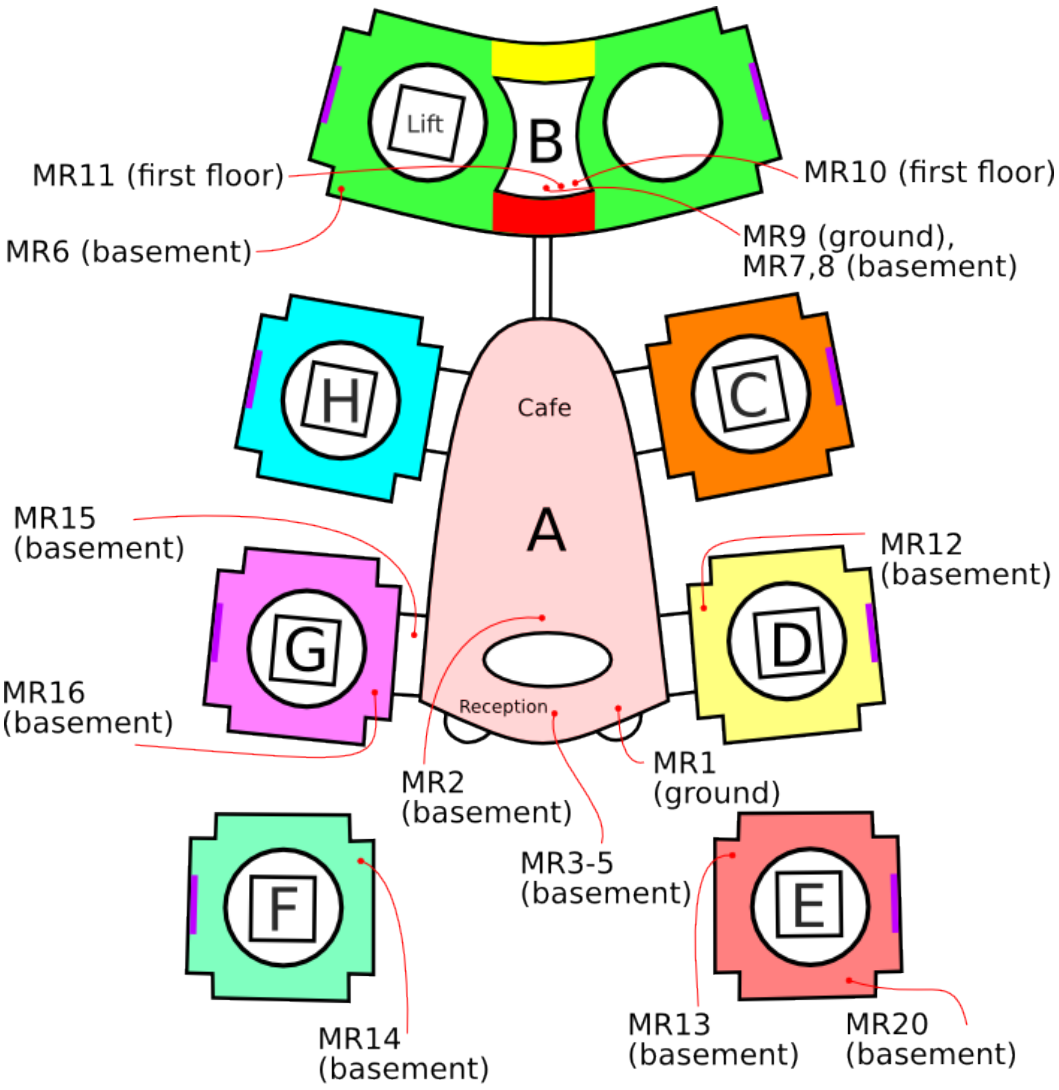
Department of Pure Mathematics and Mathematical Statistics

Research Student Handbook

October 2015


Lift
B
MR11 (first floor)
MR10 (first floor)
MR6 (basement)
MR9 (ground),
MR7,8 (basement)
H
Cafe
C
A
MR15
(basement)
MR12
(basement)
G
D
MR16
(basement)
Reception
MR2
(basement)
MR1
(ground)
MR3-5
(basement)
F
E
MR14
(basement)
MR13
(basement)
MR20
(basement)
Access to MR1-5, MR13-16
is via reception in Pavilion A;
disabled access is via lift
in Pavilion D.
All pavilions except A
have one lift each,
marked above with
squares.
Issac Newton
Institute
Betty & Gordon
Moore Library
Gatehouse

Site plan

Welcome to DPMMS

and congratulations! You probably feel a mixture of proud, slightly anxious, expectant, raring to go and not quite sure about the future as freshly baked DPMMS PhD students. You've all done really well to get this far, and have learned a lot along the way. Now you're going to be doing something slightly different: research. This handbook is supposed to help you start on your research path and give you advice along the way. Read it, and keep it on a shelf for future reference.

You are also very much encouraged to ask your more senior colleagues for help along the way. Older PhD students, Postdocs and also more senior academic staff all once started where you are now, so use their experience and advice. As Graduate Education Officer, I have a particular interest in your well-being, so do come and talk to me too.

Most of all, enjoy your time in DPMMS and make the most of it!

Julia Goedecke
Graduate Education Officer
C1.04
jg352@cam.ac.uk

From the Head of Department

Research is the central activity in DPMMS and graduate students are a significant component. Beginning research can seem daunting and we are keen from the start to provide encouragement and support. This booklet explains procedures and gives information and advice which I hope you will find useful.

The Department works best if the academic staff, postdocs and graduate students appreciate that they are part of one integrated research community and so naturally look out for each other. If at any point you have worries - whether mathematical or procedural - please do not hesitate to ask. There will always be someone happy to help.

Gabriel Paternain
Head of DPMMS

Contents

1 The Course in Prospect

1.1 Getting started

There are lots of parties and gatherings, you meet your supervisor and get told what to start reading, if you haven't been told already, there are the pleasures of induction day, lots of interesting lecture courses to go to, all the more attractive since you will not be examined on them. For those coming back, it is usually a positive and exciting time. For those coming from outside, it can be exhausting, daunting, confusing and often outright discouraging. Expecting it to be so is half the battle in coping with it. Make a deliberate effort to meet and find out who the other research students in your area are. Get involved, both in college life and in activities in the department. Join the Karate club or the choir. Go to the seminars, and hang around for tea afterwards. It may seem difficult to do so right at the beginning, but in fact, it is harder to join in later.

The University supplies PhD students with a copy of its "Code of Practice", also avaliable at his link:

`www.admin.cam.ac.uk/students/studentregistry/current/graduate/policy/quality/cop/`

The code of practice sets out the formalities of life for a research student, and you should read it. Of course, what is described there applies to all PhD students in the University. This handbook complements the University's document: it lays out how some details of University practice are implemented in DPMMS, as well as giving some factual details about the department. On a more personal note, it offers some guidelines about how to cope and to get the best out of your time during your life here.

1.2 Your Working Week

After a life of problem sets and exams which was hard in one way, many people find the adjustment to graduate student life equally hard in a different way. There are no examples sheets, no supervisions, no exams threatening, and little in the way of short term finite time goals beyond "read this paper". It helps to build a framework to your week which includes fixed points (lecture courses, seminars and supervising) to balance the blank periods in which you will be getting on with the job of your own research.

- **The framework:** Aim to work a five day week, forty hours a week. Your main job is your research, so your best working time should be reserved for that. Many people find it difficult to work on research for more than a couple of hours at a time, so that two three hour stretches are often more productive than one eight hour stretch. Figure out what works for you, and try to adopt that schedule as a matter of habit.

- **Where:** Get in the habit of working in the department, at least during the more social hours (lunchtime to 6pm). This matters — see "The Obvious", Section 7. We are really lucky in having a shiny new building in which even graduate students have offices with windows (that open and close of their own accord, but that is another matter). Take some trouble to make your office an attractive space to work. Meeting up regularly for coffee/tea/lunch with others also provides an incentive to be around the department at these times.
- **Your own research:** The job is to become sufficiently familiar with your subject to be able to guess instinctively what might be true, and then use the tools to prove it. For mathematicians, developing effective working habits is a bit like developing practice habits for pianists, or training for a distance runner. The challenges are similar: avoiding getting into ruts and pointless repetition, getting sufficient variety without losing focus, learning to spend the time available in a way which is sustainable and achieves the purpose. For mathematicians as for musicians and distance runners, the subject repays deliberate consideration. Having a variety of small projects on the go, balancing reading with working examples and asking colleagues about techniques or papers all help to provide variety.
- **Lecture courses:** You probably will continue going to one, possibly two, lecture courses during term time. It is a good way to continue learning, including learning subjects of only tangential relevance to your field. It is not difficult in a place like Cambridge to maintain a healthy breadth of interest; work at it.
- **Seminars:** CMS has the potentially lethal luxury of an enormous choice of seminars. It is possible to suffer from seminar overload even when only attending the seminars which are of direct relevance to your own research. The problem then arises that you have little idea what your colleagues are doing, and no chance of the cross-fertilization from other fields which often seeds really interesting research. Moreover, in the beginning it is inevitably going to be the case that you will not understand the seminar talks even if the talk is within your subject.

  Nonetheless, going to seminars is an important part of your job, and you must take advantage of these opportunities, right from the beginning. If the subject is unfamiliar, make note of new words/constructions. At tea following the talk grab a more senior student, and get them to explain. As a first year graduate student you are expected not to know things: take full advantage of this useful status.

  All available seminars should be listed on the department website, as well as on `www.talks.cam.ac.uk`, which also feeds to the monitors around CMS. How should you choose which seminars to go to?

  - **Subject seminars:** Almost certainly you will be part of a research group that has a regularly meeting seminar during term. Make this an obligation, whether or not you understand even the title of the talk. The important point is to talk with people after the seminar, and be part of the group. There may also

be reading seminars or junior seminars. Make these a must and be an active audient: ask if you do not understand, respond if there is any opportunity to contribute. Have questions ready at the end.

- **Reading seminars:** These can be relatively formal occasions in which the major part of a research group share out the responsibility to work through a paper or a book, or an extremely informal one, where two or three students get together to explain a paper to each other. This is an excellent exercise in whatever form it is offered: not only does it make reading the paper orders of magnitude easier, it gives those involved a common topic of interest.
- **General audience seminars:** These range from Colloquia to the Part III seminar series at the end of Michaelmas and Lent terms. This is your chance to broaden your knowledge. The Part III seminar series are particularly valuable as a chance to learn the basics in other areas in a relaxed setting. These are usually accorded lowest priority, but there are several reasons why you should attempt to get to these at least occasionally. First, as mentioned before, it will help prevent your interests from growing too narrow. Secondly, supporting these very useful series ensures that they will still be there when you need such an opportunity.

Your chance to talk. Grab any opportunity. Giving a talk provides a helpful short term goal. The need to find a clear and simple way of presenting the material often generates original ways of understanding it, and sometimes even produces a publishable result. Even if the effort of preparing the presentation does not provide a solution, your colleagues, coming from different backgrounds, may be able to provide useful insight.

- **Supervising:** You will probably do some supervisions for your college, or for your supervisor. As this is often the only teaching experience available to Cambridge students it is a good idea to get the experience. For the necessary training, see Section 5. You will need to allocate time to prepare for supervisions (marking students' work, figuring out how to do the problems) in addition to the actual hours of supervision. There are advantages to putting all supervisions on one afternoon, and supervising more than one afternoon a week begins to be too much.
- **Recreation:** Mathematical research is often frustrating. Going to seminars, supervising, even taking courses provide some relief from the unremitting struggle to understand, but it is worthwhile also pursuing some recreation — sport, music, or other entertainment — to balance the mathematics. If this is a gregarious occupation (team sports, choir or orchestra) so much the better. Exactly what activity you choose to get involved in is unimportant, but it is important to recognise that growing stale and fed-up with mathematics is a real danger, and steps to avoid that should be taken quite deliberately. Choose a suitable antidote to mathematical staleness; make room for it in your schedule.

1.3 Your supervisor

All research students carry out their work under the direction of a supervisor, appointed by the Degree Committee of Mathematics. The duty of your supervisor is to guide your research, and to keep an eye on your progress towards completing your dissertation.

Your relationship with your supervisor is a very important one; this person will play a major role in your life in the next few years. Styles of supervision are very individual, as you will discover. To begin with, the supervisor will guide your reading and assist you in understanding theory. It is important that you keep in close contact with your supervisor, all the more so if you are 'stuck'. As your work develops, your supervisor might perhaps even become involved with your research in a collaborative way.

You should meet your supervisor on a regular basis, which might typically be around once a week in your first year. However, correspondence by email is another vital part of communication. Supervisors can get busy, so it is best to be proactive in your approach: if you need help and your supervisor seems elusive, do not hesitate to seek him or her out! Supervisors vary in their approach, so you and your supervisor should talk about what arrangements will pertain in your own case, so that you both have a clear understanding.

At the appropriate time your supervisor will guide you as to the appropriate conventions of academic writing. It is very important in mathematics to take care to properly acknowledge the work of others, and you will learn good practice from your supervisor.

Your supervisor will be providing regular reports on your progress, that you will subsequently be able to access via CamSIS.

`www.camsis.cam.ac.uk`

We hope that these reports will be helpful and encouraging to you. In the unlikely event that your work is giving rise to concern, the supervisor will alert the Degree Committee and/or the Director of Graduate Education.

1.4 Your adviser

As well as a supervisor you will also have an adviser, whose appointment is overseen by the Degree Committee of Mathematics. This person should have some level of expertise in your area of research but will not have a "hands on" role in your study. However, you are free to contact them for additional advice and, for example, if your supervisor is absent for a while and unable to supervise you, the adviser will probably be the person most likely to be able to help.

In DPMMS, it is likely that your adviser will be one of those carrying out your third term registration review and, when the time finally comes, will be the internal examiner for

your PhD. (In exceptional circumstances, such as when the adviser has become involved with your research, the Degree Committee will appoint a different examiner.)

1.5 Registration

To begin with, the University regards you as being on probation as a PhD student. In order to achieve a PhD it is necessary, though not sufficient, for you to shed this unfortunate-sounding status and become formally registered as full PhD student. This process is initiated in the third term, and involves you preparing a brief report (you will receive instructions in due course), of no more than 1500 words, on the progress of your research. It is unlikely that you will have done any actual research at this stage, but that is no cause for alarm: write about what you have been doing and thinking about, and what you hope to do next. At the same time as you submit this description of your work, you should submit your Researcher Development log to the Graduate Office; this is a record that we ask you to keep of your researcher development (formerly transferable skills training) activities thoughout the year (it does not form part of the registration).

The report will be read by a couple of assessors appointed by the Degree Committee, one of whom is likely to be your adviser. If they are happy with the report (they might, if they wish, arrange to talk to you) then they will inform your supervisor and the Degree Committee. Your supervisor then has the opportunity, when writing their report, to recommend that you be registered. If the Degree Committee are happy with the recommendations then you will become registered. You will hear the outcome eventually but do not worry if you do not hear quickly: the wheels of bureacracy turn at random times and speeds.

If for some reason registration does not take place after the third term, it is no disaster. In this event, you will be informed of the recommendations of the assessors and of your supervisor. The most common outcome is that a further, similar but perhaps more in-depth, review will take place in the fourth or fifth term. The details of the arrangements in your own case will be set out by the Degree Committee. Registration is perfectly possible after a second review, and such a delay in registration has no effect whatsoever on the eventual outcome of your PhD.

1.6 Report and interview

The process of your writing a report and holding a discussion about it has great educational value. It encourages you in the discipline of writing down your work properly, and gives you the (generally very enjoyable) experience of expounding your work to those who have at least some understanding of what you are on about. For these reasons the department regards it as "A Good Thing". We could use such an occasion as a method of registration (as previously described) but the third term is generally too soon in the

development of pure mathematical PhD study for the full value to be gained. DPMMS therefore likes its second year PhD students to submit a report (longer than that for registration) and to meet one or two people (usually including the adviser) to discuss it, say for an hour or so. This process has no formal role and is not compulsory, but your supervisor might well arrange for you to take part in the process, sometime during your fourth or fifth term.

If you were not registered after the third term then such a report and interview might form the basis of another assessment.

1.7 The Prize Essay

With luck, in assembling your efforts for the report and interview, you will have realised that in fact you have made some progress. While it is rare that you will have done enough for a thesis or even a paper, it is a worthwhile exercise to write up such results. The Prize Essays provide additional motivation to do so. The rewards are modest, and the ranking of papers provides often unwelcome comparisons; nonetheless we would encourage you to take advantage of the opportunity, and to do so without attaching too much consequence to the outcome. In terms of experience you have nothing to lose and everything to gain. The deadline is the first day of Full Lent term.

1.8 Between prize essay and submitting

Hopefully the act of preparing the report and interview or prize essay will have revealed profitable avenues to explore, and attempting to frame your own conjectures and write your own proofs will take up an increasing proportion of your time. You will have established a habitual relationship with your supervisor and found sources of support to complement that which your supervisor is able to provide.

Do not be surprised if your work is taking you in a direction away from your supervisor's own area of expertise. This is a normal healthy part of gaining independence as a mathematician. It may however present difficulties, as your supervisor may no longer be the most appropriate person to supply the technical advice you need. If it is becoming a problem, talk to your supervisor, talk to your advisor, or talk to the Graduate Education Officer. It is not an insurmountable problem.

Do not be surprised or discouraged if you feel as if you are getting nowhere. A thesis often depends on one small observation. Even established mathematicians have the experience of chasing blind avenues for months before stumbling on the solution, or even a completely different result than the intended one. Keep coming in to the department. Keep going to seminars and courses. Pay even closer attention to the work of colleagues in neighbouring fields; when the obvious methods don't work, sometimes methods from other fields can be adapted. Keep talking; try explaining what you need to your colleagues. Often the

process of trying to explain what you are looking for clarifies the situation so that you can see what you need.

1.9 Writing up and submitting

For most of you, this should be your third or fourth experience of writing, and indeed much of the background material and even the new material will have been presented in seminars, or written up for reports/prize essays/papers. It may be appropriate at this time to review what the Student Registry provides in the way of guidance through this process.

`www.admin.cam.ac.uk/students/studentregistry/exams/submission/phd/`

Apart for some "Research Best Practice" (including guidelines on issues like collaboration), these pages also tell you practical things like when to apply for appointment of examiners, how your thesis should be formatted, how the submission process works, and give a copy of the declaration you will have to sign when you submit your thesis.

At this point we should remind you again of the problem of plagiarism: read the University's statement at

`www.admin.cam.ac.uk/univ/plagiarism/students/statement.html`

2 Support Systems

2.1 The department

DPMMS hopes very much that its PhD students have a great time doing mathematical research, but we know that the reality can sometimes be not quite so enjoyable. When times get hard there is a danger that you feel as though you are on your own. It is then important that you do not withdraw; remember that we are keen to support you and are committed to your welfare.

The most important person involved in your research is your supervisor, and you should make every effort to talk to them regularly, especially if you are finding things tough. They will quite likely be able to offer advice and encouragement.

A second port of call is your advisor. Though not generally involved in your research, they will be willing to talk to you about it, especially if you are finding life tough.

You are also encouraged to talk to the Graduate Education Officer, Julia Goedecke. It is Julia's job to see that you are all able to work to the best of your abilities and to encourage you to get involved in the life of the department. She is in charge of developing the programme of Researcher Development, and has the responsibility of seeing that you all get the training you need. Beyond that, her door is open: She will happily listen in confidence to problems arising within or outside of the department.

Also available is the Director of Graduate Education, currently Andrew Thomason, who is responsible for the smooth running of the PhD programme. In the (hopefully rare) case that you have exhausted the previous possibilities, then talk to him. This includes the case when you feel unable to talk to your supervisor or advisor. He will be happy to discuss things with you and try to find a way forward. This same route should be followed if a student has some formal complaint.

The Director of Graduate Education will also become involved in the antipodal case when your supervisor has serious concerns about your progress, generally indicated via the CamSIS reports. In such circumstances the director will consult with all parties and arrange a meeting with you, your supervisor, and perhaps your advisor, as appropriate.

2.2 Your College

If you have been here as an undergraduate, you will only be reading this section out of idle curiosity, having already experienced what college life can offer. To those coming from outside Cambridge, the purpose of college may seem obscure. It can be a very useful support system, but like many such systems, it will work best if you figure out how it works before you need its help. Colleges offer the following, in addition to accommodation and occasional dinners.

1. Tutor. This person is responsible for welfare issues. For example, sometimes colleges can help with funding, for anything from travel expenses to a conference to part or all of an additional year in which to finish your PhD. If the college is not rich, the Tutor might at least be aware of sources of funding — he or she will certainly have been asked for funds before! It may happen that you need support for personal problems, the need to take time off to return home because of family crises. Along with the Director of Studies, tutors are very helpful in negotiating with the Student Registry and the Department, if need be. Your tutor will almost certainly have some sort of party to welcome you. Take advantage of the opportunity and talk to him/her. It is always much better to get to know a person before you come knocking on the door for help.

2. Director of Studies ("DoS"). This person (some colleges have more than one) is mainly responsible for the mathematics undergraduates in your college. The DoS is almost certainly a member of DPMMS or DAMTP and will be familiar with the set-up of research and PhD students, even if not with your own subject area. This is the person to talk to if you want to supervise undergraduates; of course, you don't have to supervise students of your own college, but it is polite to offer before taking up other sources of students. They may also become a useful ally.

3. The MCR. It is very refreshing to escape from CMS at the end of the day, and talk to people whose lives are significantly different than yours. Hearing about the traumas experienced by those who live their lives in fume cupboards or who have become fixtures in the UL puts a day of failing to read a paper into perspective. Take the time to develop friends within the community.

4. College societies. Taking an active role in sport/music/drama is an effective antidote to TooMuchMaths syndrome.

If you are a newcomer to Cambridge, you will have to make an active effort to get involved. Just Do It.

2.3 Your peers

They may know what you need to know, and it will be easier to learn it first from them, before trying to read it for yourself in a book or paper. They often make the best audience when trying out your latest idea, and you will learn a lot through listening to their ideas. Make a deliberate effort to talk to the other PhD students; ask them what they are working on, ask them to explain constructions which may have been referred to in seminars, or in books.

2.4 The Counselling Service

Student life is stressful. A lot of the problems students have arise in response to particular difficult situations: problems with supervisors, money, research going wrong, as well as social problems, relationships and isolation. The Counselling Service has lots of experience, and offer a sympathetic, experienced and professional ear to those who for whatever reason are finding the going tough. Graduate student life is particularly tough; there is no shame in needing a helping hand on occasion, and they are good at sorting things out. If things are getting out of hand, don't hesitate, give them a call. `www.counselling.cam.ac.uk`

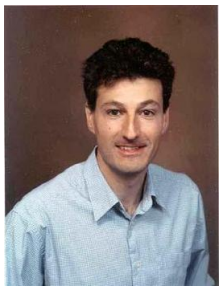
2.5 Careers Service

As a Cambridge student, you are entitled to use the Careers Service to help you with all sort of aspects of applications: finding out what to do after your PhD, going over CVs or cover letters, practicing interviews, to name but a few. Register with them and talk to them, well before you are thinking about applying to jobs. Quite apart from the fact that they are a friendly group of people, there may be more scope for your particular skills and interests in the working world than you imagine, and you may wish to shape your studies to take advantage of this. `www.careers.cam.ac.uk`

3 The Main Characters

Those who will be of chief importance to you in your life in the department are your supervisor, your colleagues, your advisor, and the other members working in your area. Beyond these, there are some who have particular roles.

Heads of Departments



Gabriel Paternain

James Norris

You will have become aware already that DPMMS divides into two halves, Pure Mathematics and the Statslab. James Norris is in charge of the Statslab, and Gabriel Paternain is Head of DPMMS. If there are problems within the department which supervisors or the Director of Graduate Education cannot sort out, these people are your ultimate resource.

Director of Graduate Education - Andrew Thomason

Andrew Thomason as Director of Graduate Education oversees the smooth operation of the PhD programme. If you have a problem which cannot be resolved by your supervisor or adviser then you can talk to him about it. If in doubt, talk to him anyway.

Graduate Education Officer - Julia Goedecke

Julia Goedecke

Marj Batchelor

It is Julia's job to see that you are all able to work to the best of your abilities and to encourage you to get involved in the life of the department. She is in charge of developing the programme of Researcher Development, and has the responsibility of seeing that you all get the training you need. Beyond that, her door is open: She will happily listen in confidence to problems arising within or outside of the department. Her office is C1.04, she publishes open office hours on her website and office door (different each term), and she can be reached best by email (jg352). Julia took over from Marj fairly recently, and you will also see Marj around the place: she was Graduate Education Officer for almost 10 years and also has a friendly ear.

Graduate Office team

Sarah Dodd runs the Faculty's Graduate Office and is located in C0.14. She can be contacted at `grad-administrator@maths.cam.ac.uk`. The Graduate Office team is based in C0.15 and should be your first port of call for administrative matters. The office can supply you with forms to apply for conference funding, advice about training opportunities and submission of your thesis, and help with any other admin processes. This office will initiate your registration (see Section 1.5) by telling you when to start preparing your report and tracking the progress of the whole operation. You should also give your researcher development logs to this office each year. Within the Graduate Office **Tessa Blackman** acts as the named contact for DPMMS PhD students and can be contacted at `purephd@maths.cam.ac.uk`, but any member of the team will be willing to help with your enquiries. Specific Researcher Development questions can be emailed to `researcherdevelopment@maths.cam.ac.uk`.

Department Administrator - Eva Roberts

Eva is the main Department Administrator. She is the principle contact with the Board of Graduate Studies, and Secretary of the Degree Committee. She can give you advice on finances available for conferences or other research activities, and later in your time here

on the submission of your thesis. Eva can also help you understand and deal with some of the more tricky regulations. The administrative structure of Cambridge University has evolved over 800 years and is complex: Eva is your best guide. Her office is C1.20, and you can email her under `dpmmssec@dpmms.cam.ac.uk`.

Others whose acquaintance you will want to make

- **Julia Blackwell** She looks after Pure Maths and the Statslab. She is a good starting point, knowing where to find the answers you may be looking for. You should be able to find her in C1.01.
- **John Shimmon** He is the port of call if you want to get your hands on some unusual stationary or if you want to arrange tea and biscuits after a junior seminar you might be organising. Look for him in D1.17.
- **Head of CMS Facilities management - Mick Young** This is the man who knows how the windows work. He is also a good person to find if you have any queries about the facilities. Phone: 66915, Email: `facilities@maths.cam.ac.uk`

4 An Active Role

The image of the brilliant mathematician working in splendid isolation free from responsibilities as well as colleagues is no longer accurate (supposing it ever was). Working mathematicians these days are members of a department, and usually members of a working group. You are members of the department, and share with your more senior colleagues the responsibility of making the department a stimulating place to come and work. We depend on your willingness to offer to serve in ways that we hope are congenial to you. Specifically, we rely on PhD students to run various activities which enrich life at CMS. The experience you gain in taking on these responsibilities is also a part of your education, and counts towards the fulfilment of the Transferable Skills Training component of your degree. It also looks good on your CV.

Responsibitilites

Part III seminar series

These take place in the 8th week of the Michaelmas and Lent terms. The Part III students are given the opportunity to give talks (30 minutes in Michaelmas term, 45 minutes in Lent term). About 50 students take part in each series. The Part III students are grouped according to subject, and each group is led by a graduate student whose responsibilities include encouraging the students individually in their preparations, and running the session and encouraging discussion on the day. Part II students are specifically invited to go to the Michaelmas term series, thus giving them a chance to talk to those who are already doing Part III. Two students, one from DAMPT and one from DPMMS, act as joint Directors for each series. The logistics are formidable and the responsibility is considerable.

Part III Drop-ins

The purpose of the Part III Dro-ins is to ensure that incoming Part III students, particularly those coming from outside Cambridge, get the assistance they need when they need it (as soon as they arrive) to ensure that their year gets off to a good start. Graduate students make themselves available to help with questions about lecture material and background, as required. Where further help seems to be needed, you can help those unfamiliar with the Cambridge system to arrange supervisions through their colleges.

Catch-up Workshops

The incoming Part III students each year have very different backgrounds. To give those who need it the chance to catch up on necessary background material, we give several catch-up workshops on subjects such as Algebraic Topology, Commutative Algebra, Probability and Measure, General Relativity, ... in the first week of lectures. These are given by PhD students, and are a good chance to practice lecturing; especially for those who may want to apply to academic positions in the USA, this is essential experience. The whole series is organised by a PhD student, who is asked to find the volunteers to give the workshops and make the time-tables.

Research in UK Afternoon

During Michaelmas, the Part III students are told all about how to apply for PhDs. Part of this is an afternoon where students from other universities are given the opportunity to talk about their research groups and departments. The Cambridge research groups of course also get their chance to introduce themselves at a different point during term. This requires organisation, which is undertaken by research student Directors. It is also an excellent opportunity to network with colleagues at other universities. Even if you have no official role in it, do come along. This year (2015) it is on Thursday 12 November.

Research Groups in Cambridge

At some point during the Michaelmas term there will be an occasion when your research group will encourage interested Part III students to come along and meet the members of the group and learn what projects they are working on. Even though you are new to the group, it is important for the Part III students to identify you as a member of the group, and someone they can talk to about the subject. It is also may be your own best chance to find out what others in the group are working on.

Cambridge University Graduate Mathematics Society

CUGMS (Cambridge University Graduate Mathematics Society) is the society that handles student-run activities, both of a social nature (for PhD and Part III students) and of a para-academic nature (mostly geared towards Part III students). Its funds go to support activities ranging from Pizza and Film Nights to small conferences. The society website

`www.srcf.ucam.org/cugms/`

has a calendar of events and various forums for discussions; it is also used to organise Part III seminars and other activities. The society depends on volunteers to serve as officers

of the society (President, Secretary, Junior Treasurer, Part III coordinator, Transferable Skills Officer, and Webmaster), or to help organise events such as the Part III seminars or catch-up workshops for Part III students.

And a whole lot else ...

which makes life in the CMS interesting and exciting, and which depends on you. This includes the Young Researchers in Mathematics organisation which runs research student conferences, in the past in Cambridge, Bristol, Warwick and Glasgow; the Junior Algebra/Number Theory/Combinatorics (Anything Else) seminars; various good-luck for exams and farewell parties for the Part III's; the induction day, and lots of other events.

5 Researcher Development

The purpose of graduate study is not just to produce a brilliant mathematician and a first class thesis, but also to learn the skills which will allow you to have a successful career, whether in research and teaching, or beyond academia in a whole range of different jobs.

Whatever your abilities, your effectiveness as a mathematician will depend on skills that have nothing to do with the subject: without the ability to give good talks, write clear papers, negotiate with other department members, teach, run a research group, encourage others, your ability to contribute to the mathematical community will be limited. We have a responsibility to provide opportunities to learn and develop these skills. You are expected to spend approximately two full working weeks each year in acquiring and developing these skills. You are required each year to describe what you have done by way of developing these skills. In June you will be asked to complete and return a form giving the details of these activities, so please keep a record throughout the year of what you have done.

The policy within CMS has been to give students the opportunity of developing their skills through taking on real responsibilities within the departments, supported appropriately by more formal training. Courses and opportunities are provided by DAMTP and DPMMS and the School of Physical Sciences, both at CMS, elsewhere in the University and nationally. These will be advertised by email throughout the year, so keep an eye out for them.

Communication Skills

1. **Giving talks**

   Training: For those who didn't have the chance to take part in the Part III seminar series, which begins with a formal session on how to prepare talks, there is the opportunity to go to that session, and those who would like to serve as group leaders for the Part III Seminar Series are strongly encouraged to do so. In addition, there are short training courses provided by the University, which while aimed at a broader audience, may still be of interest. Those serving as group leaders for the Part III Seminar Series receive training in the form of briefing sessions before the series, and a debriefing session following.

   Experience: Many of you will already have had the opportunity to give talks. Like many other skills, it requires practice. We aim to provide opportunities for you to get experience in speaking in a variety of contexts. Many groups have more or less regular junior seminar series, notably Algebra, Geometry and Category Theory. Number Theory has for years run Reading Seminars. Serving as a group leader for the Part III seminar series is in itself excellent training in the art of giving good talks:

providing assistance to those engaged in preparing their first technical talk, and observing their success and shortcomings develops one's own abilities. In addition, taking part in conferences, giving talks and presenting posters at conferences are all good experience.

2. **Writing**

   Training: Writing courses are offered by the University. Sometimes there are courses held at CMS which are especially tailored for mathematics; keep your eye out for emails advertising these.

   Experience: Formally there are three occasions where a graduate student can expect to get experience and feedback on their writing: the 4th term report, the Prize Essay, and the PhD thesis. In addition, students will be writing research papers, and can expect help in preparing those. Clearly it is a good idea to take advantage of every opportunity, even though writing does require time.

Computing

Selected graduate students are available within the Statslab to help with using statistical packages. The computing service also has a very full programme of courses on offer, including courses on LaTeX and MATLAB, for example.

`www.cam.ac.uk/cs/courses/`

Teaching and mentoring

You will want to do some supervising during your time here. You are required to get appropriate training. The dates for courses this year are Thursday 8th October, Thursday 15th October, Friday 23rd October 2015. The first of these is particularly aimed at those who were undergrads in Cambridge and the second is aimed at those coming from outside, with the third acting as over-spill catch. If you cannot make the session aimed at you, it is no problem to go to another one, but it will be more helpful if you try to go to the appropriate one. In addition to supervising, we encourage you to serve in a very informal capacity as mentors for the Part III students. The principle activities are serving on the Part III Drop-ins and as group leaders for the Part III seminar series. To get some experience in lecturing, you can give one of the Part III Catch-up workshops. The briefing prior to these activities and the post-mortem following are an essential part of your training. Giving examples classes for a Part III course is another good way of gaining experience in another style of teaching. Another different style again can be experienced by being part of the STIMULUS project, helping out in schools. You can find out more here: `stimulus.maths.org`. The training sessions are held in CMS. Registration deadline in 2015 is the 9th of October.

Running things

Most of you will go on to roles where you will be in charge — running seminars, exchanges, workshops, research groups, departments, even universities for all we know. We do our best to ensure that the great majority of you can list experience of least one Director's role when you are writing your CVs for jobs following your time here. There are many activities within the department (see for example Section 4) which require student Directors. In addition, you are very much encouraged to run your own projects. The Graduate Maths Society provides a framework, as well as a limited source of funds.

This is one aspect of your training that the Education Officers past and present feel strongly about. In our experience, mathematicians have very good ideas. A small amount of experience is sufficient to enable you to convert these ideas into action. We are very keen to see that you get that experience while you are a student. It is for that reason that we have appended the final Section 8. Read it. Do offer to take on Directorship roles. Do implement your own ideas.

The Cambridge University Skills Portal

The University has a website dedicated to the provision of Transferable Skills Training:

`www.skills.cam.ac.uk`

Under "Training Opportunities" you will be able to search for courses by subject, and enrol in courses online. You are strongly encouraged to have a browse and take advantage of the opportunities provided.

6 Practical Information

This section contains a collection of useful information of various kinds. It is (hopefully) ordered alphabetically.

Bicycles There are cycle racks at several points around the CMS site - please use these. A good lock is a necessity! Please take care not to lock your cycle to neighbouring cycles. Cycles are not allowed inside the buildings or inside the courtyard between the Gatehouse and Pavilion A.

Cars Unless you are registered disabled (and even then a place cannot be guaranteed) you will not be allocated parking.

Catering Facilities and Common Rooms The café in the central core is open from 9am to 4pm for snacks, light lunches and coffee and tea. Outside these hours there are coffee machines in the common room in each pavilion and vending machines in Pavilion A. Each pavilion has its own common room with fridge, kettle, microwave and coffee machine, which can be used as long as they are left clean. Please wash and clear away any crockery and cutlery after use. The refrigerators should not be used for long-term storage of food as space is limited. Milk and sugar are provided.

Children The University offers some help with childcare; you can find details here:

`www.admin.cam.ac.uk/univ/childcare/`

Children brought onto the site should never be left unaccompanied. Children under secondary school age are not allowed on the roof. Children should not be brought into the site routinely — the buildings are not designed and above all are not used with their safety in mind (e.g. building work, doors with automatic closers, congested car park, etc). Anybody bringing a child into the site is responsible for that child's safety whilst he/she is on the premises.

Computing For information about your departmental computing services please check the computing web pages `www.maths.cam.ac.uk/computing`.

For help and support with computing please email `help@maths.cam.ac.uk` / Ext. 66100

Health and Safety It is important that your computer monitor is running at the correct resolution for you. Please contact `help@maths.cam.ac.uk` if there is a problem.

Please contact the Computer Officers about moving computers.

Disabled Students The building was designed for universal access but please contact Mick Young (66915) for advice on your detailed access requirements. For the full range of support available via the Disability Resource Centre, please see their website at

`www.admin.cam.ac.uk/univ/disability`.

Equality and Diversity The Mathematics Faculty is committed to creating and maintaining an environment for work, learning and research which is free from discrimination. It is expected that all members of the Mathematics Faculty (staff and students) will treat each other with respect irrespective of, for example, race, disability, religion, gender or sexual orientation. If you have concerns about any such matter, you are encouraged to approach, in confidence:

- either one of the Faculty Equality and Diversity contacts:
  - Stephen Eglen, sje30, office G0.05,
  - Orsola Rath-Spivac, or100, office G0.09,
- your College Tutor.

Faults Report faults in your room (radiator or lights not working) to the Facilities Team by emailing `facilities@maths.cam.ac.uk`. Serious faults that may affect the safety of occupants or security of buildings should be notified immediately during office hours to Reception (65000) or, if out of hours, to Security (31818).

Fire Safety In the event of the fire alarm sounding, leave the building by the nearest exit. Do not re-enter the building, even if the alarm has been silenced, until advised to do so.

The external doors do not open automatically for security reasons; exit in the normal way. Assembly points are shown on posted site plans and Fire Wardens will direct you. Do not attempt to enter another building if the alarm is sounding there also.

In an emergency, and in the event of doors failing to open, break the glass in the green break glass boxes located alongside each door. Please report this to Reception/Security, as the doors will remain unlocked until the glass is replaced.

Fire alarms are tested in each building every Wednesday morning between 08:30 and 09:00. The alarm will sound for only a few seconds and for this brief period only it can be ignored; if the alarm continues to sound please evacuate the building.

First Aid First Aiders may be summoned via Reception (65000).

If an accident occurs outside normal office hours, telephone Security on 31818. The emergency number for FIRE, POLICE or AMBULANCE is via Security on 101, or 1999 on any network phone. If you do have an accident, please ensure that you complete an accident form.

The University is not insured for theft of, or damage to, your personal property while you are on University premises, so if you bring a computer with you, you should take out insurance for it. The University is insured for accidental personal injury to staff, students and visitors while they are on University premises, but only where the accident was due to fault on the University's part.

Keys A key to your office is obtainable from John Shimmon (C1.19) on payment of a returnable deposit of £10. Keep your office door locked at all times when the room is unoccupied. Do not leave any valuables unattended.

Mail and Fax Services Long-term members of the Department have their own pigeonholes; others (including research students) have shared pigeonholes allocated by first letter of surname. The pigeonholes are on the ground floor of Pavilion A, near to Reception.

Outgoing mail should be placed in the trays in Reception, before 4pm on weekdays. A University Messenger Service circulates between the University's departments and Colleges. Mail is collected by the UMS daily, and needs to be in the trays in Reception by 11am. There are no mail services at weekends. Please ask Reception if you have any queries.

Phone To obtain an outside line, it is easiest to dial the area code (e.g. 01223) first (or you can try dialing 9 first for local numbers). Student phones are restricted for outgoing calls to national calls only. University numbers are mainly 3nnnn, and outside callers have to prefix another 3 to the number. For those numbers starting with 6nnnn, callers from outside need to prefix with a 7.

Photocopying and Printing There are photocopiers in each pavilion in the stationery rooms: C1.17, D1.16 and E0.23. Some of the photocopiers can also scan: both in C, and one each in D and E.

Printers are dotted around: have a look where the nearest one to your office is, and remember its name (which should be written on it), so that you can find it in the list of printers when you want to print. If you have problems with printing, contact the Computer Officers `help@maths.cam.ac.uk`. If you need more paper to put in a printer, go and have a look in one of the stationery rooms.

Safety Mick Young (66915) is the Site Safety Officer for CMS. Please contact him if you see anything giving cause for concern. Please also note the CMS safety policy which you can find at `www.cms.cam.ac.uk/safety/safetypolicy/`.

Reports of accidents and incidents should be made to Reception in the first instance, where suitable forms for the purpose can be obtained.

Security Individual pavilions are usually locked but visitors and undergraduate students may enter via Reception (open from 08:20 to 17:30 weekdays and 08:30 to 13:30 on Saturdays in term time). Doors should not be held open, or the alarm will sound.

You need a University Card to unlock exterior doors and interior doors outside core hours. Keep your card on you at all times.

Your College is responsible for providing you with a University Card, but it will need activating to work at CMS. Ask at Reception for activation of your card; normally these can be programmed while you wait. If you wish to have out-of-hours access to the Betty and Gordon Moore Library, you will also need to take your card there for programming.

If you lose your card, report it immediately to Reception (65000) or email `reception@maths.cam.ac.uk`.

Do not let strangers without keys or entry cards into the buildings and do not move computers without contacting the Computer Officers.

Seminars Lists of forthcoming seminars within DAMTP, DPMMS and the nearby Isaac Newton Institute for Mathematical Sciences are displayed on the large CMS screens, on the department webpages and also on `www.talks.cam.ac.uk`.

Smoking There is a No Smoking policy applied to all buildings at CMS. Please do not smoke near entrances to buildings or near to windows and vents; use the ashtrays provided.

Stationery There are stationery rooms in each pavilion: C1.17, D1.16 and E0.23. If you need anything which is not provided in these rooms, talk to John Shimmon (D1.17).

Travel Expenses The department normally pays up to £500 for your first conference, and any other conference should be applied for and will be decided on a case-by-case basis. For any conference (also the first), you should apply before you commit to any expenditure. The relevant forms are available from the Graduate Office: first use "Application for approval of travelling expenses for research students" which has to be supported by your supervisor. If it is approved, you will receive an email confirmation. Then when you claim

after your trip, you should use "Expenses incurred on University Business: Application for Refund". If you claim travel expenses, you are required to produce original receipts for all items. You should always ask your College whether they can contribute to your expenses as well.

Travel Insurance If you are travelling on University business, for example attending a conference or seminar, you must take out the University's travel insurance policy. This is a single trip policy and can be obtained on-line at

`www.admin.cam.ac.uk/offices/insurance/travel`.

Women in Maths The female mathematicians at all levels, from Part III students to University Officers, meet in an informal group several times a year, usually at lunchtime. For support, advice or just a chat, contact Rachel Camina (rdc26) or Marj Batchelor (mb139) from DPMMS, or Carola Schönlieb (cbs31) or Helen Mason (hm11) from DAMTP. You may also want to have a look at the faculty's Women in Maths pages, which link on to the Athena Swan pages and some profile of female mathematicians in CMS, amongst other things.

`www.maths.cam.ac.uk/womeninmaths.html`

Useful links Some useful links are:

`cugms.soc.srcf.net/`	Cambridge University Graduate Mathematics Society
`www.admin.cam.ac.uk/students/gateway/`	Lots of info and links to other CU pages
`www.cusu.cam.ac.uk/societies/directory/`	CUSU societies directory
`www.admin.cam.ac.uk/students/studentregistry/`	Student registry
`www.careers.cam.ac.uk`	Careers Service
`www.skills.cam.ac.uk`	Skills Portal
`www.admin.cam.ac.uk/offices/accommodation`	Accommodation office
`www.admin.cam.ac.uk/offices/safety/`	Health and Safety

7 The Obvious

Assorted comments on community and mathematics by Marj Batchelor

Of Elephants and understanding

Many cultures have the story of the group of blind men, who, on learning that a menagerie including an elephant has arrived in town, request permission to pat the elephant. The keeper obliges, and the men descend upon the elephant. "An elephant is like a wall" says one patting the animal's side. "Can't be, more like a tree" says the next grabbing the elephant's leg. "A tree? Nonsense, it's a sort of spear" says the one holding the tusk. "You are all wrong, it's a hose." "Can't you see, it's a rope." The opportunity degenerates into profitless bickering.

The elephants we seek to understand no one can see. We struggle through examples to gain the intuition that allows us to conjecture the tree, the spear or the rope. We are certainly not likely to take kindly to the suggestion that we are wrong, that it is in fact the wall. There are two common responses to this situation, one being to deny loudly all other opinions, the second is to keep one's own opinions to oneself to avoid conflict. Neither is particularly helpful in the quest to chart the characteristics of elephant. A third response, to collaborate, piece together the tree, fan, tassel and hose to conjecture elephant requires a robust and effective community well practised in the matter of collaborating on lesser projects.

Mathematics is much much harder to describe than elephants. Developing the habits of communication which will make collaboration possible requires deliberate effort, and it is perhaps wise to start on simpler matters, like playing backgammon, working together to run Part III seminars, helping out in the Part III cafe and supervising. This is why the problem of community deserves your deliberate attention, why I have gone to the trouble to create such opportunities, and why you should choose from among them or find for yourself your own way of becoming involved and contributing to the life of the community.

Why not just read and work on your own? Reading is indispensable. But (as in attempting to read any foreign language in which you are less than fluent) it helps to know the story line first. Clues like "it's very like a wall" prove invaluable, even if, when examined closely, they defy clear definition or are even outright incorrect. The time saved by getting colleagues to explain the theory first is considerable. Getting several colleagues to talk about the ideas is even more valuable. Piecing the theory together from different perspectives has obvious advantages. Moreover, the input from those whose perspective differs most markedly from that of our own often proves the most valuable. It requires great patience on both sides to process the clues from these outlying sources. Take the trouble to give communication every chance.

The importance of the unlooked for

While the majority of mathematical experience that goes to furnishing our intuition comes from the deliberate mining of information from books and other people in the way described above,

the really exciting often comes from the chance encounters. Every mathematician will have their favourite story of a chance conversation that resulted in a paper, a collaboration, or a whole new field. It requires effort to cultivate the conditions in which the improbable is likely to happen. Make that effort.

This is also one of the reasons why simply reading is not entirely a satisfactory substitute for asking others to explain things. When you choose a paper or a book to study, it is likely to be one directly related to the problem you are working on. People on the other hand have an element of unpredictability. The extraneous comment might just provide the critical clue that you weren't even looking for. One of the essentials of mathematical community is to provide the conditions where such random exchanges can take place.

Of Space and Time

If paths do not cross, ideas will not either. Bluntly put, if you are not in the department, you are not likely to meet other mathematicians, and very unlikely to have useful conversations with them. The fusion of ideas requires confinement, some magnetic force that drives mathematicians into the same place at the same time, so that useful accidents can happen.

In the old department in Mill Lane life was cramped, shabby, and simple. Coffee was available from 10:45 to 11:15, tea from 3:45 to 4:15. "I'll catch him at coffee" was a plan with a reasonable chance of success. It was a fair certainty that anyone who was in the department would be in the common room during that time. The bottom line of human nature (even for mathematicians) is tea and biscuits.

The cafe in the core, open most of working hours has changed that, as has our gracious lifestyle in self-contained pavilions. There is no one place and time where there is any great likelihood of meeting up with everyone. Working at the tables in the core is not a bad way of catching people, but those caught that way are usually in a hurry going somewhere else, and not inclined to chat. Those in Pavilion C might be unaware of the existence of those in Pavilion E and conversely. The Statisticians are rather better concentrated in Pavilion D, with many still retaining the habits of regular feeding times. But that useful bottleneck in the traffic of our lives, the queue for tea, is a thing of the past.

It is therefore up to individual working groups to establish new watering holes and habits of frequenting these. Time after working group seminars is clearly useful. Some groups meet for lunch, or for coffee or for tea. It can and does work, but unlike the Old Days, Arrangements must be made. The physical environment no longer shapes the patterns.

The shape of a department

Who is your colleague? It is an interesting exercise, to sit down with the names and research interests (as listed on the website for example), and construct a simplicial model of those interests. Take a vertex for each of the n members of the department. The simplicial set representing the shape of research areas is the subset of the $n-1$ simplex, with faces being present if the members share a research interest.

The (closed) star of your vertex is your primary concern. What shape is your star? What is a good shape for a research star? Some careless generalisations can be made.

Compare this with your actual working group, the people you interact with, people whose research interests you could probably describe. This might be five or it might be thirty, that is not important. Who are these people? How do they compare with the set of people in your star? There several obviously less than optimal arrangements.

If your working group is restricted to your star and your star is very small — maybe it is an area which is not very well represented in Cambridge — you may find yourself seriously short of the regular input of other people's ideas. Even if your star includes many vertices, if all those members have but the one interest in common (the closed star is also open in the worst case) it is still possible to become dangerously isolated. In both cases deliberate action to extend your group to include members in some nearby fields is required to improve the situation.

Finally, how many of those in your star do you know? Do you know what they do? The aim should not be to gain encyclopaedic knowledge of these related areas, but to become a very efficient index to what is known by whom. A lot of breakthroughs start with the words "You should go talk to..."

"Why?" — About questions and not about answers

It is commonly supposed that the reason people ask questions is to get answers. Perhaps, but the value of questions goes well beyond any information which might or might not come back by way of reply. Questions are an invitation to contribute, an implication of respect, and an assay into the possibility of collaboration. The actual answer may turn out to be of relative unimportance compared to the opening of a regular exchange of ideas.

Moreover, questions are generally positive and non-flammable. Consider the discussion of the blind men on the subject of the elephant. Had they been restricted (as in the game between Rosencrantz and Guildenstern) to the interrogative, would it have been possible for them to have ended up in an argument? Asking (non-rhetorical) questions implies a willingness, perhaps even an eagerness to consider the answer. This willingness is the essential for dialogue; the question flags an openness to continued conversation. One of the rules in the Part III seminar series is that all participants must be prepared to ask a question at the end of the talk, even if the question is simply "I got lost at the second line. Could you give the definition of ... again?" It gets people talking. That is the point.

Many mathematicians can testify to the effectiveness of the technique of thesis by interrogation. They meet with their supervisor one week, eagerly make note of suggested lines of investigation and retire. The following week they return, having cleverly recast the suggestions of the previous week into questions, which the supervisor then happily answers. Or perhaps these questions are directed towards friends and other senior colleagues. But the usefulness of questions is not limited to situations where you are the junior partner in the matter. Those working in the Part III Cafe, or acting as group leader for the Part III seminars, or even supervising, will become quickly aware of the value of being able to ask the right questions. When you are the senior partner, a wide repertoire of variations on the theme of "So where does it all go wrong?" is

extremely useful. If you ask the first question, the junior partner gains the courage to reply with information that might not have been willingly volunteered otherwise.

"Taking fun as simply fun and earnestness in earnest..."[1]

It is surprisingly difficult to do good mathematics when you are having a miserable time. Make time to have fun. If that involves others in your working group, so much the better.

Enjoy!

[1] ... shows how thoroughly thou none of the two discernist." Piet Hein, *Grooks*

8 Appendix I — How To Run (a project)

Base training notes for first time directors by Marj Batchelor

Ideally, all PhD students would have the experience of directing a project. It might be one of the regularly scheduled projects during the year (Part III café, Part III seminar series, for example) or maybe you and a few others come up with an idea for a project that simply might be fun. You do not need to wait until your elders and betters arrange matters for you, you can do it yourself. Moreover, if the project falls within my remit, it might even be possible to support your project with transferable training funds. One example might be YRM satellite meetings — groups of PhD students from different universities meeting regularly (maybe once a term). Use your imagination.

Seeing a project through from idea to completion is a most satisfying experiences. These notes are distilled from thirty years' experience of making things happen.

- **You Can.** The first step is to understand that you can. Even as a graduate student: you do not have to wait for others to organise a project on your behalf.
- **Get at least one partner to share the organising.** Two is good, three is good, four is beginning to resemble a committee (difficult). Projects work better if they are well thought through from the beginning. It really helps to have someone who is as keen on the project as you are to listen to the plans, contribute their own and shoot down unworkable ideas. This last function of course hides a sticky point. Nobody likes having their ideas shot down. However, it is essential that the partners in the project can voice their ideas and even veto your own: this is a vital role. If you realise this from the start, there is a better chance that the collaboration will result in a successful project and not the destruction of a previously flourishing friendship.
- **Small is good.** The success of the project will not be judged by the number of people engaged in it, but the effectiveness of the project from the point of view of those who took part. If you are thinking of organising a workshop, for example, four participants might seem a small number perhaps, but often a one day meeting, in which four people give talks that everyone really tries to understand, with plenty of discussion during the breaks and a good evening to follow is more likely to generate good mathematics than a week of attendance at barely understood boasting sessions. Plan for small. If more people want to join in, fine.
- **The plan: avoid godbolts.** The rotors of a helicopter are attached to the body by a joint that for obvious reasons has been given the nickname of godbolt: failure is likely to be catastrophic. In designing a project, avoid such critical steps wherever possible. For example, in running the Part III seminar series, we try very hard to arrange the groups so that if a student drops out (or wishes to join in, it has happened) the group still is of a viable size, and the schedule will likewise permit of expansion or contraction. We usually have two people directing a project, so that (as has happened) should one be ill on the day, there are others informed and able to take on mission critical responsibilities.

- **People are quantum**. Nobody can honestly promise without fail to fulfil his or her responsibilities. Inevitably, some people are more likely to be reliable than others. This is often a source of fatal frustration in trying to run a project. This frustration can be significantly lowered if you accept from the first that a promise or a commitment is only a probabilistic statement.

- **The volunteer.** Do not expect to be overwhelmed with volunteers in response to a general e-mail shot calling for assistance in running your project. People just don't do that. On the other hand, as director of a project, you certainly may, and probably will approach people directly and ask if they would be happy to take on some responsibility. The etiquette here is to make quite sure that the person you are asking can say no. One easy way to ensure this is to preface your request with the explicit statement that "no" is an acceptable answer.

- **Suit the project to the demand.** If you find that you not only get insufficient spontaneous volunteers, but even polite direct requests do not return a sufficient number of positive responses to run the project as you have imagined it, reconsider. Unwilling helpers are generally worse than no helpers. Reduce the scope of the project, rework it, or accept that the time is not right. Some good ideas may not be workable from the present background. It doesn't mean that you are not a good organiser, or that the idea was in itself flawed. It just didnt fit with the desires of those present.

- **The importance of the back desks.**[2] This lesson comes from my experiences with children's orchestras. Within the string section there are usually a few identifiable stars, who can actually play most of the notes. It is tempting to lavish encouragement and support on those few, and neglect the youngsters slouched at the back, listlessly scratching the strings at the tip end of the bow. Do so, and the usual consequence is that those at the back decide that orchestra is Not Fun, and slouch off altogether, leaving an unworkably small string section. End of orchestra. An effective approach is periodically to send the front desks on holiday, giving those at the back the occasion to rise to the challenge of front desk responsibilities. Within mathematics too, the contribution of some players will appear to dominate over the contribution of others. Seek out the contribution of the latter: at the least, the acknowledged leaders will be freed of some responsibilities, and possibly those in the back desks will rise to the challenge and emerge as stars in their own right.

- **The importance of the interrogative.** Consult others, listen and act on their suggestions. Not only might this save you from the more obvious blunders, but there is no better way of recruiting supporters. As you mature as a mathematician, this principle becomes even more important. When you are in a position of seniority, seeking the opinions of junior members is undoubtedly the most effective way of ensuring their involvement and cooperation. Your department will depend on it. So will their mathematical futures.

- **Reign in expectations.** Success of an enterprise is not measured by objective standards, but rather by a comparison of results against expectations. Keep the design small and keep expectations low. A project of your own design will necessarily be fuelled by your

[2]This is really information for later. For now, you are the back desks.

own enthusiasm, which we may take to be considerable, if the dreams have reached implementation stage. The dreams that fuel innovation usually do not include the inevitable but unwanted setbacks. Even if you take to heart items 3, 4, 5 and 7 above, the reality is likely to fall short of the dream. Expect this, and reckon to learn from the shortcomings, rather than regard them as failures. Moreover, the projects you are setting up are not for all time, they are for now. Later generations of students will seize on them, drop them, alter them, or build on them as they see fit. That is as it should be.

Go for it!

9 Appendix II — The Betty and Gordon Moore Library

Books and library information

The main mathematical and physical sciences library of the University is the Betty and Gordon Moore Library (Moore) at CMS. (There are no separate Departmental Libraries for the Mathematics Departments.)

Detailed information on the Moore is provided on their website `http://www.lib.cam.ac.uk/BGML/`, with the maths information resource guide at `http://www.lib.cam.ac.uk/BGML/mooremathsguide.html` perhaps especially relevant. Please note that you must register when you first use the Moore and that, having done so, research students are entitled to full borrowing rights and may apply for 24-hour reference access.

Other libraries in Cambridge may also be relevant to research students. For example, a large collection of older mathematical material is retained at the main University Library building on West Road, while the Central Science Library (CSL) in Bene't Street holds biological and geological books and journals. The Isaac Newton Institute for Mathematical Sciences maintains its own library. Reference access to this library for non-Institute personnel may be granted at the discretion of the Institute Librarian. A complete listing of Cambridge libraries may be found at `http://linux02.lib.cam.ac.uk/libraries_directory/libraries_directory.cgi`

The Cambridge online library catalogue, Newton, is accessible from any computer in the Cambridge system at `http://ul-newton.lib.cam.ac.uk/` or for access to all the Newton databases, `http://www.lib.cam.ac.uk/newton/`.

The DPMMS photocopiers may be used for copying books or journals borrowed from the Moore (or elsewhere). Note that photocopying regulations allow the photocopying of one chapter or 5% of a book (whichever is the larger) or, for journals, one article from each issue (not volume) of the journal.

Access and Passwords

Many networked electronic services are made available within the "cam" domain via IP address recognition, and for these no password is required. Most of the remainder are accessible using a Raven password.

Information on Raven passwords and how to obtain one is available on the Computing Service website:

`http://www.cam.ac.uk/cs/docs/faq/n5.html`.

Now get to work

Whether you have just arrived in Cambridge, or whether this is your fifth year here, we hope it is the beginning of a very positive and rewarding three of four years.

We hope you will realise from the beginning that you are in charge of your course here, and that you will take charge of it, from the beginning.

We hope you will discover that satisfaction in work is in proportion to the amount you contribute, rather than the amount you receive.

We hope, when you come to leave, it will be with the confidence that you will be able to cope with whatever surprises a life in mathematics, in academics or otherwise, can throw at you.

And we wish you good luck on the way. It helps.