C Programming Tools: Part 1

Building and Using your own Toolkit

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  - Learn how to write portable code.

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- Core Principle: Ruthless Automation.
- Doing something boring and repetitive? Can I save time by automating this?

Or, to put that another way:
(As seen on the walkway last week).

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- There's a tarball of examples associated with each lecture, as a shorthand tarball 01.intlist refers to the directory called **01.intlist** inside the tarball. Each directory contains a README file.

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- Why? Because programmers are notoriously sectarian when it comes to..


EDITOR
WARS

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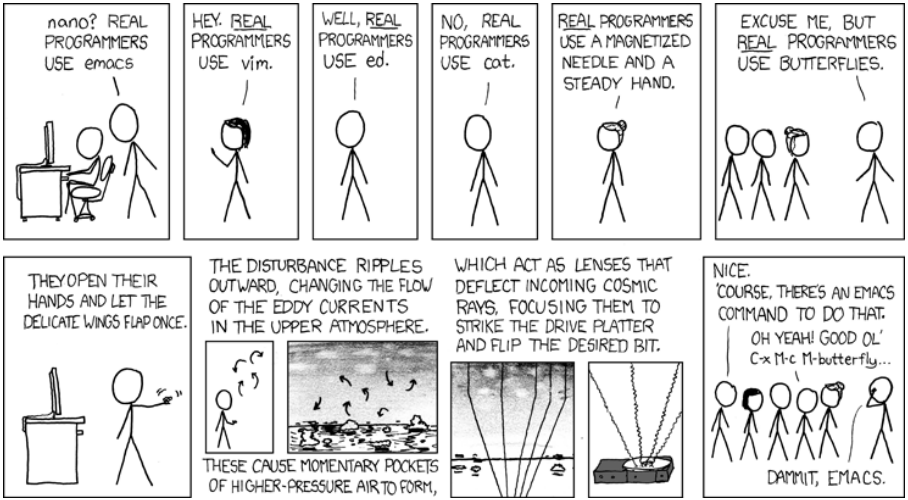
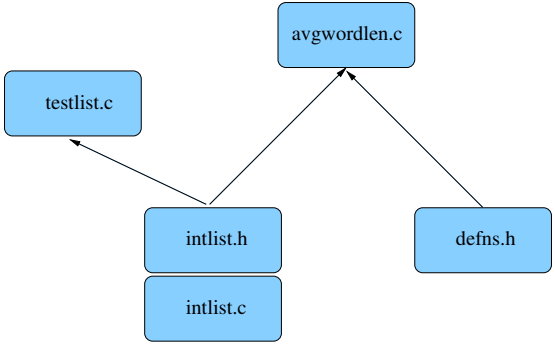
- IDEs such as Eclipse and CLion provide an editor, an automated compilation system and a debugging environment. If you're going to use an IDE, learn how to use it well, and how to extend and program it.
- Note that Hunt & Thomas aren't much in favour of IDEs. Neither am I:-)

Actually, it's well known that Real Programmers use Butterflies to edit source code:



When multi-file C programming, eg:



There are many source files:

- Module intlist comprising two files (interface intlist.h and implementation intlist.c) - defining a list-of-integers type.
- Separate basic definitions header file defns.h.
- Test program testlist.c that tests intlists.
- Main program avgwordlen.c that uses intlists.

- Dependencies between the files are vital, determined by the #include structure. See this via:

```
grep '#include' *.[ch] | grep '"'
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- Which gives:

```
intlist.c:#include "intlist.h"
avgwordlen.c:#include "intlist.h"
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- intlist.c includes intlist.h (to check implementation vs interface).
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- **Make** uses such file dependencies, encoded in a **Makefile**, to automatically compile your programs.
- The Makefile contains dependency rules between target and source files with optional actions (commands) to generate each target from the corresponding sources.

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- Makefiles also contain macros, eg `$(CC)` which C compiler to use, `$(CFLAGS)` what C compiler flags etc. Environment variables become macros too, so `$(HOME)` refers to your home directory.

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- Makefiles also contain macros, eg `$(CC)` which C compiler to use, `$(CFLAGS)` what C compiler flags etc. Environment variables become macros too, so `$(HOME)` refers to your home directory.
- Note that Make needs very few explicit dependencies and even fewer explicit actions, because it already knows that intlist.o depends on intlist.c, and how to compile .c files.

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- make takes optional target names on the command line (defaulting to the first target), then performs the minimum number of actions needed to bring the desired targets up to date, based on the timestamps of the target and source files.
- For example, if intlist.h is altered, you run make, that builds the target all, which recursively applies all the rules checking timestamps and concludes that...
- ...intlist.c, testlist.c and avgwordlen.c need recompiling, and then the new testlist.o and avgwordlen.o need relinking against the new intlist.o, giving the 2 executables testlist and avgwordlen.

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- Summary: Always use make, or some similar tool. Keep your Makefile dependencies up to date, optionally auto-generating your Makefiles.
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- There are alternatives (or frontends) to Make, for example Cmake and the Gnu autoconf system, these generate Makefiles automatically, and scale well.

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- Let's split our existing intlist and avgwordlen directory up.
- What to split? The intlist module is:
  - Logically separate.
  - Reusable - whenever we want a list of integers.
  - Depends on only the standard library.
- That is, it's highly cohesive.
- So: it's perfect for splitting out into a library sub-directory.
- In tarball directory 04.intlist-with-lib, you'll see what we have done to achieve this.

- There's a separate lib sub-directory, let's explore it first:
- lib contains intlist.c, intlist.h, testlist.c and it's own Makefile.
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- The new parts of that Makefile are:

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BUILD   =       testlist $(LIB)
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- In BUILD, I've added `$(LIB)` as an extra target to build.
- The `$(LIB)` rule says that `$(LIB)` depends on `$(LIBOBJS)`, i.e. `libintlist.a` depends on `intlist.o`, and that the action invokes ar and ranlib - tools that build library files.

- The top-level directory contains avgwordlen.c and defns.h, and a Makefile, containing the following new parts:

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CFLAGS  =       -Wall -Ilib
LDLIBS  =       -Llib -lintlist
BUILD   =       libs avgwordlen
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- This new always run rule tricks Make, with it's single directory view of the world, into first building in the lib sub-directory, before building in the current directory.

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- In brief: 05.libintlist contains only the files from the lib directory.

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- After running `make install` in 05.libintlist, your `~/c-tools` library permanently contains the intlist ADT, for you to reuse whenever you like - as shown in 06.avgwordlen-only.

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- Left for you to work through!