required.

Details of neutron source	Total number of days	Number of days per annum				
		Year 1	Year 2	Year 3	Year 4	Year 5
	0					
	0					
	0					
	0					
	0					
	0					
	0					
Total	**0**					

(iv) Please justify your proposed access to the neutron source, including the number of days requested (no more than 500 words).

Q21 REASONS FOR SUPPORT REQUESTED
In this section, justify:

(a) Staff requested **specifying their roles, responsibilities and location, if appropriate,** with respect to the proposed project.

Two postdoctoral research assistants are requested. This level of assistance is required because of the breadth of the research to be undertaken and the technical expertise required to pursue it.

It is anticipated that one RA will have a background in computing science while the other will have a background in the mathematical sciences, particularly statistics. The timetable outlined in the research details section identifies the specific research themes which each RA will be asked to address. These split naturally into two computing science and two statistical themes, with responsibility for the two medical applications to be shared.

Three years of RA assistance will be delivered in Glasgow and three years of effort in Dublin. However, in order to support the genuine interdisciplinary work which the project aims to pursue, it is expected that each appointed RA will spend significant lengths of time in each city.

(b) Materials and consumables

(c) Animal costs (numbers and species)

(d) Equipment, equipment maintenance and access charges.
For access charges, please show how they have been calculated on a cost-recovery basis. This can include (i) a maintenance or service contract providing a basic level of service, (ii) running costs, (iii) materials and consumables and (iv) staff time. Please also state the percentage of time/number of hours the equipment/facility will be used for the project.

Two laptop and two desktop computers are requested. The work will involve substantial computational effort, requiring top of the range processing power plus advanced graphics capabilities. The laptops are requested in order to facilitate visits of the RAs to the different sites involved in the project.

(e) Miscellaneous costs

Travel, accommodation and subsistence costs for the project team are based on 10 full meetings during the three year duration of the project, each meeting involving up to 9 people, at an approximate cost of 200 pounds per person.

Travel, accommodation and subsistence costs are also requested for the RAs, as it is intended that they will travel regularly and frequently around the sites involved. This will have a very helpful effect on the coherency and integration of the research undertaken.

The relocation assistance is requested because it is expected that each of the RAs will spend part of their contract in Glasgow and part in Dublin.

The administrative support reflects a contribution towards the management of the project, including some local support for the PI (2000 pounds) and some assistance towards the management of data collection on patients in Glasgow (2000 pounds) and Dublin (2000 pounds).

(f) Research Leave

(i) Please state the percentage of time per week you currently spend on:

Teaching	
Administration	
Clinical duties	
Other (please detail)	

(ii) Scientific justification for Research Leave and details of your contribution to the project (no more than 350 words)

(iii) Statement of support by current Head of Department

Q22 FULL ECONOMIC COSTING (UK applicants only)

The Wellcome Trust would like to monitor the full economic cost of research proposals. If your institution is calculating the full economic costs of this proposal, the table below should be completed.

Please note that the Wellcome Trust will not fund the full economic cost of research and the actual costs sought from the Wellcome Trust should be detailed in the 'DETAILS OF FINANCIAL SUPPORT AND RESOURCES REQUESTED' section of the form.

This information is being gathered for monitoring purposes only and will have no bearing on the peer review and decision-making process for your application.

(a) Does the host Institution use TRAC or an alternative methodology validated by the UK Research Councils to calculate full economic costs? Yes

(b) If yes, please complete the following table:

	Full Economic Cost (£)
Directly Incurred Costs	
Staff	268942
Travel and subsistence	26000
Other costs	10000
Equipment	5000
Subtotal	**309942**
Directly Allocated Costs	
Principal Applicant salary costs	36749
Coapplicant salary costs	31119
Estates costs	36555
Other directly allocated costs	0
Subtotal	**104423**
Indirect Costs	**152027**
TOTAL	**566392**

Q23 RESEARCH INVOLVING HUMAN PARTICIPANTS, BIOLOGICAL SAMPLES AND PERSONAL DATA RELATING TO LIVING OR DEAD PERSONS

(a) Does your project involve human participants? Yes
If yes, refer to notes.

(b) Will personal data be used? Yes

(c) Will your project involve use of biological samples? No

(d) Please state:

(i) By whom and when the ethics of the project has been reviewed, and specify any other regulatory approvals that have been obtained

And/or:

(ii) By whom and when the ethics of the project will be reviewed, and specify any other regulatory approvals that will be sought.

(a) Research Ethics Committee of the Health Service Executive North Eastern Area

(b) South Glasgow & Clyde Ethics Committee

(e) In the course of your project:

(i) Do you propose to use facilities within the National Health Service (NHS)? Yes

(ii) Does your research involve patients being cared for by the NHS? Yes

(iii) If the answer is yes to (i) or (ii) above, please indicate which organisation has agreed to be the sponsor for the project under the Research Governance Framework for Health and Social Care, published by the Department of Health in England or the corresponding departments in Northern Ireland, Scotland or Wales.
Please note that the Wellcome Trust cannot act as sponsor.

Greater Glasgow Hospital Health Board

(f) If your project involves a clinical trial:

(i) Please state whether it is covered by The Medicines for Human Use (Clinical Trials) Regulations.

(ii) Please indicate which organisation has agreed to be the sponsor for the project.
Please note that the Wellcome Trust cannot act as sponsor.

Q24 EXPERIMENTS ON ANIMALS

(a) Do your proposals involve the use of animals? No

(b) Do your proposals involve the use of animal tissue? No

(c) Do your proposals include procedures to be carried out on animals in the UK which require a Home Office licence?
If yes, refer to notes.

(d) Does the institution where the animal work is to be carried out hold a certificate of designation under the Animals (Scientific Procedures) Act 1986?

(e) Do your proposals involve the use of animals or animal tissue outside the UK?
If yes, refer to notes.

(f) If your project does involve the use of animals, what would be the severity of the procedures?

(g) Please provide details of any procedures of substantial or moderate severity (no more than 250 words).

(h) Why is animal use necessary: are there any other possible approaches? (no more than 250 words)

(i) Will the following species to be used?

Primate	
Cat	
Dog	
Equidae	
Genetically Altered Animals	
Other animals	

(j) Why is the species to be used the most appropriate? (no more than 250 words)

(l) Primates

(i) Do you expect facilities and practices, and the proposed research will comply with the principles set out in the 'National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs) Guidelines: Primate accommodation, care and use' (http://www.nc3rs.org.uk/downloaddoc.asp?id=418)?

If not, please explain why.

(ii) Will it be necessary to transport the non-human primates (i.e from breeding facility and within the host institution environment)?

If so, indicate approximate journey times and the measures that will be taken to minimise the potential stress during transport.

(iii) Will single housing of the non-human primates be necessary at any time?

If so, please provide details in terms of the justification for single housing, its duration, and what additional resources will be provided to the animals to minimise the impact on animal welfare.

(iv) Describe the experimental procedures involved and how any pain, suffering, distress and/or lasting harm will be minimised. Have the procedures been recently reviewed by the Named Veterinary Surgeon (NVS), Named Animal Care and Welfare Officer (NACWO) and ethical review process (ERP)?

Administration

(v) Will any of the experimental procedures involve food and/or water restriction?

If so, justify why this is necessary and outline what alternatives have been considered.

(vi) Will any of the experimental procedures involve restraint?

What alternatives have been considered? Describe the nature of the restraint, its duration and frequency, and what will be done to avoid distress?

(vii) What prior experience and training in non-human primate use, care and welfare have the staff named in the application had? What provision is made for continuing professional development in these areas?

(viii) Will any of the staff involved require specific training for any of the procedures concerned?

Please provide details of the training needed and where it will be undertaken.

(l) Cats and Dogs

(i) From where will the animals be sourced?

(ii) Will it be necessary to transport the animals?

If so, indicate approximate journey times and the measure that will be taken to minimise the potential stress during transport.

(iii) Are animals to be imported?

Where animals are to be imported, what journey times have been agreed with the Home Office? Describe the conditions for the animals at the breeding establishment and how the potential stress during transport will be minimised.

(vi) Please provide details of the housing for the animals, e.g. enclosure size, environmental enrichment.

(v) Will single housing of the animals be necessary at any time?

If so, please provide details in terms of the justification for single housing, its duration, and what additional resources will be provided to the animals to minimise the impact of the single housing.

(vi) Describe the experimental procedures involved and how any pain, suffering, distress and/or lasting harm will be minimised. Have the procedures been recently reviewed by the Named Veterinary Surgeon (NVS), Named Animal Care and Welfare Officer (NACWO) and ethical review process (ERP)?

(vii) Will any of the experimental procedures involve restraint?

What alternatives have been considered? Describe the nature of the restraint, its duration and frequency, and what will be done to avoid distress?

(viii) What prior experience and training in animal use, care and welfare will be required of the staff named in the application? What provision is made for continuing professional development in these areas?

(xi) Will any of the staff involved require specific training for any of the procedures concerned?

Please provide details of the training needed and where it will be undertaken.

Q25 RISKS OF RESEARCH MISUSE

(a) It is the responsibility of institutions in receipt of Wellcome Trust funding to ensure that any risks that research could be misused for harmful purposes are managed in an appropriate manner.

Please confirm that you have considered whether your proposed research could generate outcomes that could be misused for harmful purposes. Yes

(b) If you have identified any tangible risks of this type, please briefly describe these risks and the steps that you and your institution will take to manage them (no more than 250 words).

Q26 LOCATION OF RESEARCH

(a) Will the research project be undertaken in a Wellcome Trust Clinical Research Facility? No

If yes, please specify:

(b) Will the research project be undertaken in the Wellcome Trust Sanger Institute or a Wellcome Trust Centre? No

If yes, please specify:

Please provide a letter of support from the Director of the Centre/Clinical Research Facility specified.

Q27 CONSULTANCIES, EQUITIES AND DIRECTORSHIPS

Do any of the applicants have consultancies or any equity holdings in, or directorships of, companies or other organisations that might have an interest in the results of the proposed research? No
If yes, give brief details (no more than 200 words).

Q28 COMMERCIAL EXPLOITATION

(a) Will the proposed research use technology, materials or other invention that, as far as you are aware, are subject to any patents or other form of intellectual property protection?

No

If yes, give brief details (no more than 200 words).

(b) Is the proposed research, in whole or in part, subject to any agreements with commercial, academic or other organisations?

No

If yes, give brief details (no more than 200 words).

(c) Is the proposed research likely to lead to any patentable or commercially exploitable results?

No

If yes, give brief details (no more than 200 words).

(d) If any potentially commercially exploitable results may be based upon tissues or samples derived from human participants, please confirm that there has been appropriate informed consent for such use.

ADDITIONAL INFORMATION

Additional information you wish to communicate to the Trust. For example, please state if you are sending additional material, such as collaborators' forms, under separate cover. Suggested referees should be listed in a covering letter, which can be accessed via your homepage.

APPLICANTS SEEKING SALARY SUPPORT FROM THE WELLCOME TRUST