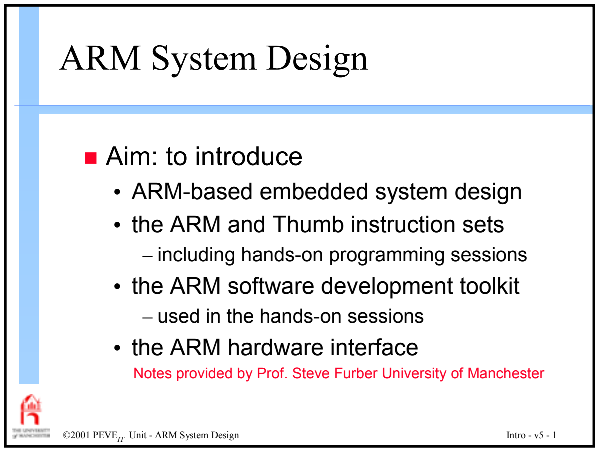
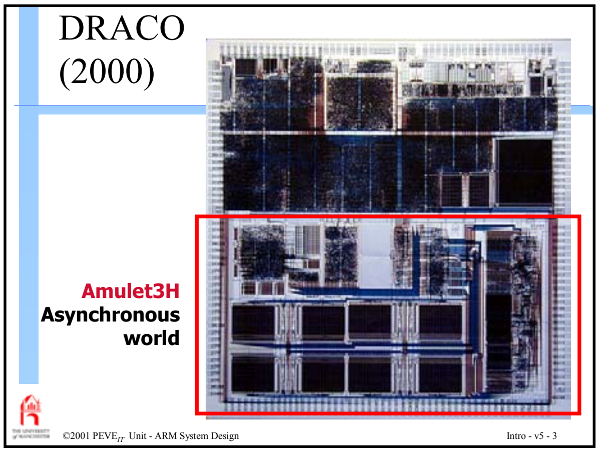


ARM System Design

- Aim: to introduce
  - ARM-based embedded system design
  - the ARM and Thumb instruction sets
    - including hands-on programming sessions
  - the ARM software development toolkit
    - used in the hands-on sessions
  - the ARM hardware interface

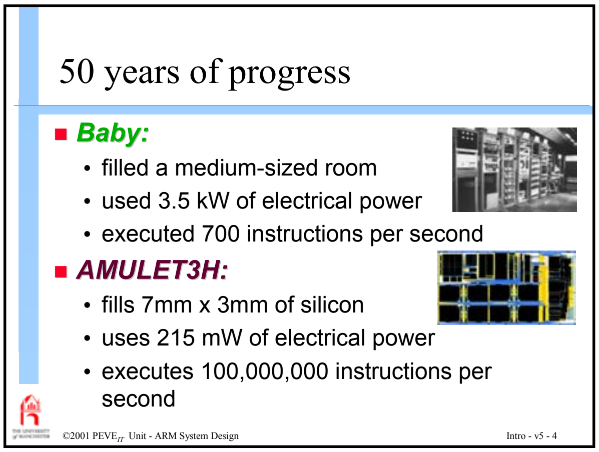
Notes provided by Prof. Steve Furber University of Manchester

The Manchester Baby (1948)



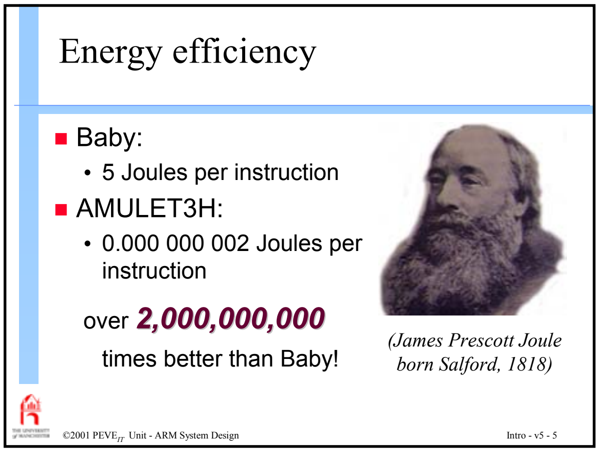
DRACO (2000)

Amulet3H
Asynchronous world



50 years of progress

- ***Baby:***
  - filled a medium-sized room
  - used 3.5 kW of electrical power
  - executed 700 instructions per second
- ***AMULET3H:***
  - fills 7mm x 3mm of silicon
  - uses 215 mW of electrical power
  - executes 100,000,000 instructions per second



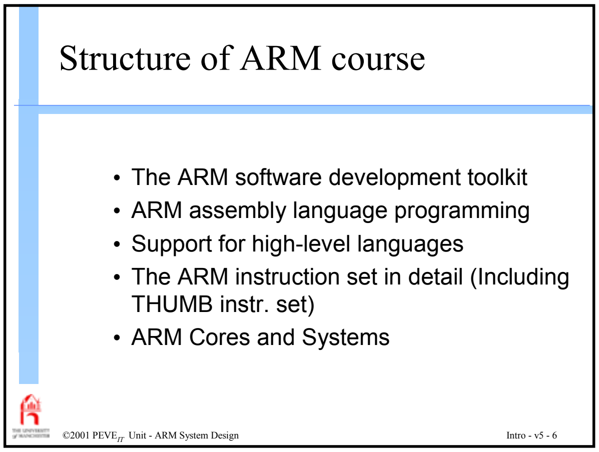
Energy efficiency

- Baby:
  - 5 Joules per instruction
- AMULET3H:
  - 0.000 000 002 Joules per instruction

over ***2,000,000,000***

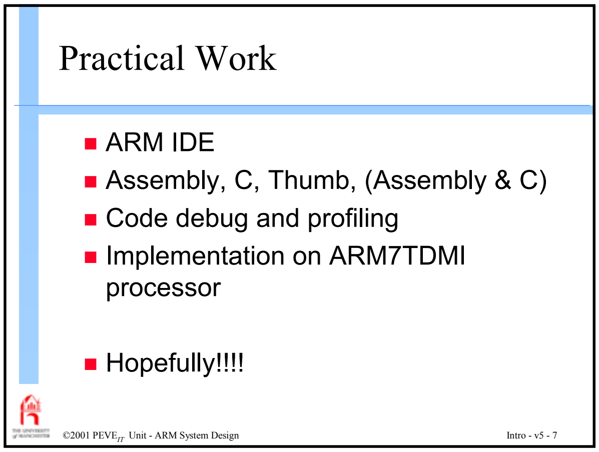
times better than Baby!

(James Prescott Joule born Salford, 1818)



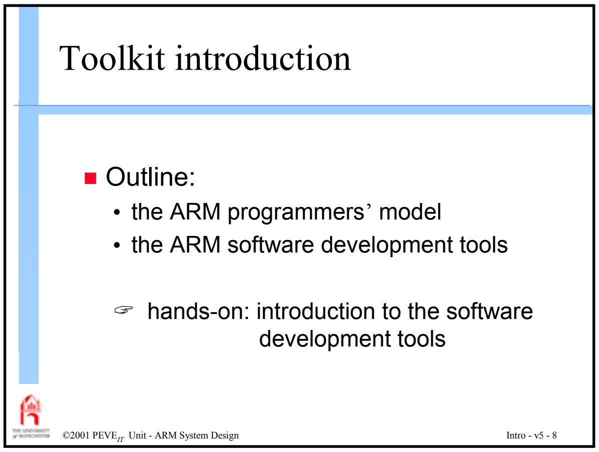
Structure of ARM course

- The ARM software development toolkit
- ARM assembly language programming
- Support for high-level languages
- The ARM instruction set in detail (Including THUMB instr. set)
- ARM Cores and Systems



Practical Work

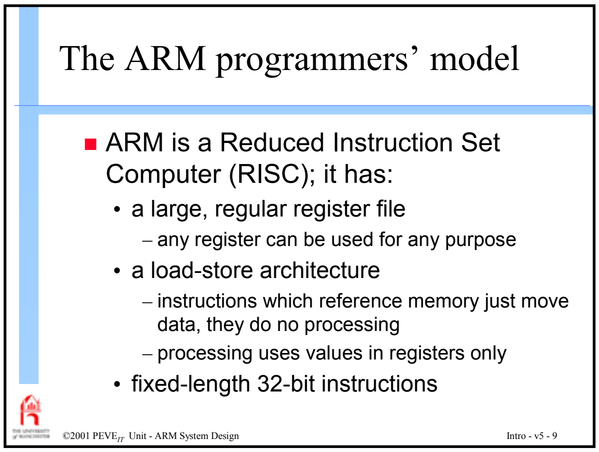
- ARM IDE
- Assembly, C, Thumb, (Assembly & C)
- Code debug and profiling
- Implementation on ARM7TDMI processor
- Hopefully!!!!



Toolkit introduction

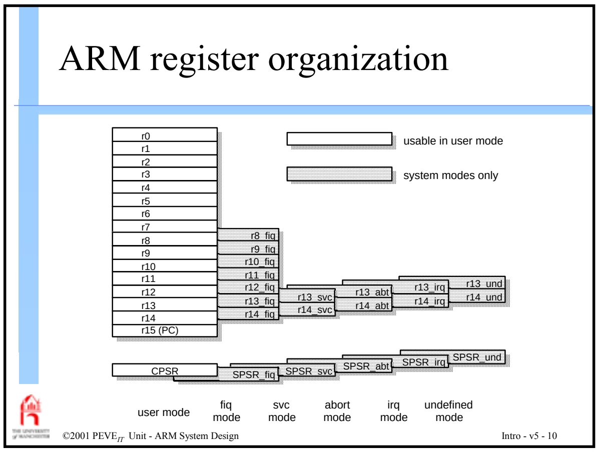
- Outline:
  - the ARM programmers' model
  - the ARM software development tools

☞ hands-on: introduction to the software development tools

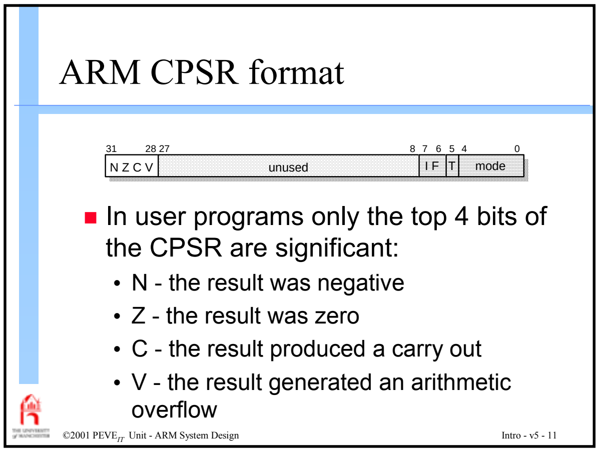


The ARM programmers' model

- ARM is a Reduced Instruction Set Computer (RISC); it has:
  - a large, regular register file
    - any register can be used for any purpose
  - a load-store architecture
    - instructions which reference memory just move data, they do no processing
    - processing uses values in registers only
  - fixed-length 32-bit instructions

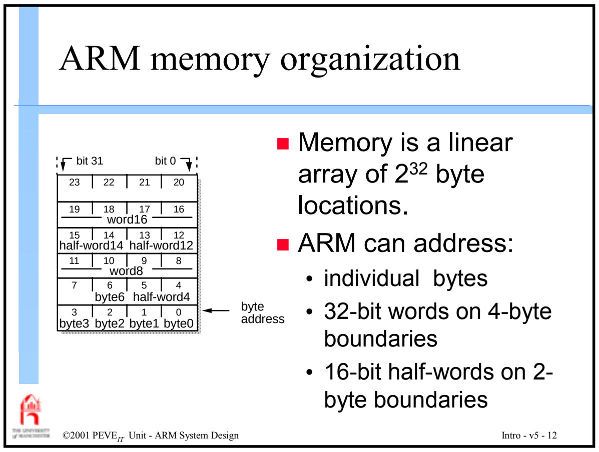


ARM register organization



ARM CPSR format

- In user programs only the top 4 bits of the CPSR are significant:
  - N - the result was negative
  - Z - the result was zero
  - C - the result produced a carry out
  - V - the result generated an arithmetic overflow



ARM memory organization

- Memory is a linear array of 2^{32} byte locations.
- ARM can address:
  - individual bytes
  - 32-bit words on 4-byte boundaries
  - 16-bit half-words on 2-byte boundaries

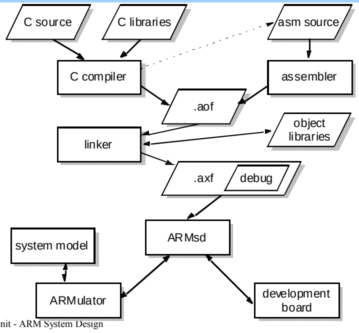
ARM software development tools

- Even experienced programmers approach a new environment by first getting a simple program to run
  - often a 'Hello World' program
- This requires some basic tools:
  - a text editor, to enter the program
  - an assembler to produce binary code
  - a system or emulator to test the code

ARM software development tools

- The toolkit has several components:
  - the ARM C compiler
  - the ARM assembler
  - the linker
  - ARMsd - the symbolic debugger
  - the ARMulator - ARM emulator
- These can all be controlled by the ARM project manager

The structure of the ARM cross-development toolkit


C source
C libraries
asm source
C compiler
assembler
.aof
linker
object libraries
.axf
debug
system model
ARMsd
ARMulator
development board