SOLUTION NOTES

Computer Design 2002 Paper 6 Question 2 (SWM)

(*a*) Microcode is a compacted version of a state machine. Each line of microcode has a number of fields which are used to control various aspects of the native hardware. Assembler provides a more abstract view of the machine. Each line of assembler indicates what operation is to be performed and what data is to be used for that operation. Unlike microcode, an assembler instruction does directly sequence the hardware to perform an operation.

(*b*) Microcode engines typically have some hardware which acts like a program counter. Branches are achieved by explicitly indicating how an alternative program counter value is to be sourced (e.g. from an ALU) and transmitted (i.e. which bus) whilst flagging that the program counter should be loaded rather than being incremented.

(*c*) I would expect a diagram of a pipeline, e.g. a classic 5-stage RISC pipeline. Feedback paths are used to forward data prior to the data being written back to the register file. For example, one would expect a feedback path directly from the output of the execute stage to the input of the execute state, thereby allowing consecutive ALU operations to occur which have dependent data. I would also expect a feedback path from the memory access stage back to the execute stage to minimise load delays.

Feedback paths improve the throughput of the pipeline by minimising data hazards which would otherwise be resolved by stalling the pipeline.

(*d*) When a branch instruction is taken, succeeding sequential instructions have been fetched into the pipeline in error. These instructions are often flushed from the pipeline, thereby introducing a bubble.