NOTES FOR MCM TEAMS

1 General Remarks

The successful participation of a team in the Mathematical Competition in Modelling involves a number of key areas:

- Logical and clear analysis of the problem.
- Ability to state and solve the mathematical problem clearly.
- Computing skills in numerical and statistical analysis, graph plotting and word processing.
- Linguistic skills in report writing.
- Good communication between team members.

Team members can offer skills in these different areas in different ways so remember that each contribution should be valued.

2 The Layered Approach to Model Building

The problems given in the MCM are usually real world and open-ended and are often stated in a non-mathematical way. The aim of any mathematical model is to restate the given problem (or perhaps some approximation to it) in a clear way as a mathematical problem based on some set of assumptions. The solution to this problem should then make some sensible and useful predictions about the system. There is not necessarily a unique model or method of solution to MCM problems. Sometimes a great deal of information is given some of which can be superfluous. On the other hand, sometimes relevant information can also be missing! It is not usually necessary to employ very sophisticated mathematics - very complicated looking formulas are probably not much better than some appropriate simpler ones. Certainly, you should **not** resort to lifting 'magic formulas' from some textbook at least not without stating the meaning and assumptions associated with such formulas. The model should form a consistent approach to the problem. To build any mathematical model, a layered approach is usually the best one to take. It is important to clearly divide the statement and consequent

solution of the problem into various stages of increasing detail and complexity. We begin with a simple model based on a restatement of the problem in some simplified form where strong, clearly defined and well understood assumptions are made. We should not become bogged down in technicalities. Many of the finer details of the original problem are set aside at this stage for later deliberation. This simple model should be solved and properly understood with clear (and perhaps obvious !) predictions. An understanding of the limitations of this simple model helps to clarify thinking so that the areas for further improvement should be apparent. The model should also be analysed for the stability of its predictions and error analysis i.e. if the assumptions are slightly modified or the inputted data, how do the predictions also vary ? The model then provides the backbone for future layers of models which should include ever more details or realistic assumptions or predictions. It is important to be clear at all stages of the model's development of the exact assumptions, approximations and information being inputted and the consequent predictions. The model's stability should at each stage again be analysed. In this way, an ever more realistic mathematical model is built up layer by layer.

3 Writing Style

The model and results that are obtained are presented in a Report together with a one page Summary Sheet. The Report is not supposed to be a mathematical text and so it is not appropriate to employ a formal 'Theorem-Lemma' format of presentation. Rather the Report should be written in clear language in an essay style with concise sentences. The Report should avoid unnecessary technical jargon and should also be a comprehensible document as a whole without unnecessary references to textbooks or papers. The overall discussion should be presented in the first person plural and in the present tense i.e. '.. we find the following polynomial fits the given data ..'. The basic headings to be covered in the Report might include:

- A restatement of the problem.
- A clear statement of assumptions and approximations made.
- The mathematical model proposed and its predictions (how it can be tested), error analysis and stability under modifications to assumptions and inputted data.
- An analysis of the strengths and weaknesses.
- References, figures and programs.

The Summary Sheet is a one page document which contains a summary of your assumptions, model and predictions. **It is vital that the summary page be very clearly and well presented with a self consistent description of your work.**

4 Timetable

4.1 Thursday

12.00p.m. The problems are handed out. A preliminary discussion on both problems should take place.

4.2 Friday

TODAY'S PRIORITY TASKS: Formulate and solve a simple model for one of the problems.

Morning. The team works together on both problems. Take the time (not less than two hours each) to consider the problems properly and formulate possible approaches to them. Undertake a literature search in the library.

5 p.m. A decision must be made by this time on which problem is to be tackled.

Night. A first simple model must be formulated and solved.

4.3 Saturday

TODAY'S PRIORITY TASKS : Decide on a Plan for remainder of the weekend and write a draft report for the simple model.

Morning. Begin the day by deciding on a Plan for the running and timetabling of the remainder of the weekend. The Plan should include the following items :

- The statement and writing up of the simple model - a draft Report must be completed by Saturday night.
- Display the assumptions contained in the simple model on wall posters/blackboard so that this is clearly understood by all team members. Communicate!
- Decide on next stage(s) of the model.
- Delegate various tasks to different team members e.g. writing up, computer programming, further model building etc.
- Timetable conference times (every two or three hours?) when team members come together to discuss progress.

Post this Plan and the Priority list below in a prominent place and keep to it!

Night. First draft of the Report on the simple model must be completed.

4.4 Sunday

TODAY'S PRIORITY TASKS: Complete the Report on the simple model and write Summary sheet.

Morning. Consolidate your work. The draft Report should be tidied up. Further refinements can then be added based on the next layer(s) of the model.

Evening. First simple model Report completed. Begin writing Summary Sheet - the Summary sheet is very significant in the judging process so it is worth doing carefully.

Night. Summary sheet completed. Make draft modifications to the Report based on improved model.

4.5 Monday

TODAY'S PRIORITY TASK: Finish by Lunchtime!

Concentrate exclusively on completing the Report and Summary sheet. Ensure all diagrams and software are available and properly labelled. Photocopy Report and Summary sheet.

Lunchtime. Everything completed and ready to be posted.

5 Final General Remarks and Advice

- The rules of the MCM allow teams any inanimate help. You must not seek or obtain advice (sought or unsought) on the problem from anyone else.
- Stick to the proposed timetable. In particular, each day has priority task(s) - do not become side-tracked away from these priorities.
- Writing up the report is a very time consuming business. Making this an early priority takes the pressure off and helps considerably in the layered building of the model. The process of explaining and ordering your arguments in the simple model will help you to criticise your simple model and hence clarify your thinking on the next stages of improvement. Furthermore, once a draft version is down on paper (or disk), it is easy to make modifications as required or add more sections.
- It is possible that a conflict of opinion may arise on some issue. We recommend that no more than half an hour should be spent in discussion on any one issue after which a majority rule vote should take place (even when you know that you are right!).
- It is not productive to go without sleep on the first few nights so we recommend not less than seven hours sleep on Thursday, Friday and Saturday nights! At the same time, it is probably better psychologically to achieve each day's priority tasks even if that means starting later on the following day.
- Remember that the point of the MCM competition is to formulate your own mathematical model and not to find 'THE ANSWER' in some textbook or other. Information quoted from textbooks must be properly motivated and understood before being incorporated into your model - you will not necessarily be rewarded by the judges for just coming up with some useful references from which you quote formulas!
- Last, but certainly not least, the MCM should be stimulating and enjoyable for all concerned. So have fun !

6 DAILY PRIORITY TASKS

Friday. Formulate and solve a simple model for one of the problems.

Saturday. Decide on a Plan for remainder of the week-end and write a draft report for the simple model.

Sunday. Complete the Report on the simple model and write Summary sheet.

Monday. Finish by Lunchtime!