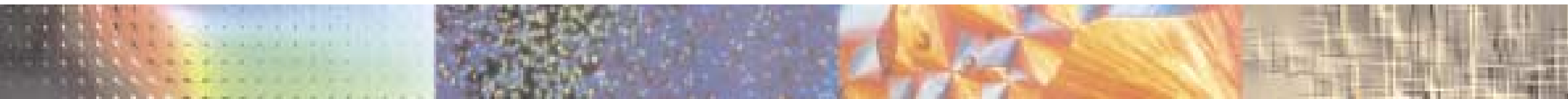
DEPARTMENT OF
MATERIALS

Materials Science
Part II Course Handbook 2023-24



Department of Materials

MS Part II Course Handbook 2023/2024

Version	Action	Date
Version 1.0	Published MT23 (electronic only)	09/09/2023

Part II Projects 2023/24

Student	College	Project	Supervisor
Danyaal ABDUL	STA	Optimising the manufacturing process of Oxide based Ceramic Matrix Composites for heat shields in gas turbine and rocket engines	MLG / TJM / T Pirzada
Rohit ABRAHAM	CCC	Artificial Intelligence for multi-modal X-ray Imaging of metal solidification	EL / A Zisserman (EngSci)
Chidiebube ANYANECHI	QNS	Tunable Field Effect Devices Using Dielectric Nanolayers	RSB / A Soeriyadi
George BALL	STC	High-resolution characterization of metal powders for Additive Manufacturing of space materials	SLP
Tushar BHUDIA	CCC	Analysis of in situ high resolution synchrotron tomography of graphite fracture	TJM
Fabian BOURDEAUX	STA	Size-selected multi-component alloy nanoparticles for electrochemical hydrogen production	RSW / L Jones
Rowan BURFORD	MAN	Mechanical properties of coatings for nuclear fusion	A Kareer / DEJA / AJW
Tehillah CAMPBELL	SEH	Exploring ion-exchange methods to make novel multivalent cathodes	RAH / PGB
Millie CAST	STC	Investigating the coupling of electronic properties with atomistic structure with different exchange-correlation functionals	CEP / JRY
Jacx CHAN	QNS	Studying the structure and excited states of defect complexes in crystals using machine learning	JRY / J Prentice
Oliver CLEMENT	TRI	Miniaturised high-cycle fatigue testing of crack initiation and short crack growth in aero-engine materials	J Gong / AJW
Alistair DARNTON**	CCC	Nano-dispersoid phases as natural helium/tritium sinks in fusion structural materials	Prof. J Li (MIT) / DEJA
Carys DAVIES	TRI	Fabrication of Oxide based ceramic matrix nano-composites for creep applications at 1100°C	MLG / RIT / T Pirzada
Jake DAVIES	SEH	Understanding magnetostriction in Laves phase rare earth compounds	CEP / JRY
Aryan DIXIT	MAN	Revealing edge sites in graphite electrodes for Li-ion batteries	RSW / P Didwal
Jack GINNIS	CCC	Nanoindentation mapping of Th6Mn23 based intermetallics	DEJA / AJW / A Kareer
Ruth GREGG*	MAN	Co-printed biocompatible composites for implantable electronic systems	Dr M Nai (EngSci) / JTC
Imogen HAYDON	CCC	Liquid lithium corrosion of materials for nuclear fusion	DEJA / CRMG
Yihong HU	STC	Modelling a quantum computer based on colour centres in diamond	JMS
Jingxuan HUANG	CCC	Persistent joints in high temperature superconductors	SCS/CRMG
Yixuan HUANG	CCC	Machine Learning in Materials Modelling	JRY / V Deringer (Chem)
Thian ISKANDAR**	QNS	Elucidating the Delamination Mechanics of an Oxygen-Compatible Environmental Barrier Coating	Prof. Z Cordero (MIT) / RCR
Kyung KIM	TRI	Disordered rocksalt cathodes for rechargeable Zn batteries	RAH / PGB
Chun LIU	CCC	Cleaning up dirty lakes, rivers and seas	JTC
Sirui Liu	MAN	New nanoscale materials for next-generation device engineering	HB
Anahita MANCHALA	MAN	Predicting the performance and usefulness of near-term quantum computers	SCB
James McQUEEN	TRI	Semiconductor Device Modelling of Tandem Solar Cells	RSB
William METCALF	SEH	Understanding ion damage in TEM specimen preparation, comparing Ar, Ga and Xe ions	NPY / I Griffiths / G Hughes

Student	College	Project	Supervisor
Harry MYERS	STA	Micromechanical Measurements of Manufactured Moon Metal	AJW / DEJA / M Meisnar (ESA)
Myra NG	STA	Li alloys for solid state batteries	CRMG / DEJA
Toby ONONA	SEH	Modelling the activity of Cu, Zn and CuZn catalysts for methanol generation	RSW / RJN / J Swallow
Alex PLANT	STC	Improving the reliability of solid state battery electrolytes and other ceramics by surface residual stress	RIT / D S Jolly
Laura POYSTI	CCC	Computational Study of Frenkel defects for quantum technologies	JRY / JMS
Finn SQUIRES	TRI	Superconducting thin films for quantum devices	SCS / C Barker
Andrew STURT	QNS	Novel, low-cost approaches to ‘STEM-in-SEM’ electron microscopy	NPY / I Griffiths
Hang SU	SEH	Transport and thermodynamic properties of Zn-ion electrolytes	MP
Veerakit SUKAMONGKOL	TRI	Advanced Metallisation Technology for Next-Generation Photovoltaics	AARW / RSB
Darya SUTTON	TRI	Modelling adsorption and assembly of nucleobases on gold surfaces	CEP / MRC
Wajahat TARIQ	TRI	Persistent joints in high temperature superconductors	SCS / CRMG
Ewan TIMMS	CCC	Effects of hydrogen on mechanical behaviour of steels	AJW / DEJA / P Karamched
Emily TREACHER	SEH	In situ study of the compressive failure of densified wood	TJM
Emily WACKAN	STA	Investigating the atomic-scale irradiation damage in an Inconel 617 superalloy	MPM / PAGB / C Hofer
Kate WELLSTEAD	SEH	APT investigation of ceramic coatings to prevent tritium permeation in nuclear fusion reactors	MPM / PAGB / H Gardner (UKAEA)
Zhen YAP**	TRI	Shape Retention during Directional Recrystallization of Additively Manufactured Ni-base Superalloys	Prof. Z Cordero (MIT) / MPM/ T Tang
Ben ZELIN	TRI	Modelling New Materials for Rechargeable Batteries	JRY / MSI

Induction Course Schedule

Monday 11th September 2023, Hume-Rothery Lecture Theatre

0930 – 1020hrs **Jan Czernuszka**
Welcome and introductions. Purpose and overview of the day.

The Part II Project:

- Registration, extended terms and residency requirements.
- Postgraduate and Part II lectures.
- Ordering materials and equipment.
- The thesis.
- Deadline for thesis submission.
- The viva voce examination and marking the Part II project.
- What are the examiners looking for in a good Part II thesis?
- Plagiarism.
- Analysis of errors.
- Keeping a lab book.

1020 – 1030hrs **Helena Cotterill**
Opportunities for outreach activities

1030 – 1040hrs **Neil Young**
Electron microscopy training courses

1040 – Coffee
\+
– 1140hrs **Les Chorley**
The workshop and signing up for the workshop practice course. The course is compulsory for all those doing their Part II in the Department.

Students are to be split into 3 groups with one group going on a tour at a time, whilst the others have coffee – and then swap over
(Allowing 5mins @beginning, middle and end to walk to and from the Thom Building)

1145 – 1220hrs **Christina Foldbjerg-Holdway**
Safety lecture

1220 – 1315hrs **Paul Warren**
Information technology in the Department

1315 – 1330 **Jan Czernuszka** Project Management: the Part II Talk continued.

Thursday 14th September 2023, Hume-Rothery Lecture Theatre

1330 – 1500hrs	**Gerry Litchfield (formerly QinetiQ) and Jan Czernuszka** Project Management and the Part II.
1500 – 1530hrs	Coffee
1530 – 1650hrs	**Gerry Litchfield (formerly QinetiQ) and Jan Czernuszka** Project Management and the Part II
1650 – 1700hrs	**Jan Czernuszka** Departmental project management forms and concluding remarks.

To be completed by 5pm Friday 15th September 2023

Online Anti-Plagiarism Course
https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism
please forward your certificate to
undergraduate.studies@materials.ox.ac.uk

Monday 25th September 2023, Hume-Rothery Lecture Theatre (tbc)

1000 – 1100hrs	**Rachel Scanlon (OULS)** Information Skills for Part II students including an introduction to Reference Management

Ethics & Sustainability Workshop – MT week 4, Wednesday 2-5pm, tbc HRLT

1400 – 1700hrs	**Steve Newbury (Ultima Forma)** **Stella Job (CompositesUK)** **Louis Brimacombe (Consultant and ex. Tata Steel)**

Composites sustainability; Lifecycle sustainability of metals and ethical considerations

This will be followed by a second workshop in Hilary Term exploring the ethics and sustainability issues associated with your own projects.

LabView Workshop – timing tbc

Engineering Context Workshop – MT week 7, Monday 10am, tbc

Other Transferable Skills Training & Related Topics

You may find it useful to attend some of the following workshops/events. For details see the on-line termly lecture list.

- Part II writing skills, laboratory notebooks, IPR & patents, HT, Prof Assender & others.
- Presentation skills, PowerPoint, modern A/V technology, PPT for posters, practical tips, HT, OUCS & Dr Taylor.
- The Oxford University Careers Service – Active job hunting, MT, Dr Evans.
- Careers & networking evening with alumni, MT.
- DPhil poster competition, HT.
- Preparing an article for submission to a materials journal, TT

In addition, see the on-line MS FHS Handbook, section 8, for details of Foreign Language options that are available to you.
NOTE: REGISTRATION REQUIRED BY WEDNESDAY OF WEEK 1 MT.

Extended Terms and Residency Requirements

Statutory residence of **37 weeks** (Examination Decrees and Regulations)

Extended terms:

Michaelmas Term 2023
Friday, 8th September - Saturday, 9th December

Hilary Term 2024
Friday, 5th January - Saturday, 23rd March

Trinity Term 2024
Friday, 5th April - Saturday, 29th June

Postgraduate and Part II Lectures

You are strongly encouraged to attend any postgraduate lectures that you consider useful or interesting. A copy of this year's General Scheme is available on the Department's website (www.materials.ox.ac.uk/teaching/lecturelists.html).

In particular, if you are planning to do any X-ray diffraction work then you should attend the 'X-ray diffractometry' course given by Prof. S.C. Speller (tbc).

If you wish to use any of the electron microscopes you must first receive training (and attend the relevant lectures), co-ordinated by Dr. N.P. Young.

Ordering Materials, Equipment, etc

- You should agree your request for consumables, materials etc. with your supervisor.
- For items held in the departmental stores you will need an account code. Each student will be allocated £50 total for minor consumables and your supervisor will give you a code that you can use in this respect. For further information on stores, please consult the following web address:

  www.materials.ox.ac.uk/stores-and-workshops.
- If the items are not held in stores you should request that your supervisor or another member of the research group submits a requisition on your behalf. Please pass any delivery notes straight on to the Finance Office.
- You should note that orders for consumables, materials etc. from external suppliers – particularly **new** suppliers – may take some time to arrive and you should factor this into your planning when orders need to be submitted. Where possible goods should be ordered from an existing preferred supplier; if you elect to use a new supplier you may be asked to confirm items cannot be sourced elsewhere.

The Thesis

Extract from the Examination Regulations for the Honour School of Materials Science Part II

'Every candidate for Part II is required to submit a report on the investigations which they have carried out under the direction of their supervisor. The report on the investigations shall also include an abstract, a literature survey, a description of the engineering context of the investigation, and a special chapter to cover reflective accounts of project management, ethical and sustainability considerations, and health, safety and risk assessment. Candidates will be required to submit the coursework in the format and length specified in the Course Handbook and to the University approved online assessment platform not later than 4pm on the Monday of the seventh week of Trinity Full Term. The report must be accompanied by a declaration indicating that it is the candidate's own work, and that the work is within the allowed word and page limits. Candidates seeking permission to exceed the word and/or page limits should apply to the Chair of Examiners at an early stage. Appendices are not included within the limits of the word or page counts of the thesis and, entirely at the discretion of the Examiners for each report, may or may not be read.'

Word limit: 12,000 words for the main body of the thesis, plus 3,000 words for the mandatory final chapter covering reflective accounts of project management (max 1,500 words), health, safety and risk assessment processes (max 500 words), and the ethical and sustainability considerations relevant to your project and its outcomes (max 1,000 words). These word counts exclude references, title page, acknowledgements, table of contents and the three Project Management Forms. All other text is included in the word count, including the abstract, tables and the figure captions.

Page limit: 100 pages for the main report. This page limit excludes references, title page, acknowledgements, table of contents and appendices. Every other part of the main report is included in the page limit. **All** pages of the thesis should be numbered sequentially.

If you feel that you have an exceptional case for exceeding the word and/or page limit, and you wish to seek permission to do so, both you and your supervisor should contact the Part II Project Organiser who will put your case to the Chair of Examiners. Such a case should be made at the earliest possible stage. The Examiners will enforce the word limit strongly, and any thesis submitted over the word limit may be subject to penalties (see Examination Conventions for details).

Appendices: the purpose of the above word and page limits is to prevent the excessive inclusion of material that is unnecessary for development of the key argument(s) of the thesis. Material which is additional to the main body of the thesis, e.g. further detailed data, computer programs and similar material may be included in appendices. However, whilst Examiners are required to consider the main body of the thesis, whether they read appendices is entirely at their discretion.

The thesis **MUST** include:

(i) a one-page abstract.
(ii) a literature survey.
(iii) a brief account of the Engineering Context/Relevance of your project (a requirement of Accreditation).
(iv) a final chapter covering reflective accounts of project management, health, safety and risk assessment processes, and the ethical and sustainability considerations relevant to your project and its outcomes.

Further information on the structure and content of a thesis is provided on pages 18-21 and pages 36-37.

The thesis must be submitted via Inspera, Oxford's e-assessment platform (https://oxford.inspera.com/) by 4.00 pm on **Monday of week 7 of Trinity Term.** You will be required to sign an electronic declaration on Inspera at the point of submission confirming that it is your own work and that it adheres to the previously described word and page limits.

The thesis **MUST** be word-processed suitable for printing on A4 paper. The text should fit within a page area of 247 mm x 160 mm (i.e. top and bottom margins totalling 50 mm, and left and right margins totalling 50 mm) with a left hand margin of at least 30 mm (for ease of reading after printing and binding). The text should be double line-spaced. The typeface should be of at least 11pt size.

Note that the requirements relating to the printed material need to be observed as a hard-copy will be printed subsequent to submission and retained in the library of the Department of Materials.

The **viva voce examination** is normally held in 9th or 10th week of Trinity Term. Please keep these weeks clear in your diary.

Marking the Part II Project

The Part II contributes a maximum of 400 marks towards the total of 1200 marks for the whole degree.

Your thesis will be read independently by two internal examiners or one internal examiner and an assessor, who will each allocate a provisional mark before the viva.

Those two marks are declared to all the examiners present before the vivas begin.

Each thesis will be inspected by one of the two External Examiners.

After the viva the Part II Examiners present at the viva discuss the marks from the two internal examiners/assessors and agree **collectively** a mark out of 400.

The examiners in the Department of Materials for 2023-24 are expected to be as follows:

Examiners for the Part II Examination: Prof. Sergio Lozano-Perez (Chair), Prof. Jan Czernuszka, Prof. Marina Galano, Prof. Mauro Pasta, Prof. Richard Todd and Prof. Andrew Watt. The external examiners are Prof. Paul Midgeley, University of Cambridge and Prof. Geraint Williams, University of Swansea.

It must be stressed that in order to preserve the independence of the Examiners, you are not allowed to make contact directly about matters relating to the content of the exams or the marking of coursework. Any communication must be via the Senior Tutor of your college, who will, if they deem the matter of importance, contact the Proctors. The Proctors in turn communicate with the Chair of Examiners. If you have any queries about the Examinations or anything related to the Examinations, for example, illness, personal issues, please don't hesitate to seek further advice from your College tutor, or one of the Department's academic support staff.

Extract from FHS Examination Conventions for Materials Science 2022-23

3. PART II

The Part II project is assessed by means of a thesis which is submitted online to the Examiners, who will also take into account a written report from the candidate's supervisor. The marking criteria are published in the Part II Course Handbook.

The Supervisor's report is divided into Parts A & B: Part A provides simple factual information that is of significance to the examiners, such as availability of equipment, and is seen by the two markers before they read and assess the thesis. Part A does **not** include personal mitigating circumstances which, subject to guidance from the Proctors, normally are considered only in discussion with **all** Part II examiners thus ensuring equitable treatment of all candidates with mitigating circumstances. Part B of the supervisor's report provides their opinion of the candidate's engagement with the project and covers matters such as initiative and independence; it is not seen by the examiners until the discussion held after the viva.

The project is allocated a maximum of 400 marks, which is one third of the maximum available marks for Parts I and II combined. Two Part II examiners read the thesis (including the final chapter with the reflective accounts of project management, health, safety & risk assessment processes, and ethical and sustainability considerations), together with Part A of the supervisor's report, and each of them independently allocates a provisional mark based on the guidelines***** published in the course handbook. In addition, normally the thesis will be seen by one of the two external examiners.

A *viva voce* examination is held: the purpose of the viva is to clarify any points the readers believe should be explored, and to ascertain the extent to which the work reported is the candidate's. Any examiners who have supervised the candidate's Part II project or are their college tutor will not be present at the viva or the subsequent discussion. Normally four individuals will have specified examining roles: Two examiners, or one examiner and an assessor, who have read the thesis entirely; the external examiner to whom the thesis was assigned; and an examiner acting as the session Chair who will complete any necessary documentation for that viva. Other examiners beyond these four individuals will be present to the extent possible given the existence of parallel sessions. A discussion involving all examiners present is held after the viva, during which Part B of the supervisor's report is taken into account. The outcome of the discussion is an agreed mark for the project. In arriving at the agreed mark the Examiners will take into account all of the following, (i) the comments and provisional marks of the original markers, (ii) the candidate's understanding of their work as demonstrated during the viva and (iii) the opinion of the external examiner who has seen the thesis.

If the two provisional marks allocated in advance of the viva differ significantly (that is, normally by more than 10% of the maximum available for a Part II project) this will be addressed explicitly during the discussion after the viva. In the majority of other cases the viva has only a small influence on the agreed mark awarded to a Part II thesis.

It is stressed that it is the scientific content of the project and the candidate's understanding of their work that is being considered in the viva.

Where a candidate or candidates have made a submission, under Part 12 or Part 13, that unforeseen circumstances may have had an impact on their performance in an examination, a subset of the internal examiners will meet to discuss the individual applications and band the seriousness of each application on a scale of 1-3 with 1 indicating minor impact, 2 indicating moderate impact, and 3 indicating very serious impact.

For Part II, a subset of the internal examiners will meet to band the seriousness of each notice in advance of the Part II vivas and prior to sight of any preliminary marks awarded by the internal examiners. When reaching these decisions on MCE impact level, the subset of examiners will take into consideration, on the basis of the information received, the severity and relevance of the circumstances, and the strength of the evidence. The banding information will be used at Part B of the meeting of Part II internal examiners, which is held after the vivas, at which the marks agreed following the discussion after the viva are reviewed and recommendations to the Finals Board formulated regarding any action(s) to be taken in respect of each MCE.

Further information on the procedure is provided in the *Examination and Assessment Framework, Annex E* and information for students is provided at https://www.ox.ac.uk/students/academic/exams/problems-completing-your-assessment. It is very important that a candidate's MCE submission is adequately evidenced and, where appropriate, verified by their college; the University forbids the Board of Examiners from seeking any additional information or evidence.

* These guidelines may change and candidates are notified of any such changes before the end of Hilary Term of their 4th year.

Supervisor's Report Form – Parts A & B

UNIVERSITY OF OXFORD
DEPARTMENT OF MATERIALS

Trinity 2023

From: Chair of Examiners
To: Supervisors of MS Part II Projects
Return to: **Examinations Administrator**

Please provide your assessment of the project which you have supervised. In the case of co-supervision please submit only one form (agreed by all supervisors) per candidate.

PLEASE ENSURE YOU COMPLETE BOTH PARTS A & B OF THIS FORM

This form must be returned by 10am Monday 5th June (Week 7)

Please complete the form electronically and send it to undergraduate.studies@materials.ox.ac.uk.

Supervisor/s:
Candidate Name: **College:**
Project Title:

MS Part II Supervisor's Form - part A

Factual Information (to be read by examiners in conjunction with the candidate's thesis)

i) To what extent does the project form part of a well-established research programme in your group, and what input has been received from other members of the group?

ii) What have the candidate's own original contributions been, and in which sections of the thesis are they reported?

iii) Have there been major factors outside the candidate's control that have significantly affected the progress of the work?

Signature and date ....
(your signature confirms that all co-supervisors have been consulted prior to completion of this form)

PART B OF THIS FORM FOLLOWS ON THE NEXT PAGE

Supervisor/s:
Candidate Name: **College:**
Project Title:

MS Part II Supervisor's Form - part B

Supervisor's Assessment (which may be made available to examiners when determining the candidate's final classification)

Please give an overall assessment of the student's work on the project including:

- the competence and application of the student;
- the quality of the student's work;
- the balance between the student's own input to the project and the assistance you or other members of the research team gave the student (including project planning and the write-up of the thesis)
-

(If you supervised an externally placed student please ensure you incorporate comments from the external supervisor(s).)

Signature and date ……………………………….
(your signature confirms that all co-supervisors have been consulted prior to completion of this form)

Default Structure and Content for a Part II Thesis

The Part II thesis reports on a substantial research project and as such it is appropriate that it is structured in a similar manner to a traditional-style PhD thesis in Materials Science, but taking account of the eight-month duration of the Part II project, compared to forty-two months for a typical PhD. Your supervisor will guide you on any variations to the structure outlined below that might be appropriate for a thesis in the research area of your particular project.

- Title Page
- Abstract
- Acknowledgements
- Table of Contents
- Optional brief scene-setting chapter
- Literature Review chapter
- Apparatus, Experimental/Computational Methods and Background Theory chapter
- Results & Discussion chapter(s)
- General Discussion and Conclusions chapter (to include a brief commentary on potential applications and future work)
- Special chapter for Part II, to cover reflective accounts of Project Management, Ethical & Sustainability considerations, and Health, Safety & Risk Assessment
- References

It is important that the thesis is considerably more than just a narrative of what you have done. As well as the content outlined below, do indicate when you have provided creative input to the project direction and/or evidence of how you have steered or driven the project. For example, be clear on the reasoning that underlies decisions taken on what experiment(s) to do next, or changes to experimental methodology, in the light of the results of your previous experiments and/or your understanding of the literature.

Your literature review should include both a summary of the relevant literature and a critical reflection on this literature. For example are there flaws or limitations in some of the previous work; do you agree with the authors' conclusions; do all previous reports on related topics fully agree, or are there differences; if the latter do you agree with the authors' explanations of the differences (if the authors do not comment on these differences can you suggest reasons why the differences might exist)?

In your apparatus, methods & theory chapter include brief explanations of why these particular approaches are the most appropriate. Do not go into detail about methods or instruments where you are using routine applications or for which the underlying theory or calculations are standard topics in undergraduate text books.

Following presentation of your results, you should include a critical discussion of these results: what do they mean, how do they compare and contrast with, and extend, the previously published work in this field. Finally draw succinct conclusions from your work and comment briefly on potential applications and future work.

You are strongly advised to complete a final draft of your literature review chapter by the end of week 8 Hilary Term, so that your supervisor is able to provide early feedback on this draft chapter, and to devote a substantial majority of your time from the beginning of the extended Trinity Term to writing the other chapters of your thesis, aiming to submit a draft to your supervisor **at least two weeks** prior to the deadline for submitting the thesis to the examiners.

MS Part II Thesis Assessment Report and Marking Guidelines

Examiners should write a report of not more than two pages giving their assessment of the thesis, taking into account the marking guidelines overleaf, and including explicit comments explaining their assessment under **each** of the headings.

Name of Candidate	
Aims & Objectives What were the aims and objectives of the project? Are these clearly identified in the thesis?	
Project Management Is the account of project management clear? Does it show that the project was well managed? Were the original objectives kept to, and if they were changed, is it shown why?	
Does the reflective account of H&S and risk assessment demonstrate an appropriate understanding?	
Does the reflective account of ethics and sustainability demonstrate an appropriate understanding?	
Engineering Context Has the candidate identified the engineering (or equivalent) context of the work? Did the candidate reflect on the engineering implications of the *project findings* or cover this only in a generic manner?	
Literature Review Is the background literature to the project reviewed adequately? (comprehensively, focused on the project's area and *critically.*)	
Methods (including data analysis methods) Are the methods and analysis of data used in the project clearly described? Did the student develop any new methods?	
Results Are the "raw" results attained clearly described? Are the results analysed adequately and appropriately? If appropriate, are errors handled adequately?	

Discussion Are the results properly discussed: in themselves? in relation to previous work in the area? in relation to the aims and objectives of the project?	
Summary and Additional Comments What do you consider to be the main achievements of the project? Are these clearly identified in the thesis? What are the key strengths of the thesis? Does the thesis show original thinking on the part of the student? Are there any areas of minor, significant or serious weakness. Does the thesis show awareness of these? Comment on the quality of the report. (use of English, clarity of structure, extent to which structure & style follows that normally expected of a research thesis in the field of the research topic, coherent story, overall style, quality of diagrams and figures, use of references to previous work, etc.)	
Overall Mark Give short justification for mark	

Although in general examiners should mark to the guidelines for the class boundaries, examiners should bear in mind that the Faculty has recommended that Part II examiners should “make use of the full range (0-100%) of marks available when marking Part II projects”. This marking guide should be used in conjunction with the report form, which asks examiners to comment on the quality of the thesis under a total of several headings – these are the criteria which the candidates themselves have been told will be assessed.

Examiners should also bear in mind the relative inexperience of the candidates and the limited time available for the project. In particular examiners should not penalize candidates solely because the project turned out to be incapable of yielding interesting results, and thus could not produce anything publishable (so the guidelines below should be interpreted in this light). The main criterion for assessment is how well each candidate has tackled the various aspects of his or her individual project.

90-100%	Thesis rated very highly in all categories of the assessment guidelines. Typically this would be an extremely high quality thesis showing extensive evidence of original thought, results very well analysed and put in context, very well presented, and with no important deficiencies.
80-89%	Thesis demonstrating very strong performance across most areas, with some minor weaknesses in one or two areas. Typically this would be a very high quality thesis showing evidence of original thought, results very well analysed and put in context, very well presented, but with some minor deficiencies.
70-79%	Very strong overall performance, but with significant weakness in one area or minor weaknesses in several. Typically this would be a high quality thesis showing some evidence of original thought, results well analysed and put in context, well presented. May be deficient in one or two areas accounting for a minority of the whole.
60-69%	Strong overall performance, but with significant weaknesses in several areas. Typically the work would have been competently carried out and reasonably well presented and analysed. This mark range should be achievable by an average student with reasonable effort.
50-59%	Satisfactory overall performance, but with serious weaknesses in at least one area. Typically the work would have been carried out mostly with competence, but with some flaws (e.g. errors, misinterpretations). Little evidence of original thought.
40-49%	Poor overall performance with serious weaknesses in several areas. No evidence of original thought.
30-39%	Poor overall performance with serious weaknesses in the majority of areas. The thesis of a candidate who has done little work and has presented this work poorly.
<30%	Very poor performance with little or no meaningful content.

MS Degree Final Mark Guidelines

The final marks for the Materials Science degree in its entirety (Part I exams and coursework, and Part II) conform to the University's standardised expression of agreed final marks, as follows:

70-100	First Class (I)
60-69	Upper Second (IIi)
50-59	Lower Second (IIii)
40-49	Third (III)
30-39	Pass
0-29	Fail

With the qualitative descriptors for each classification level being:

Class I The candidate shows excellent problem-solving skills and excellent knowledge of the material over a wide range of topics, and is able to use that knowledge innovatively and/or in unfamiliar contexts.

Class IIi The candidate shows good or very good problem-solving skills, and good or very good knowledge of much of the material over a wide range of topics.

Class IIii The candidate shows basic problem-solving skills and adequate knowledge of most of the material.

Class III The candidate shows reasonable understanding of at least part of the basic material and some problem solving skills. Although there may be a few good answers, the majority of answers will contain errors in calculations and/or show incomplete understanding of the topics.

Pass The candidate shows some limited grasp of basic material over a restricted range of topics, but with large gaps in understanding. There need not be any good quality answers, but there will be indications of some competence.

Fail The candidate shows inadequate grasp of the basic material. The work is likely to show major misunderstanding and confusion, and/or inaccurate calculations; the answers to most of the questions attempted are likely to be fragmentary only.

What are the Examiners Looking for in a Good Part II Thesis?

G D W Smith

Chairman of Part II Examiners 1999-2000

Let's start with the obvious. What the examiners most want to see is high quality scientific work, professionally carried out and well presented. There is **not** a requirement in the regulations that you should discover something entirely new and revolutionary. You only have nine months to carry out your project, and one of the essences of scientific research is its unpredictability. You may run into unexpected difficulties, or the project may not work out at all in the way you anticipated. It may even happen that other people are working on the same scientific problem, entirely unknown to you, who publish their results shortly before you complete your own work. You have no control over such events. For this reason, the examination regulations require only that you submit a report on **your** investigations. Tell us what **you** did. If it worked, that's great. If it didn't, tell the examiners why, and if appropriate, suggest how the project might be improved or redesigned to get better results. If you find that other people have duplicated your work, you should include a critical comparison of your work and theirs. If the various results agree, that's good: if not, that's interesting – try to explain the reasons for the discrepancies.

Now to some details. The Part II year forms part of your training for the M.Eng. degree, and for subsequent Chartered Engineer status. Thus there are a number of professional skills that you should be acquiring during the year, and for which training will be provided. These include experimental and / or computational abilities, literature searching, data analysis, oral and written presentational skills, and project management. Your Part II thesis should demonstrate what you have learnt in a number of these areas. For example:

- Your literature survey should be concise and critical, and you should include mention of what databases or other information sources you have used in compiling it.
- An engineering context of your work also needs to be included.
- Full information should be given about the materials that you study – their source, purity, full composition, prior thermal and mechanical treatments, etc.
- The reproducibility of experimental measurements should be stated, and an estimate of experimental errors and uncertainties should be included alongside the results.
- Analysis of the statistical significance of experimental results should be included whenever appropriate.
- Where computer modelling has been used, an assessment of the reliability of the model and the accuracy of the calculations should be attempted.

- A short discussion [mandatory final chapter from 1 Oct 2007] of project management aspects of your research should be included, describing the evolution of the aims and objectives of the work, the chronology of what was actually done, and the reasons for any changes of strategy as the year progressed.
- The thesis should contain a clear summary of the main results and conclusions and (where appropriate) should identify key objectives for further work.

One aspect of the Part II which is **not** formally assessed for examination purposes is your development of oral presentational skills. You will give a talk about your project at a Departmental 'mini-symposium' which is held shortly after Easter, and there is a prize for the best presentation on that occasion. But the examiners will not take this oral presentation into account when awarding your degree. The reason is simple – some people are naturally much better talkers than others! For the same reason, although you will have a viva voce examination following the submission of your thesis, you will not be marked for your presentational skills on that occasion. The purpose of the viva is to establish that you fully understand the subject matter of your thesis, that you are conversant with the workings of the equipment or computer models that you have used, and that you have a good critical appreciation of the significance of your results.

In assessing the thesis, the examiners will seek information from the project supervisor(s) about the extent of your interaction with other people, the nature of your specific contributions to the overall research, and about the effects of factors outside your control. But it is important not to let the existence of this form of evaluation distort your behaviour pattern. Don't hide away in a corner and refuse to talk to anyone about your work for fear of being penalised at the end of the year. Teamwork is vital, and discussing plans and ideas with colleagues is a very important and enjoyable aspect of research – it's just that, at the end of the year, the examiners have to try to establish what contribution **you** have made to the overall work of the research group of which you have been a member.

Have a great year – the Part II should be one the most enjoyable parts of the whole course.

Engineering Context

Professor Roger Reed

Chair of Examiners 2018-2019

The field of materials is broad. It emphasises – on the one hand – the fundamental aspects of materials discovery, synthesis, fabrication and behaviour. Materials physics, materials chemistry and materials biology are associated sub-disciplines. There is often a strong element of curiosity-driven research reliant upon observation using state-of-the-art equipment of great spatial/chemical resolution, the proposing of new erudite theories, and detailed mathematical modelling. One overarching aim is to reveal and rationalise the extreme complexity of materials behaviour so that it is better understood and new knowledge is generated. This is the materials science paradigm.

But also included in the field of materials is the more applied aspect of materials engineering. This implies a materials engineering context which – for a well-rounded Part II project – needs to be acknowledged. Here, one is referring to the application of the new materials knowledge for the benefit of humankind and our planet. Often, one is concerned with the materials aspect of design, innovation, and processing – but also the reliability/maintenance of components, devices, machines or structures which make use of those materials. It can also encompass materials aspects within systems, and complex processes including manufacturing streams and organisations. One can also be dealing with aspects of sustainability, recycling or management of the overall lifecycle of materials and components made from them. Experience shows that it is often the materials engineering aspect which determines whether a new materials solution is taken up commercially.

These concepts are addressed in the Workshop on Engineering Context, normally delivered in MT Week 7 by Professor Reed, and where students will have the opportunity to ask questions.

If later on in your project you need further guidance on how to address the Engineering Context of your particular project, the Part II Organiser, Professor Czernuszka, may be approached for advice.

Engineering Context and the Part II Thesis

At appropriate points in your thesis you should identify the engineering (or equivalent) context of the work. This should include reflection on the engineering implications of **your** project findings, as well as covering engineering context in a generic manner for the project topic.

Plagiarism

This information can be applied to all aspects of assessment during the course.

It is **mandatory** that you complete the university's online course on Plagiarism during the first induction week of Michaelmas Term. In order to pass you will need to score 80% or above on the course quiz which will then issue you with a certificate. You are allowed to attempt the quiz multiple times. Once you receive your certificate by email, please forward it to undergraduate.studies@materials.ox.ac.uk to confirm completion by 17:00 on **Friday 15th September 2023**. You can find the course at the web address below:
https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism

In Section 7.7 of the **Student Handbook**, the University's Proctors and Assessor draw attention to extremely important disciplinary regulations for all students related to plagiarism.

You must read the Proctors' Disciplinary Regulations for University Examinations, which make clear that:

- you must indicate to the examiners when you have drawn on the work of others, using quotation marks and references in accordance with the conventions of your subject area
- you must not present as your own work material generated by AI
- other people's original ideas and methods should be clearly distinguished from your own
- the use of other people's words, illustrations, diagrams etc should be clearly indicated regardless of whether they are copied exactly, paraphrased or adapted
- material you have previously submitted for examination, at this University or elsewhere, or published, cannot be re-used – including by drawing on it without referencing it, which constitutes 'autoplagiarism' - unless specifically permitted in the special Subject Regulations.
  https://governance.admin.ox.ac.uk/legislation/proctors-regulations-1-of-2003

Failure to acknowledge your sources by clear citation and referencing constitutes plagiarism. The University's description of plagiarism should be read carefully. That description includes a link to the University's online course about understanding what plagiarism is, and how to avoid it.

The University reserves the right to use software, and routinely does, to screen submitted work for matches either to published sources or to other submitted work.

Any unauthorised use of AI during assessment constitutes cheating and plagiarism under University rules, penalties for which include failing the exam and, in appropriate cases, expulsion. Any use of AI during assessment is unauthorised unless you are specifically told differently in advance of the assessment by your department (e.g. Computer Science assessments involving use of AI). Work submitted for assessment and open-book exam responses may be screened for matches either to published sources or to other submitted work. Any matches might indicate plagiarism, collusion or use of AI.Work submitted for assessment and open-book exam responses may be screened for matches either to published sources or to other submitted work. Any matches might indicate plagiarism or collusion.

Although you are permitted to use resources published electronically in academic work, remember that the plagiarism regulations apply to online material and other digital material just as much as they do to printed material.

Guidance about the use of source materials and the preparation of written work is given in departments' literature and is explained by tutors and supervisors. If you are unsure how to take notes, use web-sourced material or acceptable practice when writing your work, please ask for advice.

Under new UK legislation, providing or using professional essay writing services, or 'essay mills', is now a criminal offence. Students have also been advised that using these services directly contravenes the University's code of conduct. If students are found to be using professional writing services, passing off other people's work as their own, or unauthorised AI, they should expect to face disciplinary action.

If examiners believe that submitted material may be plagiarised they will refer the matter to the Proctors' Office. The result for the assessment (and any other elements for the same assessment unit) will be pended while an investigation is carried out (which can include an interview with the student). If the Proctors consider that a breach of the disciplinary regulations has occurred, they can determine the penalty themselves in suitable cases or refer the matter to the Student Disciplinary Panel (which can in the most serious cases expel the student).
www.ox.ac.uk/students/academic/guidance/skills/plagiarism

Student Handbook 23-24, Section 7.7
www.ox.ac.uk/students/academic/student-handbook

Some Brief Guidance

Text

Take care when referring to the work of others. Not only are published words subject to plagiarism, but ideas and opinions can be plagiarised too. You should not allow the opinions and conclusions of others to appear to be your own or confused with your own criticism.

An extract from Stone IC & Tsakiropoulos P, Materials Science and Engineering A, Vol.189 (1994) 285-290:

> "The peak-aging time of Al-4wt.%Cu, aged at 463 K, was not altered by the addition of 20 wt.%SiCp. The particle size of the reinforcement and the matrix to reinforcement particle-size ratio did not affect the peak-aging time. This implies that, on a bulk scale, aging is not affected by the spatial distribution of the reinforcement, although it is likely to be affected locally."

Here is one example of the use of this extract:

> Stone and Tsakiropoulos studied the aging of metal matrix composites based on Al-4wt%Cu containing 20wt% SiC particles [Stone & Tsakiropoulos, 1994]. The peak-aging time of Al-4wt.%Cu, aged at 463 K, was not altered by the addition of 20 wt.%SiCp. The particle size of the reinforcement and the matrix to reinforcement particle-size ratio did not affect the peak-aging time. This implies that, on a bulk scale, aging is not affected by the spatial distribution of the reinforcement, although it is likely to be affected locally.

The first sentence is fine and is properly referenced. However the rest is plagiarised because (i) it is **directly copied** from the original without being identified as a quote and (ii) the author has not attributed the opinion in the fourth sentence to the original authors.

A second example:

> Stone and Tsakiropoulos studied the aging of metal matrix composites based on Al-4wt%Cu containing 20wt% SiC particles [Stone & Tsakiropoulos, 1994]. They showed that the addition of the reinforcing particles had no effect on the time for peak aging of the matrix at 463K. The implication of this is that whilst aging is likely to be affected locally by the dispersion of the particles, it is not affected macroscopically by the spatial distribution of the reinforcement.

This example is an improvement because the second sentence is now attributed to the original authors. The opinion in the final sentence is still plagiarised. This final sentence could be improved by

> The authors concluded that the implication of this is that whilst aging is likely to be affected locally by the dispersion of the particles, it is not affected macroscopically by the spatial distribution of the reinforcement. This is a sensible conclusion.

because whilst the new author agrees with the original opinion/conclusion they have not passed it off as their own. A belt and braces approach might be:

> The authors concluded, "This implies that, on a bulk scale, aging is not affected by the spatial distribution of the reinforcement, although it is likely to be affected locally" [Stone & Tsakiropoulos, 1994]. This is a sensible conclusion.

Quite often you will not be simply referring to a single piece of published work, but comparing & contrasting several reports of relevance to a particular point in your own document and then offering your own considered opinion on this previous work and/or comparing it with your own data and conclusions. The principles illustrated above in respect of Stone & Tsakiropoulos of course still apply to this more complicated case and in addition it is necessary to separately identify each contribution, for example:

> It has been reported by two groups that the time for peak aging of the matrix at aging temperatures in the range 460-475K is not affected by the addition of reinforcing particles [Stone & Tsakiropoulos (1994), Bloggs & Jones (1997)]. Although a more recent study did observe an apparent influence of the reinforcing particles [Smith (2006)], in the present work we have been unable to reproduce this effect, our data being fully consistent with the original work of Stone & Tsakiropoulos. It seems likely that the results reported by Smith were an artefact of the analytical method that they adopted, such artefacts having been observed by others in related studies of a series of Al-Cu-Mg alloys [Jones et al (1999)].

Figures

Figures too are a potential source of plagiarism. If you use somebody else's diagram, graph, photograph or other artwork without acknowledging the original source then you are guilty of plagiarism (and possibly also of breach of copyright). If you use a figure from elsewhere then you should cite the original reference in the figure caption and in the associated body text. Even if you redraw a figure then you should still refer to the original source, e.g. [redrawn from Jones et al, 2006]. If you use a collection of data from other works to create a completely new figure (e.g. a graph to show a trend arising from a collection of data from several sources) then you must acknowledge the original data sources.

Why is referencing important?

Quite apart from the need to avoid plagiarism because of the danger that this may invalidate a piece of assessed work and/or lead to some other penalty, there are a number of other good reasons for the internationally accepted practise of using references in a factual document:

(i) It is a simple professional courtesy to a fellow scientist who has laboured long & hard to generate the work that you are referring to.

(ii) It enables the reader to verify the statements that you are making, to make his/her own judgements on both the conclusions that you report from the referenced work and the judgements that you make on this work, and of course to learn more about the detail of the original work.

(iii) Your work is strengthened by its reference to respected authorities in a given field; as scientists we all build our work 'on the shoulders of giants'.

(iv) It enables the reader to identify very clearly what are your own original contributions to the matters discussed. Since these contributions will undoubtedly be erudite and valuable, you will want the world to know that they are yours and to be able to give you credit for them when your work is referenced in the future!

The two main referencing systems are Harvard (author name, year of publication) and Vancouver (numbered sequentially in order of use). Whichever system you decide to use, good practice dictates that references should include (depending on publication type): authors, title of book or article, title of journal or other work, name of conference, place of publication, date of publication, publisher and page numbers. The conventions for citing internet resources include URL and date accessed. Your tutor will be able to provide further guidance.

Other useful information on plagiarism can be found on the Education Committee (EdC) web pages at http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism

Analysis of Errors

A former external examiner, Professor Goodhew of Liverpool University, commented in his report on the:

> 'almost complete absence of sensible estimates of experimental errors, or any careful attempts to assess the reproducibility of individual data points.'

There was also a:

> 'complete absence of use of any form of statistical analysis or even proper curve fitting in order to establish confidence limits for results.'

He concluded that:

> 'critical judgement was seriously lacking.'

Remedies:

1. You may recall the Y1 Errors in Measurement lecture course; if you no longer have your own notes, please contact the Undergraduate Studies Office for a replacement set if you wish to refresh your familiarity

2. Handout from Dr Jakubovics (see Appendix A of this Handbook).

Lab Books

AIM: To enable you to keep a complete record of everything that you do in your Part II project.

Extremely useful for writing up.

Good scientific practice - very common in industry and academe to document procedures, results and analysis, and to maintain traceability of records, and to safeguard IPR.

You will be provided with a lab book free of charge. Formally your laboratory notebook(s) and their content are the property of your supervisor, who may wish to retain your lab book or a copy of it at the end of the project.

Normally they will not be used for examining purposes.

Supervision, Formative Feedback and Training

The following teaching norm has been adopted by the Faculty of Materials for the supervision of MS Part II projects:

“Responsibility for the project rests with the student, who should be **proactive** in seeking support and guidance when necessary and in making use of existing written resources. MS Part II students should expect to hold regular meetings with their supervisor. These will normally be held at least every two weeks for the duration of the project but significantly more intensive support is usual in the initial and final stages of the project. The support given by the supervisor at these scheduled meetings may include formal discussion of research, feedback on the student’s derivations, analyses of results, thesis drafts etc. that have been read by the supervisor and direction to relevant literature. You are entitled to receive **thorough** formative feedback on one draft of your thesis provided that it is submitted to your supervisor significantly in advance of the deadline for submission of the thesis to the Examination Schools; feedback may not be possible if the draft thesis is submitted later than two weeks before this deadline. If a first draft is submitted to your supervisor well in advance of the final deadline then he or she is permitted, but not required, to provide limited feedback on revised drafts. Formal meetings with your supervisor will be in many cases supplemented by brief discussions of particular aspects of the research on an ad hoc basis, as required for the investigation to progress smoothly. Further support will be given in the techniques required for the student to carry out their research. Examples include the use of equipment and the performance of experimental techniques, training on modelling software and computer programming and tuition in mathematical methods. Students should note that (i) it is in the nature of research that not all projects require the same type or level of support, and (ii) for some projects the supervisor will personally deliver specialist training, whilst for others such training will be provided by informal mentors or via scheduled Departmental training courses.”

Note too that, in addition to the feedback on a draft of your thesis (provided submitted early enough – as above), your supervisor also provides formative feedback on a termly basis, via TMS, to your and your college tutors.

Project Management

The Part II Project is the first time that you have to focus on a full-time, self-driven piece of work for such a lengthy period. You are expected to take control of, and responsibility for, your own projects. For some this can be a daunting prospect. To help you, and to provide some development of what is a useful generic skill, there is a workshop on project management as part of the Part II induction programme (the slides will be available for review on Canvas - https://canvas.ox.ac.uk/courses/227419), and there is a formal Part II project management process which all students must undertake.

Why is project management important?

- Setting goals. Identifying your goals and objectives at the beginning of your project helps you to focus and remain focussed on what you aim to achieve. You wouldn't want to get on a flight to New York only to realise half-way across the Atlantic that actually you should have been going to Paris!

- You have a pre-determined, fixed deadline. Planning what tasks you need to carry out, how long each will take, and the order in which you will do them will help you to understand if your goals are realistic, and to achieve them efficiently and on time. Avoid 'two steps forward, one step back…'

- Planning resources. A carefully planned sequence of tasks will mean little if you haven't thought about what you will need to carry out each of those tasks. Identifying what resources you will need (consumable items, equipment bookings, technical staff time, training etc), and having them in place at the right time is crucial. Consider also the availability of resources when scheduling your activities, e.g. the basic SEMs normally available to Part II students will be essentially unavailable during the Advanced Characterisation of Materials module (wks 1 & 2 of HT).

- Assessing and mitigating risks. It is in the nature of research that things can and do go wrong, e.g. suppliers fail to deliver, a technician that is helping you falls ill, or an instrument breaks down. Many of these things are outside of your control, but thinking in advance about the risks to the success of your project will help you to plan what to do if something does go wrong. Expect the unexpected.

- Monitoring progress. Having a pre-determined project schedule provides you with a means of continuously monitoring your own progress. Setting yourself milestones also helps you to keep on track. Although 'following your nose' can be fun, it's easier to navigate by checking where you are in relation to landmarks on a map.

- Self-control. If left unchecked, your scientific curiosity may lead you along a variety of side-paths, some of which will be dead ends, and some of which may lead to very interesting but irrelevant outcomes. Effective project management will help you to resist that temptation, or at least help you to consider any risks to your project, and to re-plan, if you do decide to take a detour.

The Formal Part II Project Management Process

Throughout your Part II you are required to complete **three** 1-page forms. Once these have been signed off by your lead supervisor, and by the deadlines detailed below, send them to the Undergraduate Studies Office (please retain a signed copy for yourself). These forms should be downloaded from Canvas and are also available on the Department's internal web pages at www.materials.ox.ac.uk/teaching/part2/pt2projectmanagement.html. Examples of these forms can be seen on the pages 37, 38 & 39. When completing these, you may wish to consider that you will need to include a copy of each in your thesis, so you should ensure they are legible and succinct! If you are undertaking an external Part II project, note that both your local supervisor and your Oxford supervisor will need to review and sign-off these forms.

The Part II Project Organiser will review the forms, and if your project is falling on stony ground then the Part II Project Organiser will invite you for a discussion, possibly with your supervisor.

Project Management Form 1 (due Fri 0th wk MT) asks you to set out what you expect to achieve during your project, how you expect to achieve it and what resources you will need to achieve it.

Project Management Forms 2 (due Fri 6th wk MT) and **3** (due Fri 6th wk HT) provide you with an opportunity to reflect on your progress, and to describe any difficulties you are experiencing and how you intend to resolve them.

Please take the management of your project and the completion of the Project Management forms seriously. Be honest with yourself and with us. Don't tell us what you think we want to hear. By all means discuss the completion of the forms with your supervisor, but you should not allow them to influence your responses unduly.

Please do not feel that you have to wait until the next Project Management form is due before you can raise any issues that you are concerned about. Your supervisor is normally your first port of call, but you should feel free to discuss any matters of concern with the Part II Project Organiser at any time.

Compulsory Final Chapter of the Part II Thesis

Reflective accounts of your project management, your health, safety & risk assessment processes, and the ethical & sustainability considerations relevant to your project and its outcomes.

Project Management and the Part II Thesis (max. 1500 words, excluding the PM forms)
Assessment of your ability to manage your project is an integral part of the Examiners' overall evaluation of your thesis. The Examination Regulations require that your Part II thesis includes a compulsory final chapter on the project management aspects of your investigation. The chapter should include a reflective account, of no more than 1,500 words, of how you managed your project and copies of the three project management forms which you may refer to in the reflective account.

It is important that you provide in this compulsory chapter a good description of the way in which you managed your project in order that the scientific fruits of your labour could be borne. The following are some ideas that might help you to plan this chapter (N.B. they are not exhaustive and should not be considered as template):

- Remind the Examiners of your initial objectives and what milestones you set yourself to achieve along the way. Note down whether you achieved those milestones in time. If not, why not?

- Were your early results in-line with your original hypothesis/objectives, or did they suggest an alternative path for your project (as much as we can plan, research projects often turn out to have a strong evolutionary element).

- In the early stages, did you think about what might go wrong and have a set of mitigating back-up plans? Did the things you thought might go wrong actually go wrong? Were you successful in putting your predetemined back-up plan into action?

- Did unexpected things go wrong? How did you cope with them?

- Did you plan what resources (raw materials, consumables, access to equipment and laboratories, other people's time) you were going to need in advance? How did you ensure that they were all available to you at the right time? Were there any circumstances outside of your control that put those resources out of reach?

- How did you go about making decisions about your project? Did you take autonomous decisions, or did you take decisions only after consultation with your supervisor(s)? Did you have regular review meetings with your supervisor(s)? Were your meetings more ad-hoc as and when problems arose?

- Describe whether you essentially worked alone or as part of a group. If you worked as part of a group describe your role in that group, and how you ensured other members of your group carried out their roles in helping you achieve your aims.

- You might want to describe how you planned to write your thesis. Did you wait until you had done all of your practical work before starting your thesis, or did you draft sections as you went along? Did you use your lab book to help you write your thesis?

- Finally, you might also like to reflect on the planning and management of your project, and show the examiners that you have used this opportunity as a learning experience for the future; e.g. with the benefit of hindsight are there any aspects of your project that you now realise could have been better planned or managed.

Health, Safety & Risk Assessment and the Part II Thesis (max. 500 words)
Assessment of your understanding of the appropriate aspects of health, safety & risk assessment for the work carried out in your project is an integral part of the Examiners' overall evaluation of your thesis. In the final chapter, as well as the account of your project management, you should include a reflective account, of no more than 500 words, of the hazards associated with your work and the appropriate risk assessments and control measures.

Even those of you carrying out a purely modelling or theory project will have completed a project Risk Assessment that can be commented on in this section, but you are likely to need only a small fraction of the 500 word limit to cover this.

Ethics & Sustainability and the Part II Thesis (max. 1000 words)
Assessment of your understanding of the ethical and sustainability (including life cycle analysis where appropriate) implications of your project and its potential applications is an integral part of the Examiners' overall evaluation of your thesis. In the final chapter, as well as the account of your project management and risk assessments, you should include a reflective account, of no more than 1000 words, of the broad and any specific ethical and sustainability implications of your particular project and its potential applications.

PROJECT MANAGEMENT FORM 1

Part II Project Description Form

After discussion with your supervisor YOU should complete this form and send a copy to the Undergraduate Studies Office by Friday of 0th week of Michaelmas Term.

Name: College:

Address for correspondence:

Contact telephone number:

Title of project:

Supervisor:

What are the objectives of the project in order of priority?

List the major milestones that must be accomplished in order to meet the objectives of the project

Are you working essentially on your own or as part of a team? If you are part of a team what is your role, and to what extent is the success of your project dependent on other members of the team?

What resources (equipment, materials, technician support etc.) will you need?

Do you require any training to meet your objectives, e.g. in the use of specific experimental equipment or software, and how are you going to obtain that training?

Complete the following plan for your entire project as you see it now. List each major task down the left hand column, and for each one draw a horizontal line to indicate the period you expect to allocate to it. For example, the final task, writing your thesis, is shown as occupying mid-April to mid-June.

Task	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Writing up							xxxx	xxxx	xxxx

Has your supervisor completed a *Risk Assessment Form* about your project yet?

Your signature:
Date:

Your supervisor's signature:
Date:

PROJECT MANAGEMENT FORM 2

1st Part II Project Analysis Form

Complete this form and send a copy to the Undergraduate Studies Office by Friday of 6th week of Michaelmas Term

Name:

Title of Project as given in your Project Description:

Refer back to the project plan in your Project Description and list the goals you set for this term. Comment briefly on the extent to which you have achieved them.

Identify clearly any difficulties you have encountered. Are they surmountable in the time available?

State any refinements, modifications or replacements of the original objectives for your Part II project:

Are you intending to change the title of your project? If so, state the new title:

Have the training needs you identified in the Project Description been met, and have you identified any further training requirements?

Tick the appropriate box. Do you have

	None	Some	Sufficient
Results			
Analysis of results			

Do you have any other comments you wish to make?

After looking at the project plan in your Project Description complete the following project plan for the remainder of your Part II.

Task	Dec	Jan	Feb	Mar	Apr	May	Jun
Writing up					xxxxx	xxxxx	xxxxx

General comments by the supervisor:

Your signature:
Date:

Your supervisor's signature:
Date:

PROJECT MANAGEMENT FORM 3

2nd Part II Project Analysis Form

Complete this form and send a copy to the Undergraduate Studies Office by Friday of 6th week of Hilary Term

Name:

Title of Project:

Refer back to the project plan you made last term and list the goals you set for this term. Comment briefly on the extent to which you have achieved them.

Identify clearly any difficulties you have encountered. Are they surmountable in the time available?

State any refinements, modifications or replacements of the objectives you set for your Part II project:

Are you intending to change the title of your project? If so, state the new title:

What is the title of the talk you will give to the Department?

Have all your training needs for this project now been met?

Tick the appropriate box. Do you have

	None	Some	Sufficient
Results			
Analysis of results			

Do you have any other comments you wish to make?

General comments by the supervisor:

Your signature:
Date:

Your supervisor's signature:
Date:

The Part II Talk

You will be **required** to give a talk on your Part II project at a mini-symposium in early **Trinity Term**.

No exemptions.

AIM: To give you experience of giving an oral presentation

Each talk will last 12 minutes + 3 minutes for discussion.

All members of the Department are invited.

The talk is **not** examinable! Part II examiners are allowed to attend **only** presentations of projects that they supervise.

You will receive brief, confidential, feedback about your talk from the Part II Project Organiser.

The talk should be aimed at non-specialist scientists. It should include a brief description of the engineering relevance of your project.

Should your talk include content which refers to potentially exploitable intellectual property (IP) it is vital that you alert the Part II Project Organiser to this **in advance** who will arrange for a non-disclosure undertaking to be signed by all external people who may be present. An example of this form can be found at Appendix B.

Prizes

Part II Talks

There is a prize of £450 and a medal from **The Worshipful Company of Ironmongers** for the best talk.

Best Project

Armourers and Brasiers' Company Medal and Prize: The Armourers and Brasiers' Company award a medal and a prize of £250 for the best MS Part II project.

The award is based on the recommendation of the Part II examiners, after the examination of the Part II thesis is completed.

The Armourers like to award the prize and medal at a formal presentation by one of their senior people, on a public occasion.

Leaving the Department

In the closing stages of the course you will be asked to complete Part II Leavers Forms

Part II Leavers Form A

Form A relates to sponsorship and vacation work whilst on course, and your onward career. This information is very important for various audits and assessments that the University and Department are subject to; for instance accreditation by IOM^3.

Please submit Form A before you have your viva.

Part II Leavers Form B

Form B is a declaration that you have returned your library books and keys, and cleared your workspace. You should have each field of this form initialled on behalf of the Department by the named individual.

Part II Leavers Form C

Form C seeks your feedback on the Part II year. As you will know by now, feedback is important to us and we welcome hearing your views about your 4th year experience.

All forms are shown on the following pages and will be available on Canvas. They will be sent to you towards the end of Trinity Term with further instructions.

Form A

Materials Science Part II Leavers: Destination Information

Name:	
Email:	
Telephone No:	
Address for forwarding mail (if possible, please provide an address relevant for the long-term)	
What are your plans for the next year?	☐ Job Where? Start Date: Starting Salary (only if you wish to provide): ☐ Training Where? Start Date: ☐ Further research Where? Start Date: ☐ Other Please give details:
Please indicate if these plans are contingent on your degree results:	☐ Conditional. ☐ Unconditional Please give details if conditional:
Please provide details of any industrial experience prior to coming to Oxford:	
Were you sponsored as an undergraduate?	☐ Yes By whom? ☐ No
Were you involved in any vacation work that proved relevant to your study or future aspirations?	☐ No ☐ Yes Where: For how long? Type of activity: Please provide contact details for any company that you would recommend to future students for a summer placement:

Please complete all fields. If you are unable to complete a field then please enter "Not applicable" or "Do not know" or "Confidential" rather than leaving it blank.

The above gives an indication of the questions asked via an online form.

Materials Science Part II Leavers Declaration

Name: ……………………………………………..

Requirement	**Statement**	**To whom**	**Initials**	
			Leaver	**For Dept**
Laboratory Workspace	I have cleaned my laboratory workspace and correctly labelled any chemicals and samples that I have left behind. I have disposed of any excess chemicals / samples safely and through the appropriate channels.	Chemical Safety Technician		
IT matters	I have followed the advice on the Department's website concerning email account and IT matters; I have spoken to my supervisor about backing up my electronic data. (Contact IT Support if you have any further queries)	Part II Supervisor		
Restricted Content in Thesis	I sign over to my Part II supervisor (or responsible member of the Department, as appropriate) the rights to lift or retain the embargo on any restricted content. (Note: this section to be completed only if thesis content has been restricted.)	Part II Supervisor		
Library Books	I have returned all library books	Librarian		
Keys	I have returned any keys to Facilities. (Note: this must be done by the end of June.)	Facilities		

Leaver's Signature: …………………………….. Date: ………………

This form must be returned to before you leave Oxford

Form C

Materials Science Part II Leavers: Feedback

Please provide identifying information only if you are comfortable doing so	
Name:	
Email:	
Research Group / Supervisor	
What did you enjoy most about your Part II Project?	
What aspect of the Part II project did you find to be the most beneficial?	
What did you enjoy least about your Part II Project?	
What aspects of the Part II project did you find to be the least beneficial?	
What recommendations, if any, do you have for improvements to the Part II experience?	
In hindsight what, if anything, would you have changed in your own approach to the Part II project?	
What advice would you give to future Part II students?	
Are there any skills you were surprised to find you developed during your project?	☐ No ☐ Yes If yes, please give details:

Again, this gives you an indication of the questions asked via an online form

Part II Organisation

Part II Project Organiser :

Prof Jan Czernuszka

Room 10.15, 21 Banbury Road

Phone: (2)73771

jan.czernuszka@materials.ox.ac.uk

(Please e-mail me in the first instance)

Administration for Part II Projects :

Undergraduate Studies Office

Room 30.06, Hume-Rothery

Phone: (2)73703

undergraduate.studies@materials.ox.ac.uk

Appendix A: Treatment of Experimental Errors, J.P. Jakubovics

1. Introduction

Results obtained by experiments are never perfectly accurate, and therefore they are only meaningful if their accuracy can be estimated. The accuracy is expressed in the form of a quantity called **the error**, which is a measure of the **lack of accuracy** of the measurement. If the result of an experiment is the magnitude of some quantity, then it is just as important to estimate the error in this quantity as it is to calculate the quantity itself.

The following notes contain a summary of the basic points necessary for undergraduate practical work. For more details, reference should be made to textbooks. An excellent introduction to the subject at an elementary level is **Errors of Observation and their Treatment** by J. Topping (Chapman and Hall).

These notes deal with the estimation of **random** errors (those that are equally likely to occur with positive or negative sign). In any experiment, there might also be **systematic** errors (those that have a bias towards occurring with the same sign). Systematic errors cannot be treated by statistical methods, and it is therefore important to eliminate them at the experimental stage, or to calculate their effect afterwards.

2. The error in a measured quantity

Suppose a measurement is made of a quantity x whose actual value is x_0. This actual value can never be precisely established by experimental measurements. The result of the measurements might be a quantity x_m. Suppose that the error in x_m has been estimated to be ε. This does not mean that the actual value x_0 is definitely between $x = x_m - \varepsilon$ and $x = x_m + \varepsilon$, and cannot be outside that range. Neither does it mean that x_0 is equally likely to be anywhere in the range $x = x_m - \varepsilon$ to $x = x_m + \varepsilon$. What it does mean is that there is a certain probability p (say 50% or 80%) that x_0 is in the range $x = x_m - \varepsilon$ to $x = x_m + \varepsilon$, and that the probability that x_0 is outside that range is $1 - p$. Moreover, the probability that x_0 is between $x = x_m - 2\varepsilon$ and $x = x_m + 2\varepsilon$ is higher than p, and the probability that x_0 is between $x = x_m - 3\varepsilon$ and $x = x_m + 3\varepsilon$ is even higher. The meaning of x_m is that it is the **most probable** value of x_0. In most cases of practical interest, p varies with x according to a Gaussian law

$$p = A\exp\left[-\frac{(x-x_0)^2}{2\sigma^2}\right]. \quad (1)$$

Eq. (1) means that the probability that the result of a measurement will be between x and $x + dx$ is $p(x)dx$, and is called the Gaussian or normal distribution. We see that

1. p is a maximum when $x = x_0$,

2. σ is a measure of the 'sharpness' of the peak at $x = x_0$. The smaller σ, the more rapidly p decreases with increasing difference between x and x_0. Therefore, σ is related to the error ε in some way. The relationship between ε and σ is discussed below.

3. The total probability must be 1, so that A is given by the condition

$$\int_{-\infty}^{\infty} p\, dx = 1 . \quad (2)$$

It can be shown that this condition gives

$$A = \frac{1}{\sigma\sqrt{2\pi}} . \quad (3)$$

Of course, to establish the exact form of the probability function would need an infinite number of independent measurements of the quantity x. But even with only a finite number of measurements, we can make a reasonable guess. Suppose we have made n measurements whose results are x_1, x_2, x_3,…, x_n. The most likely value of the 'actual result' x_0 is the arithmetic mean x_m of the measurements:

$$x_m = \frac{x_1 + x_2 + x_3 + ... + x_n}{n} . \quad (4)$$

We can therefore regard x_m as the 'result of the experiment'. Now consider the quantities

$$\begin{aligned}
\delta_1 &= x_1 - x_m\,, \\
\delta_2 &= x_2 - x_m\,, \\
&\dots \\
&\dots \\
\delta_n &= x_n - x_m\,.
\end{aligned} \tag{5}$$

The δ-s are called the **deviations**, and the best guess we can make for σ is

$$\sigma = \left(\frac{\delta_1^2 + \delta_2^2 + \delta_3^2 + \ldots + \delta_n^2}{n-1} \right)^{1/2}. \tag{6}$$

The quantity σ is called the **standard deviation**. Note that as we make more and more measurements of x (i.e. as $n \to \infty$), σ does not keep decreasing, but tends to a constant value. It is a measure of how much an individual measurement is likely to differ from x_m. The error, however, is a measure of how much x_m is likely to differ from the 'actual value' x_0, and this error must obviously get smaller as n increases. It is usual therefore to define the error by the expression

$$\begin{aligned}
\varepsilon &= \frac{\sigma}{\sqrt{n}} \\
&= \left[\frac{\delta_1^2 + \delta_2^2 + \delta_3^2 + \ldots + \delta_n^2}{n(n-1)} \right]^{1/2}
\end{aligned} \tag{7}$$

which is called the **standard error**.

3. Superposition of errors

In many cases, the quantity of interest is not directly measured, but is calculated from a formula that contains several directly measured quantities. In general, we calculate a quantity y from a formula

$$y = f(x_1, x_2, \ldots, x_n)\,, \tag{8}$$

where x_1, x_2,…, x_n are the experimentally measured quantities. Suppose we have determined the errors in x_1, x_2,…, x_n by using the formulae in the previous section, having made repeated measurements of each of the quantities. Let the errors in x_1, x_2,…, x_n be δx_1, δx_2,…, δx_n respectively. Then according to the 'chain rule', the error δy in y should be

$$\delta y = \frac{\partial y}{\partial x_1}\delta x_1 + \frac{\partial y}{\partial x_2}\delta x_2 + \ldots + \frac{\partial y}{\partial x_n}\delta x_n\,, \tag{9}$$

provided δx_1, δx_2,…, δx_n are sufficiently small. However, if we use this formula to find δy, we would be taking too pessimistic a view of the accuracy of the result. In effect, we would be assuming that all the errors δx_1, δx_2,…, δx_n occur with the same sign. However, since these errors are random, there is an equal probability for each of them to be positive or negative. In order to take this randomness into account, we consider what happens when we square the expression for δy:

$$\begin{aligned}(\delta y)^2 = &\left(\frac{\partial y}{\partial x_1}\right)^2(\delta x_1)^2 + \left(\frac{\partial y}{\partial x_2}\right)^2(\delta x_2)^2 + \ldots + \left(\frac{\partial y}{\partial x_n}\right)^2(\delta x_n)^2 \\ &+ 2\left(\frac{\partial y}{\partial x_1}\right)\left(\frac{\partial y}{\partial x_2}\right)\delta x_1\delta x_2 + \ldots + 2\left(\frac{\partial y}{\partial x_{n-1}}\right)\left(\frac{\partial y}{\partial x_n}\right)\delta x_{n-1}\delta x_n\end{aligned} \tag{10}$$

Clearly, the squared terms will always be positive, whether the δx-s are positive or negative. However, each of the cross-product terms can change sign if either of the δx-s it contains changes sign. Thus, there is an equal probability for any of the cross-product terms to be positive or negative. We are justified in assuming that the **average** value of each cross-product term is zero. The correct expression for the error in y is therefore

$$\delta y = \left[\left(\frac{\partial y}{\partial x_1}\right)^2(\delta x_1)^2 + \left(\frac{\partial y}{\partial x_2}\right)^2(\delta x_2)^2 + \ldots + \left(\frac{\partial y}{\partial x_n}\right)^2(\delta x_n)^2\right]^{1/2}. \tag{11}$$

4. Examples

Here are two simple examples of the use of Eq. (11).

1. An aircraft is flying west, and its windspeed indicator registers a speed of $v_1 \pm \delta v_1$. The weather report gives an easterly wind of speed $v_2 \pm \delta v_2$. Then the speed of the aircraft relative to ground is

$$V = v_1 + v_2 . \tag{12}$$

Since

$$\frac{\partial V}{\partial v_1} = \frac{\partial V}{\partial v_2} = 1 , \tag{13}$$

Eq. (11) gives

$$\delta V = \left[(\delta v_1)^2 + (\delta v_2)^2 \right]^{1/2} . \tag{14}$$

This example shows that the square of the error in a sum is equal to the sum of the squares of the individual errors.

2. The unit cell of an orthorhombic crystal is a rectangular parallelepiped. The lattice parameters (lengths of the sides of the unit cell) have been found to be $a \pm \delta a$, $b \pm \delta b$ and $c \pm \delta c$. Then the volume of the unit cell is

$$V = abc . \tag{15}$$

Since

$$\frac{\partial V}{\partial a} = bc, \qquad \frac{\partial V}{\partial b} = ac, \qquad \frac{\partial V}{\partial c} = ab, \tag{16}$$

Eq. (11) gives

$$\delta V = \left[b^2 c^2 (\delta a)^2 + a^2 c^2 (\delta b)^2 + a^2 b^2 (\delta c)^2 \right]^{1/2} . \tag{17}$$

This result can be simplified by using Eq. (15), giving

$$\frac{\delta V}{V} = \left[\left(\frac{\delta a}{a} \right)^2 + \left(\frac{\delta b}{b} \right)^2 + \left(\frac{\delta c}{c} \right)^2 \right]^{1/2} . \tag{18}$$

This example shows two important points.

(i) The square of the **fractional** error in a product is equal to the sum of the squares of the individual **fractional** errors.

(ii) In many cases, as in this example (but not in the previous one), it is simpler to relate fractional errors to each other, rather than absolute errors.

The method of superposition of errors outlined here is a most important one, since it is used in nearly all experiments in which quantitative measurements are made. The quantity one is trying to determine is in many cases not directly measured, but is calculated from other, directly measured quantities.

5. Straight line fitting

In many cases, measurements are made of a quantity y as a function of x, when a linear relationship

$$y = a + bx \tag{19}$$

is believed to exist between y and x. The object is to determine a and b by finding the straight line that is the 'best fit' to the set of measured points. Suppose that n values of x are chosen ($x_1, x_2, \ldots, x_n$), and the corresponding values of y, i.e. ($y_1, y_2, \ldots, y_n$) are measured. We assume that $x_1, x_2, \ldots, x_n$ are accurately known, but $y_1, y_2, \ldots, y_n$ are subject to error. The problem is to find the line that is as near as possible to the points (x_1, y_1), (x_2, y_2),…, (x_n, y_n). There are several methods for finding a line that satisfies this criterion to some extent. The best line is the one found by the **method of least squares**. In this method, we consider the sum of the squares of distances of the points from any given line, measured in the y-direction, and try to find the values of a and b that make this sum a minimum. The distance of the point (x_1, y_1) from a line such as that given by Eq. (19) is

$$d_1 = |y_1 - a - bx_1|, \tag{20}$$

for the point (x_2, y_2), the distance is

$$d_2 = |y_2 - a - bx_2|, \tag{21}$$

and so on. The sum Q we are trying to minimise is

$$Q = (y_1 - a - bx_1)^2 + (y_2 - a - bx_2)^2 + ... + (y_n - a - bx_n)^2 . \tag{22}$$

The conditions for Q to be a minimum are

$$\frac{\partial Q}{\partial a} = 0 \qquad \text{and} \qquad \frac{\partial Q}{\partial b} = 0 . \tag{23}$$

From the first condition we get

$$-2(y_1 - a - bx_1) - 2(y_2 - a - bx_2) - ... - 2(y_n - a - bx_n) = 0 , \tag{24}$$

which can be rewritten

$$(y_1 + y_2 + ... + y_n) - an - b(x_1 + x_2 + ... + x_n) = 0 . \tag{25}$$

Since $x_1, x_2, \ldots, x_n$ and $y_1, y_2, \ldots, y_n$ are known, we can calculate the expressions in the brackets. For simplicity we put

$$S_x = x_1 + x_2 + ... + x_n , \tag{26}$$

$$S_y = y_1 + y_2 + ... + y_n . \tag{27}$$

Then

$$an + bS_x = S_y . \tag{28}$$

Similarly, from the second condition we have

$$-2x_1(y_1 - a - bx_1) - 2x_2(y_2 - a - bx_2) - ... - 2x_n(y_n - a - bx_n) = 0 \tag{29}$$

which gives

$$aS_x + bS_{xx} = S_{xy} , \tag{30}$$

where

$$S_{xx} = x_1^2 + x_2^2 + \ldots + x_n^2, \tag{31}$$

$$S_{xy} = x_1 y_1 + x_2 y_2 + \ldots + x_n y_n. \tag{32}$$

We can obtain a and b from Eqs (28) and (30):

$$a = \frac{S_{xx} S_y - S_{xy} S_x}{n S_{xx} - S_x^2}, \tag{33}$$

$$b = \frac{n S_{xy} - S_x S_y}{n S_{xx} - S_x^2}. \tag{34}$$

It is also important to estimate the error in a and b. They are given by

$$\delta a = \left[\frac{Q S_{xx}}{(n-2)(n S_{xx} - S_x^2)} \right]^{1/2}, \tag{35}$$

$$\delta b = \left[\frac{n Q}{(n-2)(n S_{xx} - S_x^2)} \right]^{1/2}. \tag{36}$$

6. Average value of results with different errors

Suppose a quantity x is measured independently n times, and the results are $x_1 \pm \delta x_1, x_2 \pm \delta x_2, \ldots, x_n \pm \delta x_n$. In such cases, the arithmetic mean

$$\langle x \rangle = \frac{1}{n} \sum_{i=1}^{n} x_i \tag{37}$$

does not give the best estimate of the result. As the various measurements are not equally accurate, the result is more likely to be close to the more accurate measurements than the less accurate ones. It is therefore better to estimate the result using a **weighted mean**, in which we give **greater** weight to the values whose errors are **smaller**. The weighted mean is

$$\langle x_w \rangle = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}, \tag{38}$$

where $w_1, w_2, \ldots, w_n$ are the weights assigned to $x_1, x_2, \ldots, x_n$ respectively. It is usual to assume that the weights are inversely proportional to the errors:

$$w_i = \frac{1}{(\delta x_i)^2} \quad (i = 1, 2, \ldots, n). \tag{39}$$

The error in $\langle x_w \rangle$ can be calculated in two different ways.

1. The **external** error δx_E is related to the scatter of the x_i-values about $\langle x_w \rangle$:

$$(\delta x_E)^2 = \frac{\sum_{i=1}^{n} \frac{x_i - \langle x_w \rangle}{(\delta x_i)^2}}{(n-1)\sum_{i=1}^{n} \frac{1}{(\delta x_i)^2}}. \tag{40}$$

2. The **internal** error δx_I is related to the individual errors δx_i. It can be derived by applying the superposition formula, Eq. (11), to Eq. (38):

$$(\delta x_I)^2 = \sum_{i=1}^{n} \left(\frac{\partial \langle x_w \rangle}{\partial x_i} \right)^2 (\delta x_i)^2 = \left[\sum_{i=1}^{n} \frac{1}{(\delta x_i)^2} \right]^{-1}. \tag{41}$$

The results are **consistent** if δx_E and δx_I are of the same order of magnitude. (For example, if each measurement is thought to be very accurate but the different measurements differ from each other by large amounts, then something must be wrong. Conversely, it is rather an unlikely coincidence if the measurements are thought to be rather inaccurate but the different values are all nearly equal.)

We can define a consistency parameter, $Z = \delta x_E / \delta x_I$, which should be of the order of 1 for the results to be consistent. From Eqs (40) and (41),

$$Z^2 = \frac{1}{n-1}\sum_{i=1}^{n}\frac{x_i - \langle x_w \rangle}{(\delta x_i)^2}. \qquad (42)$$

The best estimate of the error in $\langle x_w \rangle$ is either the larger of δx_E and δx_I, or

$\delta x = \left[(\delta x_E)^2 + (\delta x_I)^2\right]^{1/2}$.

7. Quoting the results and errors

In most experiments, the error itself is unlikely to be known very accurately (unless the result is based on a very large number of measurements of the same quantity). The error should in most cases only be quoted to one significant figure, except if that first figure is 1, then sometimes two significant figures may be given. The error can now be used to find the number of significant figures in the result, and the result should be rounded off accordingly. The general rule is that the result and error should be quoted to the **same number of decimals**. For example, a measured interatomic distance could be given as a = (0.427 ± 0.003) nm, or as a = (0.43 ± 0.02) nm, or as a = (0.427 ± 0.013) nm, or as a = (0.427 ± 0.010) nm, or as a = (0.42735 ± 0.00007) nm, depending on the magnitude of the error. But the following examples are incorrect: a = (0.42735 ± 0.003) nm (the last two decimals of the result are not significant), a = (0.43 ± 0.002) nm (not enough significant figures in the result), a = (0.427 ± 0.01) nm (which should be either 0.427 ± 0.010 or 0.43 ± 0.01), a = (0.427 ± 0.00385) nm (the error should be rounded off to 0.004), and a = (0.42735 ± 0.00385) nm (the error should be rounded off to 0.004 and the result to 0.427). The result and error should always be quoted **together**, as in the first four examples above. The error may sometimes **also** be quoted as a percentage, which is a convenient way of comparing the accuracy of results obtained by different methods.

J P Jakubovics
Department of Materials 11 July 1995

Appendix B: Non-Disclosure Undertaking for Part II Presentations

In return for the opportunity to attend the presentations given by **[Student Name]**, each of the undersigned agrees with **[Company Name]** and the University of Oxford that he or she will not use for his or her own benefit or disclose to anyone else any information which is disclosed during the presentation unless **[Company Name]** first gives its consent in writing.

Each of the undersigned understands that information disclosed during these presentations is confidential and that failure to maintain confidentiality of the information may prevent its owner from obtaining patent protection for the information and may lead to substantial financial loss, including loss to individual students and researchers.

Signed and agreed by:

Print Name:	**Signature:**

I confirm that every person attending the presentation has signed this agreement:

Signature:

Name:

Position:

Sheet.....of....

Appendix C: External MS Part II Briefing Notes

These notes are to give you some guidance only, on making arrangements for external Part II projects. They are not exhaustive and no two cases are quite the same. There are many pitfalls to making such arrangements and whilst it is your own responsibility to organise external projects yourselves, it is important that you keep the Part II Organiser (currently Prof Jan Czernuszka) informed, such that they can offer guidance, can ensure that the arrangements (host institution, project) are appropriate for an Oxford Part II, can help to protect your interests if necessary, and ultimately approve the project. If you are interested in undertaking an external Part II project, the earlier you start organising it the better.

Note that although external projects are allowed, we do not necessarily encourage them, and particularly not for all students. You will need to secure the permission of your tutor to undertake an external project before progressing arrangements.

Timeline

- By the end of MT you should be aiming to have
  - secured approval from your tutor,
  - identified a host institution,
  - identified a supervisor at the host institution,
  - identified an internal Oxford academic supervisor,
  - have agreed an outline project description.
- By the end of MT you **must** have notified the Exchange and Placements Organiser (currently Prof. Andrew Watt) and the Part II Project Organiser of your intention to proceed with an external project and at which institution. There are strict legal requirements that must be addressed before your project can be formally approved and it can be a lengthy process for the Department and your intended institution to finalise these.

Responsibility and Requirements for Organising External Projects

- Arrangements are entirely your responsibility - we can of course offer some guidance and help.
- You must keep the Part II Project Organiser in the loop, i.e. informed of all developments.
- External projects are attractive for your CV, but there are risks involved in such projects:
  - we may not know the external supervisor or how well respected they are,
  - we cannot guarantee that an external supervisor fully understands what is required of the Part II,
  - we cannot keep a constant eye on the progress of you or your project, etc.

- Given those risks, we will only allow you to carry out your project externally if
    - we feel that the external supervisor is appropriately senior,
    - the project is appropriate for the length and standard of Part II,
    - that the college tutor, the Part II Organiser and the appointed internal Oxford academic supervisor feel that the student is academically able and sufficiently self-motivated and strong to work well away from Oxford.
- In the case of an external Part II project that is enabled by an exchange scheme between Oxford Materials and the external host, the Oxford Materials student's college must guarantee that they will provide the following for the student hosted by Oxford:
    - Visiting Student status and,
    - accommodation for two terms (Note: this may not map directly to the terms of the Oxford Materials student's external project).

Project Length

- The Part II year is longer than usual.
- At least 36 weeks long, over "extended" terms (longer than the normal 8 week terms).
- Mid-September to the end of June (The thesis is handed in on Monday of 7th week of Trinity Term).
- Whole of Trinity term in Oxford, and so must return to Oxford shortly after Easter, in time for the Part II talks.

Assessment

- The thesis is key to the assessment of Part II.
- The external institution is not required to provide any formal assessment of the project, but all supervisors are requested at the end of the project to make some comments on the way the student has dealt with the project, if any difficulties arose, how much help they had etc.
- After submitting the thesis you will be subject to a viva voce exam in week 9 or 10 of Trinity Term.
- In addition to the thesis all Part II students are required to give a presentation (early Trinity Term), but the presentation does not count towards the exam mark.

Lecture Courses and Training

- The Part II is a research project and you are not required by us to sit any lecture courses.
- We do encourage Part II students to attend some lectures that might be of use to their projects or be of general interest.
- In Oxford these often take the form of postgraduate lecture courses or departmental seminars/colloquia, for instance.
- Part II students carrying out their projects in Oxford may be required to attend lectures associated with training for the use of certain experimental techniques, e.g. electron microscopy, or safety lectures.
- Essentially then you would be at the host institution to do research, but it is likely that host institutions will take a similar approach to us and you should attend any courses necessary, as required by the host institution, for training on instrumentation and safety etc.
- You will need to check with the host institution how you will receive training etc

Publication

- There is no requirement to produce published works from your Part II project
    - although some research publications are produced after projects have been completed,
    - examiners may well consider if the work is publishable.

Confidentiality and Intellectual Property

- Host institution will be concerned with issues of confidentiality and IP, e.g.
    - project may be part of a large research programme that has restrictions on what information can be released,
    - or you may be working as part of a team that invents something that could be of commercial benefit to the host institution.
- Better to avoid such projects if possible
    - but if these issues are apparent then a research contract will need to be drawn up between the host institution and the University of Oxford which will establish what measures need to be taken to preserve confidentiality and to assign the ownership of any IP that might be developed during your project, and to protect your interests in ensuring that you are not prevented from fulfilling the requirements of your degree.
- Such negotiations can be very protracted and it is best that we know if this is likely to be an issue at the earliest possible stage.

- Do NOT sign any such agreements the host institution before getting advice from the Part II Organiser or Exchange and Placements Organiser.

Oxford Academic Supervisor

- It is likely that the time spent abroad would be for practical work and reviewing the literature, whilst the bulk of the thesis will be written once you have returned – no later than Monday of week 0 of Trinity Term.
- As a result, and to ensure that your progress is being monitored continually, we insist that an internal (Oxford based) supervisor is appointed to the project.
- The internal supervisor should be knowledgeable in the field in which you will be working.
- It is up to you to find an internal supervisor who is willing to oversee your progress remotely, and to give guidance during the preparation of the thesis (of course you should keep in contact with the external supervisor during this period).
- We will also ask the internal supervisor to comment on the suitability of the project in the first place.
- If an internal supervisor cannot be found, the project will not be approved.

Project Management

- All Part II students are required to complete a series of project management forms during the project, to encourage you to think periodically about your objectives and progress.
- You should discuss the completion of these forms with **both** your external and internal supervisors – both will be required to sign these.
- If you are away from Oxford, you will miss the Project Management Workshop given to Part II students by an external professional project manager. The relevant material on Canvas should be reviewed.

Costs

- Any costs associated with carrying out the project externally, e.g.
    - travel,
    - maintenance,
    - health insurance,
    - course fees required by the host institution

  must be met by you.
- We can offer some assistance in applying for funding to contribute towards the costs.
- No fees are to be paid to the external institution; you will still be liable for Oxford fees and your college will require fees for the full year.

- Your college may be able to help financially, but you will have to investigate this with your particular college.
- It is quite possible that you will meet students from other Oxford departments at the same host institution. They may be there under a specific scheme and may be receiving funding. You will not. (Princeton is an example.)
- MIT do not currently charge a fee – if your potential supervisor there tells you they do, ask them to speak with Stephen Barnes.
- **There may be implications for your fee status and your student loan. It is very important you understand this fully before you commit to an external project.**

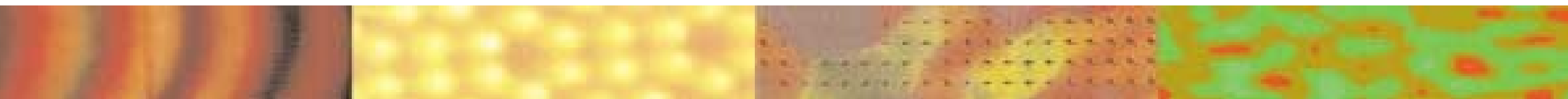
Checklist

- Identify host institution.
- Identify supervisor at host institution.
- Inform the Part II Organiser of your plans (they will seek confirmation from your College tutor on your suitability for an external project).
- Approach host institution. Make the host supervisor aware of the MS Part II Course Handbook, so that they can familiarise themselves with the course requirements.
- Obtain one or more project descriptions (one side of A4 for each project should be sufficient).
- Identify an internal Oxford academic supervisor who would be willing to act.
- Discuss project descriptions with Part II Organiser, College Tutor and Oxford supervisor.
- Put your proposed host institution supervisor in contact with the Part II Organiser to discuss any confidentiality/IP issues.
- Identify personal costs for the project, and apply for supporting funds.
- Alert the Exchange and Placements Manager that a Memorandum of Understanding (MoU) will be required between Oxford and the host institution.

Later in the process

- There will be another checklist dealing with such items as flights, health insurance etc.
- You will have to take out appropriate **travel** insurance and **health** insurance, **including travel insurance cover through the Oxford University block policy**.
- In order to obtain the University Insurance you will need to do a risk assessment for your project. The Exchange and Placements Organiser will provide some initial guidance on this, but it will be your responsibility.
- You may need to take out additional insurance to that provided via the University if you intend to take holiday while away or take part in potentially dangerous leisure activities.

- You will need to take out additional health insurance – the insurance via the University only covers you in case of emergency.
- The Exchange and Placements Organiser will check with your host institution as to **their insurance cover for you** while you are working there. This is known as their *liability insurance*. If we have concerns over the adequacy of this cover and are unable to arrange appropriate independent cover **it may be necessary to cancel your external project**.



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