

UNIVERSITY OF LONDON  
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 1998

BEng Honours Degree in Computing Part III  
BEng Honours Degree in Information Systems Engineering Part III  
MEng Honours Degree in Information Systems Engineering Part III  
BSc Honours Degree in Mathematics and Computer Science Part III  
MSci Honours Degree in Mathematics and Computer Science Part III  
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the  
Associateship of the City and Guilds of London Institute  
Associateship of the Royal College of Science*

PAPER 3.02 / I3.8

SOFTWARE ENGINEERING - METHODS

Monday, April 27th 1998, 10.00 - 12.00

*Answer THREE questions*

For admin. only: paper contains 4  
questions

- 1 You have just been employed by Babel Fish Software, a new start-up company. Babel Fish is in the machine translation business. The company's initial aim is to develop and market a Windows-based package that will translate documents from any major European language to any other. Subsequently the company intends both to improve the quality of translation and to extend the range of supported languages.

The company founder and Managing Director is a former academic. He is an acknowledged expert in the "theory" of machine translation, but has little software engineering experience. Other key figures in the new company are the Marketing Director (who has previous experience in marketing shrink-wrapped software) and the Financial Director (who previously worked for a firm of accountants).

Your role within the company is Head of Software Development. You will lead a team of six people who are responsible for actually developing the software package that the company will sell.

You decide that your first concerns should be the *stakeholders* and the *quality profile*.

- a Identify the stakeholders in this development.
- b Provide an initial quality profile for the translation package. (As a rough guide, this profile should contain between 10 and 20 quality characteristics.)
- c Briefly describe how you would check and refine this initial quality profile before proceeding further with the development.

*(The three parts carry, respectively, 15%, 65% and 20% of the marks.)*

- 2 Following your outstanding success at Babel Fish, you are now working as an independent software engineering consultant. You have been contacted by the Managing Director of Energy Management Systems PLC (EMS) and invited to “come in for an informal chat, to see if you might be able to help us”.

At this informal chat, the Managing Director explains that EMS markets a family of shrink-wrapped software packages to assist large companies with monitoring their energy consumption, identifying potential problem areas and improving energy efficiency. All these packages have been developed by EMS themselves.

In response to your enquiries, the Managing Director briefly summarises their approach to development, which is as follows:

- (i) by contacting various existing and potential customers, the company’s marketing team identifies customer needs that could be addressed by a new EMS product
- (ii) the marketing team then identifies a new potential package and produces a one-page English description of the package function and key features
- (iii) the software development group then expands this description into a full technical specification, and obtains approval for this specification from both the Marketing Director and the Managing Director
- (iv) once the specification is approved, the software development group produces estimates of the total time and effort needed to develop the specified package, and obtains approval for these estimates from both the Financial Director and the Managing Director
- (v) the software development group then produces and delivers the software as specified

Having outlined this approach, the Managing Director explains that “our experience with software development has been unhappy. Development always takes much longer than planned and costs much more. Then when the software is delivered, it always seems to have major quality problems – it’s full of bugs. And even when those bugs are finally sorted out, our customers never seem to be entirely satisfied. They always seem to be asking for changes, most of which we’re not able to make.”

The Managing Director then asks for your opinions and suggestions. What might be the causes of all these problems? Could EMS reduce its problems by changing its approach to software development? And what specific techniques should they consider? Of course, the Managing Director isn’t at this stage “expecting any definitive answers”, but just “looking for broad ideas”.

- a What would you suggest as possible causes of the problems that EMS has been experiencing?
- b What changes would you suggest to EMS’s overall approach to software development?
- c What specific techniques would you suggest for consideration?

[Note. Lengthy, essay-style answers are not necessary; simple statements of key points will be quite sufficient.]

*(The three parts carry, respectively, 30%, 40%, 30% of the marks.)*

*Turn over ...*

- 3 For a simple language with: assignments (A), binary conditionals (C), loops (L), and sequencing (S); a measure,  $M$ , for “lines of code” can be defined hierarchically as follows:

$$\begin{aligned}
 M(A) &= 1 \\
 M(C(p1, p2)) &= M(p1) + M(p2) + 1 \\
 M(L(p1)) &= M(p1) + 1 \\
 M(S(p1, p2)) &= M(p1) + M(p2)
 \end{aligned}$$

where  $p1$  and  $p2$  are sections of the program.

- a Give the structure as a tree of the following program fragment and draw the control flowgraph for it. Use the above definition to calculate (showing working) the number of lines of code.

```

while(x > 1) do
  if (x mod 2 == 0)
    then x := x/2
  else x := x * 2
  endif
;
  if (x mod 3 == 0)
    then x := x/3
  else x := x * 3
  endif
enddo

```

- b The “visit each loop” strategy executes all combinations of possible outcomes of decisions at conditionals and loops. Loops are not required to be executed more than once.

Define a measure for the maximum number of tests required by this strategy and calculate its value (again showing working) for the above program fragment.

- c For the visit each loop strategy, what is the largest number of tests which could be required for 100% coverage of a program of 7 lines of code.

Give a formula in  $n$ , the number of lines of code, which expresses the maximum number of tests which could be required for 100% coverage with this strategy.

*(The three parts carry, respectively, 35%, 35% and 30% of the marks).*

- 4a What characterises *adaptive techniques* for software unit test? What are the advantages of adaptive techniques for test case selection? What problems remain with these techniques?
- b Use the path prefix approach to give a test suite for 100% branch coverage of the following program fragment. (Consider the tuple (x,y,z) as the input and (a,b,c) as the output. Start with the input (0,0,0).)

```
if x = 0 then a :=1 else a := 2;  
if y = 0 then b :=1 else b := 2;  
if z = 0 then c :=1 else c := 2;
```

What would be the smallest number of tests which could give 100% branch coverage of this program fragment.

- c Distinguish between *faults* and *failures*. Which are being looked for in unit test and which in system test?

Explain the terms *usage model* and *testing model* as used in statistically based system testing. How are these models used to determine the reliability of the software.

(The three parts carry, respectively, 30%, 30% and 40% of the marks).

*End of Paper*