Henry Mattinson

Excello: Music Composition in Excel

Computer Science Tripos – Part II

Christ's College

March 29, 2019

Proforma

Name:	**Henry Mattinson**
College:	**Christ's College**
Project Title:	**Excello: Music Composition in Excel**
Examination:	**Computer Science Tripos – Part II, June 2019**
Word Count:	**????**[1]
Project Originator:	Alan Blackwell
Supervisor:	Dr Advait Sarkar

Original Aims of the Project

The main aim of the project was to create a system for music expression and playback allowing users to play individual notes and chords and define their durations, define multiple parts, play loops, define sequences of notes and chords and be able to call these for playback and define the tempo of playback. Followed by the implementation of a converter from an existing musical notation to the Excel system (with compression as an extension) and usability testing of the Excel system.

Work Completed

I designed a notation for music expression in Excel and built a prototype (Excello) satisfying the success criteria above. Participatory design sessions with 21 users served as formative evaluation leading to the implementation of many additional features as extensions. I contributed part of my implementation to an open-source library, this has been merged and published. I built a converter from MIDI to the Excello notation which can convert exactly or perform lossy compression. This was used to translate a corpus of music to the Excello notation. I performed summative evaluation with the users from the participatory design.

Special Difficulties

None.

---

[1] This word count was computed by `detex diss.tex | tr -cd '0-9A-Za-z \n' | wc -w`

Declaration

I, Henry Mattinson of Christ's College, being a candidate for Part II of the Computer Science Tripos, hereby declare that this dissertation and the work described in it are my own work, unaided except as may be specified below, and that the dissertation does not contain material that has already been used to any substantial extent for a comparable purpose.

Signed [signature]

Date [date]]

Contents

Chapter 1

Introduction

1.1   Overview of the files

This document consists of the following files:

- `makefile` — The makefile for the dissertation and Project Proposal

- `diss.tex` — The dissertation

- `proposal.tex` — The project proposal

- `figs` – A directory containing diagrams and pictures

- `refs.bib` — The bibliography database

1.2   Building the document

This document was produced using LaTeX 2_ε which is based upon LaTeX[1]. To build the document you first need to generate `diss.aux` which, amongst other things, contains the references used. This if done by executing the command:

    pdflatex diss

Then the bibliography can be generated from `refs.bib` using:

    bibtex diss

Finally, to ensure all the page numbering is correct run `pdflatex` on `diss.tex` until the `.aux` files do not change. This usually takes 2 more runs.

1.2.1   The makefile

To simplify the calls to `pdflatex` and `bibtex`, a makefile has been provided, see Appendix B.1. It provides the following facilities:

`make`

      Display help information.

`make proposal.pdf`
> Format the proposal document as a PDF.

`make view-proposal`
> Run `make proposal.pdf` and then display it with a Linux PDF viewer (preferably "okular", if that is not available fall back to "evince").

`make diss.pdf`
> Format the dissertation document as a PDF.

`make count`
> Display an estimate of the word count.

`make all`
> Construct `proposal.pdf` and `diss.pdf`.

`make pub`
> Make `diss.pdf` and place it in my `public_html` directory.

`make clean`
> Delete all intermediate files except the source files and the resulting PDFs. All these deleted files can be reconstructed by typing `make all`.

1.3   Counting words

An approximate word count of the body of the dissertation may be obtained using:

```
wc diss.tex
```

Alternatively, try something like:

```
detex diss.tex | tr -cd '0-9A-Z a-z\n' | wc -w
```

Chapter 2

Preparation

This chapter is empty!

Chapter 3

Implementation

3.1 Verbatim text

Verbatim text can be included using \begin{verbatim} and \end{verbatim}. I normally use a slightly smaller font and often squeeze the lines a little closer together, as in:

```
GET "libhdr"

GLOBAL { count:200; all  }

LET try(ld, row, rd) BE TEST row=all
                        THEN count := count + 1
                        ELSE { LET poss = all & ~(ld | row | rd)
                               UNTIL poss=0 DO
                               { LET p = poss & -poss
                                 poss := poss - p
                                 try(ld+p << 1, row+p, rd+p >> 1)
                               }
                             }
LET start() = VALOF
{ all := 1
  FOR i = 1 TO 12 DO
  { count := 0
    try(0, 0, 0)
    writef("Number of solutions to %i2-queens is %i5*n", i, count)
    all := 2*all + 1
  }
  RESULTIS 0
}
```
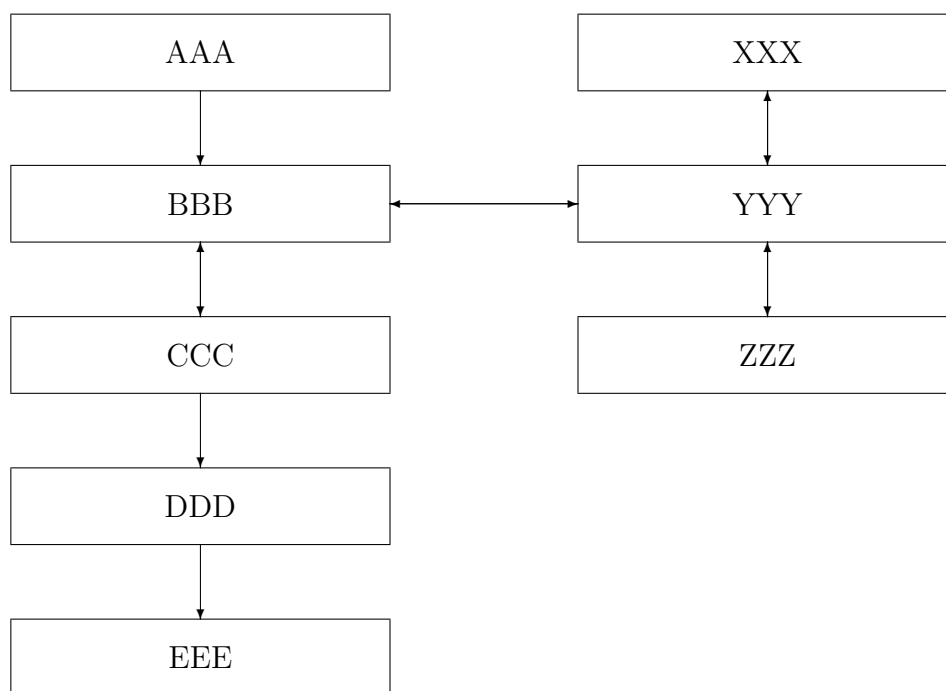
Figure 3.1: A picture composed of boxes and vectors.

3.2   Tables

Here is a simple example[1] of a table.

Left Justified	Centred	Right Justified
First	A	XXX
Second	AA	XX
Last	AAA	X

There is another example table in the proforma.

3.3   Simple diagrams

Simple diagrams can be written directly in LATEX. For example, see figure 3.1 on page 12 and see figure 3.2 on page 13.

3.4   Adding more complicated graphics

The use of LATEX format can be tedious and it is often better to use encapsulated postscript (EPS) or PDF to represent complicated graphics. Figure 3.3 and 3.5 on page 14 are
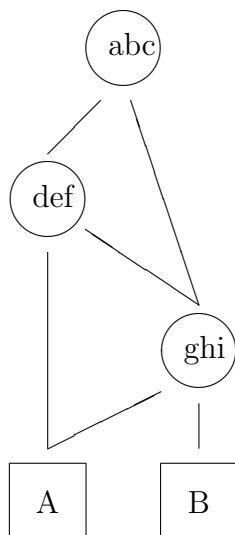
---

[1]A footnote

Figure 3.2: A diagram composed of circles, lines and boxes.

examples. The second figure was drawn using `xfig` and exported in `.eps` format. This is my recommended way of drawing all diagrams.
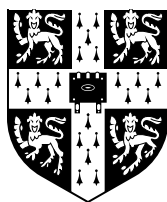
Figure 3.3: Example figure using encapsulated postscript

Figure 3.4: Example figure where a picture can be pasted in
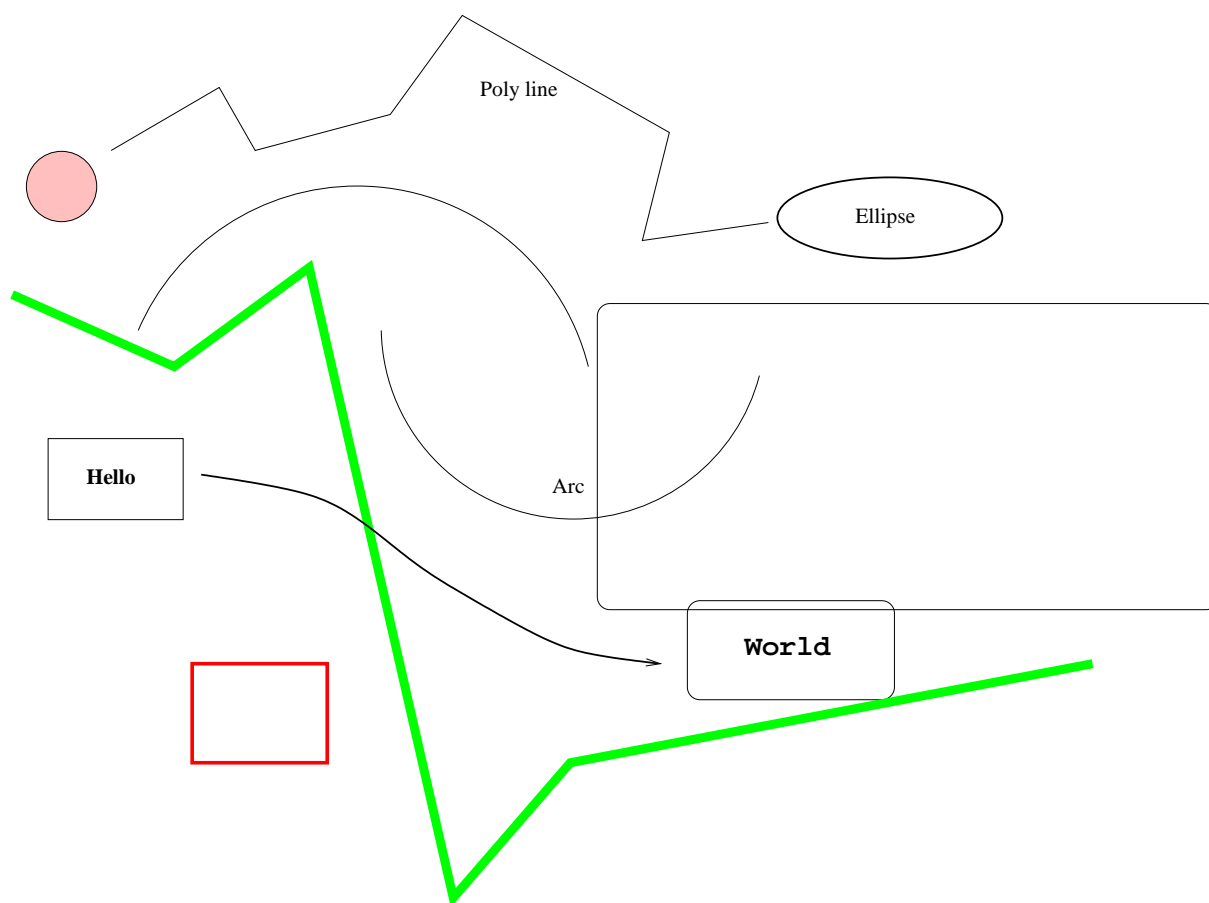
Figure 3.5: Example diagram drawn using `xfig`

Chapter 4

Evaluation

4.1   Printing and binding

Use a "duplex" laser printer that can print on both sides to print two copies of your dissertation. Then bind them, for example using the comb binder in the Computer Laboratory Library.

4.2   Further information

See the Unix Tools notes at

> `http://www.cl.cam.ac.uk/teaching/current-1/UnixTools/materials.html`

Chapter 5

Conclusion

I hope that this rough guide to writing a dissertation is LaTeX has been helpful and saved you time.

Bibliography

[1] L. Lamport. *LaTeX — a document preparation system — user's guide and reference manual.* Addison-Wesley, 1986.

Appendix A

Latex source

A.1   diss.tex

```
% Template for a Computer Science Tripos Part II project dissertation
\documentclass[12pt,a4paper,twoside,openright]{report}
\usepackage[pdfborder={0 0 0}]{hyperref}    % turns references into hyperlinks
\usepackage[margin=25mm]{geometry}  % adjusts page layout
\usepackage{graphicx}  % allows inclusion of PDF, PNG and JPG images
\usepackage{verbatim}
\usepackage{docmute}    % only needed to allow inclusion of proposal.tex

\raggedbottom                          % try to avoid widows and orphans
\sloppy
\clubpenalty1000%
\widowpenalty1000%

\renewcommand{\baselinestretch}{1.1}    % adjust line spacing to make
                                        % more readable

\begin{document}

\bibliographystyle{plain}


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Title


\pagestyle{empty}

\rightline{\LARGE \textbf{Henry Mattinson}}

\vspace*{60mm}
\begin{center}
\Huge
\textbf{Excello: Music Composition in Excel} \\[5mm]
Computer Science Tripos -- Part II \\[5mm]
Christ's College \\[5mm]
\today  % today's date
\end{center}

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Proforma, table of contents and list of figures

\pagestyle{plain}

\chapter*{Proforma}
```

```
{\large
\begin{tabular}{ll}
Name:               & \bf Henry Mattinson                      \\
College:            & \bf Christ's College                     \\
Project Title:      & \bf Excello: Music Composition in Excel \\
Examination:        & \bf Computer Science Tripos -- Part II, June 2019  \\
Word Count:         & \bf ????\footnotemark[1]  \\
Project Originator: & Alan Blackwell                           \\
Supervisor:         & Dr Advait Sarkar                         \\
\end{tabular}
}
\footnotetext[1]{This word count was computed
by \texttt{detex diss.tex | tr -cd '0-9A-Za-z $\tt\backslash$n' | wc -w}
}
\stepcounter{footnote}


\section*{Original Aims of the Project}

The main aim of the project was to create a system for music expression and playback allowing users to play individual notes

\section*{Work Completed}

I designed a notation for music expression in Excel and built a prototype (Excello) satisfying the success criteria above. P

\section*{Special Difficulties}

None.

\newpage
\section*{Declaration}

I, Henry Mattinson of Christ's College, being a candidate for Part II of the Computer
Science Tripos, hereby declare
that this dissertation and the work described in it are my own work,
unaided except as may be specified below, and that the dissertation
does not contain material that has already been used to any substantial
extent for a comparable purpose.

\bigskip
\leftline{Signed [signature]}

\medskip
\leftline{Date [date]]}

\tableofcontents

% \listoffigures

% \newpage
% \section*{Acknowledgements}
%
% This document owes much to an earlier version written by Simon Moore
% \cite{Moore95}.  His help, encouragement and advice was greatly
% appreciated.

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% now for the chapters

\pagestyle{headings}

\chapter{Introduction}

\section{Overview of the files}

This document consists of the following files:
```

```
\begin{itemize}
\item \texttt{makefile} --- The makefile for the dissertation and
                          Project Proposal
\item \texttt{diss.tex} --- The dissertation
\item \texttt{proposal.tex}  --- The project proposal
\item \texttt{figs} -- A directory containing diagrams and pictures
\item \texttt{refs.bib} --- The bibliography database
\end{itemize}
\section{Building the document}

This document was produced using \LaTeXe which is based upon
\LaTeX\cite{Lamport86}.  To build the document you first need to
generate \texttt{diss.aux} which, amongst other things, contains the
references used.  This if done by executing the command:

\texttt{pdflatex diss}

\noindent
Then the bibliography can be generated from \texttt{refs.bib} using:

\texttt{bibtex diss}

\noindent
Finally, to ensure all the page numbering is correct run \texttt{pdflatex}
on \texttt{diss.tex} until the \texttt{.aux} files do not change.  This
usually takes 2 more runs.

\subsection{The makefile}

To simplify the calls to \texttt{pdflatex} and \texttt{bibtex},
a makefile has been provided, see Appendix~\ref{makefile}.
It provides the following facilities:

\begin{description}

\item\texttt{make} \\
 Display help information.

\item\texttt{make proposal.pdf} \\
 Format the proposal document as a PDF.

\item\texttt{make view-proposal} \\
 Run \texttt{make proposal.pdf} and then display it with a Linux PDF viewer
 (preferably ``okular'', if that is not available fall back to ``evince'').

\item\texttt{make diss.pdf} \\
 Format the dissertation document as a PDF.

\item\texttt{make count} \\
Display an estimate of the word count.

\item\texttt{make all} \\
Construct \texttt{proposal.pdf} and \texttt{diss.pdf}.

\item\texttt{make pub} \\ Make \texttt{diss.pdf}
and place it in my \texttt{public\_html} directory.

\item\texttt{make clean} \\ Delete all intermediate files except the
source files and the resulting PDFs. All these deleted files can
be reconstructed by typing \texttt{make all}.

\end{description}


\section{Counting words}

An approximate word count of the body of the dissertation may be
```

```
obtained using:

\texttt{wc diss.tex}

\noindent
Alternatively, try something like:

\verb/detex diss.tex | tr -cd '0-9A-Z a-z\n' | wc -w/


\chapter{Preparation}

This chapter is empty!


\chapter{Implementation}

\section{Verbatim text}

Verbatim text can be included using \verb|\begin{verbatim}| and
\verb|\end{verbatim}|. I normally use a slightly smaller font and
often squeeze the lines a little closer together, as in:

{\renewcommand{\baselinestretch}{0.8}\small
\begin{verbatim}
GET "libhdr"

GLOBAL { count:200; all  }

LET try(ld, row, rd) BE TEST row=all
                        THEN count := count + 1
                        ELSE { LET poss = all & ~(ld | row | rd)
                               UNTIL poss=0 DO
                               { LET p = poss & -poss
                                 poss := poss - p
                                 try(ld+p << 1, row+p, rd+p >> 1)
                               }
                             }
LET start() = VALOF
{ all := 1
  FOR i = 1 TO 12 DO
  { count := 0
    try(0, 0, 0)
    writef("Number of solutions to %i2-queens is %i5*n", i, count)
    all := 2*all + 1
  }
  RESULTIS 0
}
\end{verbatim}
}

\section{Tables}

\begin{samepage}
Here is a simple example\footnote{A footnote} of a table.

\begin{center}
\begin{tabular}{l|c|r}
Left      & Centred & Right \\
Justified &         & Justified \\[3mm]
%\hline\\%[-2mm]
First     & A       & XXX \\
Second    & AA      & XX  \\
Last      & AAA     & X   \\
\end{tabular}
\end{center}
```

```
\noindent
There is another example table in the proforma.
\end{samepage}

\section{Simple diagrams}

Simple diagrams can be written directly in \LaTeX.  For example, see
figure~\ref{latexpic1} on page~\pageref{latexpic1} and see
figure~\ref{latexpic2} on page~\pageref{latexpic2}.

\begin{figure}
\setlength{\unitlength}{1mm}
\begin{center}
\begin{picture}(125,100)
\put(0,80){\framebox(50,10){AAA}}
\put(0,60){\framebox(50,10){BBB}}
\put(0,40){\framebox(50,10){CCC}}
\put(0,20){\framebox(50,10){DDD}}
\put(0,00){\framebox(50,10){EEE}}

\put(75,80){\framebox(50,10){XXX}}
\put(75,60){\framebox(50,10){YYY}}
\put(75,40){\framebox(50,10){ZZZ}}

\put(25,80){\vector(0,-1){10}}
\put(25,60){\vector(0,-1){10}}
\put(25,50){\vector(0,1){10}}
\put(25,40){\vector(0,-1){10}}
\put(25,20){\vector(0,-1){10}}

\put(100,80){\vector(0,-1){10}}
\put(100,70){\vector(0,1){10}}
\put(100,60){\vector(0,-1){10}}
\put(100,50){\vector(0,1){10}}

\put(50,65){\vector(1,0){25}}
\put(75,65){\vector(-1,0){25}}
\end{picture}
\end{center}
\caption{A picture composed of boxes and vectors.}
\label{latexpic1}
\end{figure}

\begin{figure}
\setlength{\unitlength}{1mm}
\begin{center}

\begin{picture}(100,70)
\put(47,65){\circle{10}}
\put(45,64){abc}

\put(37,45){\circle{10}}
\put(37,51){\line(1,1){7}}
\put(35,44){def}

\put(57,25){\circle{10}}
\put(57,31){\line(-1,3){9}}
\put(57,31){\line(-3,2){15}}
\put(55,24){ghi}

\put(32,0){\framebox(10,10){A}}
\put(52,0){\framebox(10,10){B}}
\put(37,12){\line(0,1){26}}
\put(37,12){\line(2,1){15}}
\put(57,12){\line(0,2){6}}
\end{picture}
```

```
\end{center}
\caption{A diagram composed of circles, lines and boxes.}
\label{latexpic2}
\end{figure}



\section{Adding more complicated graphics}

The use of \LaTeX\ format can be tedious and it is often better to use
encapsulated postscript (EPS) or PDF to represent complicated graphics.
Figure~\ref{epsfig} and~\ref{xfig} on page \pageref{xfig} are
examples. The second figure was drawn using \texttt{xfig} and exported in
{\tt.eps} format. This is my recommended way of drawing all diagrams.


\begin{figure}[tbh]
\centerline{\includegraphics{figs/cuarms.pdf}}
\caption{Example figure using encapsulated postscript}
\label{epsfig}
\end{figure}

\begin{figure}[tbh]
\vspace{4in}
\caption{Example figure where a picture can be pasted in}
\label{pastedfig}
\end{figure}


\begin{figure}[tbh]
\centerline{\includegraphics{figs/diagram.pdf}}
\caption{Example diagram drawn using \texttt{xfig}}
\label{xfig}
\end{figure}


\chapter{Evaluation}

\section{Printing and binding}

Use a ``duplex'' laser printer that can print on both sides to print
two copies of your dissertation. Then bind them, for example using the
comb binder in the Computer Laboratory Library.

\section{Further information}

See the Unix Tools notes at

\url{http://www.cl.cam.ac.uk/teaching/current-1/UnixTools/materials.html}


\chapter{Conclusion}

I hope that this rough guide to writing a dissertation is \LaTeX\ has
been helpful and saved you time.


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% the bibliography
\addcontentsline{toc}{chapter}{Bibliography}
\bibliography{refs}

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% the appendices
\appendix

\chapter{Latex source}
```

```
\section{diss.tex}
{\scriptsize\verbatiminput{diss.tex}}

\section{proposal.tex}
{\scriptsize\verbatiminput{proposal.tex}}

\chapter{Makefile}

\section{makefile}\label{makefile}
{\scriptsize\verbatiminput{makefile.txt}}

\section{refs.bib}
{\scriptsize\verbatiminput{refs.bib}}


\chapter{Project Proposal}

\input{proposal}

\end{document}
```

A.2   proposal.tex

```
% Note: this file can be compiled on its own, but is also included by
% diss.tex (using the docmute.sty package to ignore the preamble)
\documentclass[12pt,a4paper,twoside]{article}
\usepackage[pdfborder={0 0 0}]{hyperref}
\usepackage[margin=25mm]{geometry}
\usepackage{graphicx}
\usepackage{parskip}
\begin{document}

\begin{center}
\Large
Computer Science Tripos -- Part II -- Project Proposal\\[4mm]
\LARGE
How to write a dissertation in \LaTeX\\[4mm]

\large
M.~Richards, St John's College

Originator: Dr M.~Richards

14 October 2011
\end{center}

\vspace{5mm}

\textbf{Project Supervisor:} Dr M.~Richards

\textbf{Director of Studies:} Dr M.~Richards

\textbf{Project Overseers:} Dr F.~H.~King  \& Dr A.~W.~Moore

% Main document

\section*{Introduction}

\emph{The problem to be addressed.}

Many students write their CST dissertations in \LaTeX\ -- and spend a
fair amount of time learning just how to do that. The purpose of this
project is to write a demonstration dissertation that provides
a starting point to show how it is done.
```

```
This core proposal document will be augmented by a separately-printed
cover sheet at the front and a resource form at the end. Additional
sheets for risk assessment and human resources may also need to be
included.

This document will elaborate much of the material that is summarised on
the additional sheets.

\section*{Starting point}

\emph{Describe existing state of the art, previous work in this area,
  libraries and databases to be used. Describe the state of any
  existing codebase that is to be built on.}

I am already able to write prose using the English language. I have an
online dictionary, etc.

\section*{Resources required}

\emph{A note of the resources required and confirmation of access.}

For this project I shall mainly use my own quad-core computer that
runs Fedora Linux. Backup will be to github and/or to an SVN
repository on an external hard disk that is dumped to writable CD/DVD
media. I have another similar computer to hand should my main machine
suddenly fail. I require no other special resources.

\section*{Work to be done}

\emph{Describe the technical work.}

The project breaks down into the following sub-projects:

\begin{enumerate}

\item The construction of a skeleton dissertation with the required
  structure. This involves writing the Makefile and making dummy
  files for the title page, the proforma, chapters 1 to 5, the
  appendices and the proposal.

\item Filling in the details required in the cover page and proforma.

\item Writing the contents of chapters 1 to 5, including examples of
  common \LaTeX\ constructs.

\item Adding a example of how to use floating figures and ``encapsulated
  PostScript'' or PDF diagrams.

\end{enumerate}

\section*{Success citeria}

\emph{Describe what you expect to be able to demonstrate at the
end of the project and how you are going to evaluate your achievement.}

The project will be a success if I have a completed dissertation with
the correct chapter titles and I have achieved my other success
criteria, which are to blah \ldots


\section*{Possible extensions}

{\em Potential further envisaged evaluation metrics or extensions.}

If I achieve my main result early I shall try the following
alternative experiment or method of evaluation \ldots
```

```
\section*{Timetable}

\emph{A workplan of perhaps ten or so two-week work-packages,
as well as milestones to be achieved along the way. Provide a
target date for each milestone.}

Planned starting date is 16/10/2011.

\begin{enumerate}

\item \textbf{Michaelmas weeks 2--4} Learn to use X. Read book Y. Read papers Z.

\item \textbf{Michaelmas weeks 5--6} Do preliminary test of Q.

\item \textbf{Michaelmas weeks 7--8} Start implementation of main task A.

\item \textbf{Michaelmas vacation} Finish A and start main task B.

\item \textbf{Lent weeks 0--2} Write progress report. Generate corpus of
  test examples. Finish task B.

\item \textbf{Lent weeks 3--5} Run main experiments and achieve working project.

\item \textbf{Lent weeks 6--8} Second main deliverable here.

\item \textbf{Easter vacation:} Extensions and writing dissertation main
  chapters.

\item \textbf{Easter term 0--2:}  Further evaluation and complete dissertation.

\item \textbf{Easter term 3:} Proof reading and then an early submission
  so as to concentrate on examination revision.

\end{enumerate}

\end{document}
```

Appendix B

Makefile

B.1 makefile

B.2 refs.bib

```
@BOOK{Lamport86,
TITLE = "{LaTeX} --- a document preparation system --- user's guide
and reference manual",
AUTHOR = "Lamport, L.",
PUBLISHER = "Addison-Wesley",
YEAR = "1986"}

@REPORT{Moore95,
TITLE = "How to prepare a dissertation in LaTeX",
AUTHOR = "Moore, S.W.",
YEAR = "1995"}
```

Appendix C

Project Proposal

Computer Science Tripos – Part II – Project Proposal

How to write a dissertation in LaTeX

M. Richards, St John's College
Originator: Dr M. Richards
14 October 2011

Project Supervisor: Dr M. Richards
Director of Studies: Dr M. Richards
Project Overseers: Dr F. H. King & Dr A. W. Moore

Introduction

The problem to be addressed.

Many students write their CST dissertations in LaTeX – and spend a fair amount of time learning just how to do that. The purpose of this project is to write a demonstration dissertation that provides a starting point to show how it is done.

This core proposal document will be augmented by a separately-printed cover sheet at the front and a resource form at the end. Additional sheets for risk assessment and human resources may also need to be included.

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I am already able to write prose using the English language. I have an online dictionary, etc.

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A note of the resources required and confirmation of access.

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Describe the technical work.

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2. Filling in the details required in the cover page and proforma.

3. Writing the contents of chapters 1 to 5, including examples of common LaTeX constructs.

4. Adding a example of how to use floating figures and "encapsulated PostScript" or PDF diagrams.

Success citeria

Describe what you expect to be able to demonstrate at the end of the project and how you are going to evaluate your achievement.

The project will be a success if I have a completed dissertation with the correct chapter titles and I have achieved my other success criteria, which are to blah ...

Possible extensions

Potential further envisaged evaluation metrics or extensions.

If I achieve my main result early I shall try the following alternative experiment or method of evaluation ...

Timetable

A workplan of perhaps ten or so two-week work-packages, as well as milestones to be achieved along the way. Provide a target date for each milestone.

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1. **Michaelmas weeks 2–4** Learn to use X. Read book Y. Read papers Z.

2. **Michaelmas weeks 5–6** Do preliminary test of Q.

3. **Michaelmas weeks 7–8** Start implementation of main task A.

4. **Michaelmas vacation** Finish A and start main task B.

5. **Lent weeks 0–2** Write progress report. Generate corpus of test examples. Finish task B.

6. **Lent weeks 3–5** Run main experiments and achieve working project.

7. **Lent weeks 6–8** Second main deliverable here.

8. **Easter vacation:** Extensions and writing dissertation main chapters.

9. **Easter term 0–2:** Further evaluation and complete dissertation.

10. **Easter term 3:** Proof reading and then an early submission so as to concentrate on examination revision.