# Guidelines for the production of lab notebooks for Computer Science modules at Aberystwyth University

A lab notebook is intended to provide a record of experiments as they are done and should be completed in the laboratory. The lab notebook is not to be written up later, but it may need to be prepared before the lab session. You may add reflections after a lab session to comment and analyse your results, but the lab book must be presented in chronological order.

The lab notebook generally records the process that takes place in the laboratory where the experimenter:
- thinks about something that interests them;
- formulates a hypothesis which can be tested;
- devises an experiment that can test that hypothesis;
- performs that (series of) experiments, recording the experiment and results;
- analyses the results noting whether the hypothesis is supported or rejected;
- forms conclusions from the findings leading to new hypotheses.

## Writing the lab notebook

The skill of writing the lab notebook – even the existence of such a notebook – has probably fallen somewhat into disuse with the advent of the photocopied worksheet. Yet it is a vital part of industrial and academic research, and indeed can in these activities be required in law to establish, for example, patent rights, or even used as evidence during Forensic Computing investigations.

Kanare[2] offers many insights into how such rights may be protected, and is worthwhile reading for more detail on lab notebooks.

## Plain Language

The whole point of a lab notebook is that it should:
- say exactly what was done, and when;
- make clear who did it;
- enable someone else to reproduce the experiment at some future date;
- be durable and verifiable.

Any rules that are used must attend to these points; anything else is spurious. Plain language is the least spurious of all.

## Hardware

Books, pens and paper are the tools of your academic trade; skimping on them is absurd. Paper trees are a crop – paper is not made from rainforest timber, it's made from spruce or larch grown for the purpose – so do not be mean with paper.
Here are some rules for hardware:
- Lab notebooks should be hardback bound notebooks – you can stick worksheets in where needed. Generally these notebooks should be A4 sized unless you are informed otherwise. The Students' Union shop stocks a variety of these.
- Writing must be done in ink. Black ballpoint pen is best; fountain pen inks are not as durable as ballpoint inks and are more prone to fading, and do not withstand solvent

spills as well as ballpoint does. Blue ink fades more readily than black, and red is least fade-proof of all. Some pens contain waterproof fade-resistant inks and are made in many colours.
- Pencil should not be used for anything.

## Organising your notebook

Anyone should be able to pick up your notebook and understand what you have written. This must be the main thing – you are writing for someone else. If the writing is clear to them, then it certainly will be to you. Achieving this requires some organisation as well as a certain style.

The notebook MUST be laid out in the following manner:
- Title page. Give a page to state your name, address (you might lose the book) and a brief indication of its purpose. Module identifier and name should be here.
- Table of contents. Give two pages to the Contents so that you can list the experiments and find them easily when needed. But you will need to...
- Number the pages. Tedious but essential. Do it when the notebook is new.
- Glossary of terms and abbreviations. Reserve two pages immediately following the table of contents. Computer scientists use abbreviations a lot – they save time and effort. If you use them, write a glossary to explain them. Don't assume that others know what all the abbreviations mean, or that the reader knows which one of the many definitions for a term you are using at this point in time.
- Start each new piece of work on a fresh page. A fresh page is a challenge; rise to it.
- Don't leave blank pages, you can always write "Continued on/from..."

## Good notebook practices

### The Experimental Introduction

The introduction to each experimental report should have the following:
- The title of the experiment – and this should appear on any added pieces of paper, graphs, whatever, that are pasted into the notebook.
- A statement of the problem or task – short and to the point. The elaboration of this comes later.
- The date. In industry or research this is exceedingly important, and may be in your work too. Write the date unambiguously and include the year – for example 2 July 2000 or, for purists, 2nd July 2000. Do not write 2/7/2000 since those who use the American date system will think you mean 7th February.

### The experimental plan

This is the part of the account that tells what you are going to do. It may be that you have detailed instructions already, in which case they can be written or pasted into the notebook. If you are planning an investigation you will have to write out your own plan. Your plan should address the following points:
- Use simple, direct statements or a bulleted or numbered list of instructions.
- State clearly what you intend to do – do not repeat the introduction.
- Comment on any special features of the equipment to be used – perhaps they require special storage or handling. Do disks need to be mounted in particular ways? Do equipment or operating systems need to be set up in a way that is not normal. Such factors are very important and must be recorded.

- Safety! There are certain experiments that may present hazards to your health. You should be aware of the existence of high voltages and currents that can cause injury or death. The use of lasers as communication sources can cause health issues. The viewing of certain types of data can cause mental and emotional distress if viewed by others. All these and other risks need to be considered when performing analyses. Standard practical exercises will have been assessed by tutors, but this does not remove the need for you to consider safety for your own experiments.

**Observations and Data**

The observations you make and the data that you record will lead to the acceptance or rejection of your hypothesis, and will decide what future experiments may be done. The observations and data are therefore central to the whole exercise.

- They must be recorded honestly.
- They should be recorded as you go along, in the notebook, in ink, immediately.
- Do not trust to memory, even for a minute or so – someone talks to you, and that data's forgotten.
- Do not trust to memory; you do not want your mind occupied with trivial things and small details. You need to keep the overall experimental plan in mind.
- Do not use odd scraps of paper or the edge of your lab coat to record data.
- The raw data is precious – Kanare[2] suggests that the data is treated with the care you'd bestow on a family heirloom.
- The data must be recorded as completely as is possible. Don't worry too much about interpreting the data as you go along, and don't worry if some of the observations appear banal.
- Use good penmanship. Take care with numbers – never over-write, always cross out erroneous material with a single line and re-write the correct data.
- NEVER use Tipp-ex or other white-out liquids.

**Formatting Observations and Data**

- Spread your work out – paper is a crop, not a rarity, and you are not depleting rain-forests. It is a necessary resource for your work.
- Tables must be written in vertical columns, each column being headed with the quantity and the appropriate units.
- Drawings need only illustrate novel apparatus – everyone knows what a beaker looks like.
- Drawings should be sectional – do not draw the apparatus as you see it on the bench.
- Drawings should be large enough to allow labelling.
- Drawings should be simple and to the point.

**Graphs**

- Do not computer-plot your graphs. Graph-plotting is an art, and once you have learned it you can then decide whether to use machines, and whether the graphs they plot are silly or useful. You may be allowed to use gnuplot or other software packages by specific lecturers.
- Each graph should have the experimental title and the date written clearly.
- The axes must be labelled with the quantity divided by its unit.
- Include error bars if you know the error limits or distribution.
- Give a clear table of the data you used to plot the graph.

**Discussion and conclusion**

- Write any calculations out clearly, showing all the steps and using units throughout.
- Relate your results to your hypothesis – do they support or refute it? Comparisons must be as quantitative as possible. Of course a simple analysis practical session will only produce a result.
- Record any ideas you have, however brief – if you don't write them down, you'll forget them.
- Your conclusions should state:
  - what you found out;
  - whether the hypothesis was supported or not, if appropriate;
  - the error limits on your answer(s); a quantitative assessment of error should be made if possible and relevant;
  - suggestions for improvement in experimental design, if appropriate; the error analysis will be useful here;
  - what to do next, if appropriate.

## Bibliography

1. Day, Peter: The Philosopher's Tree, A Selection of Michael Faraday's Writings. Bristol: Institute of Physics Publishing, 1999. ISBN 0 7503 0571
2. Kanare, Howard M: Writing the Laboratory Notebook. Washington D.C.: American Chemical Society, 1985. ISBN 0 8412 0933 2