BCS PROFESSIONAL EXAMINATIONS
BCS Level 6 Professional Graduate Diploma

October 2007

EXAMINERS' REPORT

SOFTWARE ENGINEERING 2

General Comments

Most of the scripts produced by candidates were well structured and readable. However, the comprehension by candidates of the questions asked needs particular attention. A common practice by such students was that of writing all that had been memorised on a keyword without reference to the context given in the question. A feature of examinations at Professional Graduate level is the examiners wish to see critical choice exercised by candidates; to assist this, questions are often set in a context where critical choice is required to determine an acceptable answer. It follows that there is often no single correct answer, but reasoned and evidenced answers will be well received.

The exam sought to test candidates' knowledge and ability to apply their knowledge according to scenarios presented. Many answers were either to questions of candidates' own inventions or simply on recall of facts without reference to the given scenarios. Consequently, such answers were given low marks. Candidates should measure the effort required for the marks available; ten pages for 4 marks is not time-efficient.

It is clear from these questions that the breadth and currency of knowledge, regarding software engineering principles and practice, is very limited in some centres. Particular emphasis must be placed on the importance of candidates studying not only a recommended text, but reading more widely in terms of publications within the profession.

Similar to the previous year, some candidates continue to answer more questions than required in the examination, and this practice reduces the time available for each question and limited the opportunity to obtain the full range of marks.

Finally, similar to the previous year, some student had not completed the front cover with the number of the question and part-questions attempted. This made it very difficult to find, then determine whether it was a continuation of a previous question, and assess and record the mark for that question as a whole.

Question 1

a) Show how the steps of Risk Management interact with a Design-Build-Test development cycle for software development. **(12 marks)**

b) In your view, is there any one area of software development that would benefit from Risk Management? Give your reasons fully. **(3 marks)**

c) You are asked to create a company standard for Risk Management. Giving your reasons, derive the type of standard you would create and show the design of THREE of its elements in detail. **(10 marks)**

Answer Pointers

a) Principles of Risk Management are 5 or 6, depending on interpretations. These are identify, analyse, prioritise, plan, implement and monitor. Sometimes, implement and monitor are conflated. 3 marks for listing the steps.

Interaction with a Build-and-Test cycle is summarized in the table. Elements are my suggestions, but similar, relevant, ideas from candidates are acceptable.

Risk element/life cycle stage	**Design**	**Build**	**Test**
Identify	Standard methods	Coding standards	Testing linked to requirements
Analyse	Methods should fit comfortably around tools used	Standards should be easily understood and be about understand-ability	Tests should be traceable to requirements
Prioritise	Most important because cheapest to do.	Least important if design is good.	Equal most important because essential for good validation by customer
Plan	Training	Training	Training
Implement	On-the-job	On-the-job	On-the-job
Monitor	Metrics of design review discrepancies	Metrics of number of runs to successful compile-and-build.	Metrics of number of non-compliance test reports

3 marks for each of design, build and test.

b) Arguably, design control is least well done in small development shops and deserves quality attention for its contribution to profitability and low maintenance costs when well done. However, any element of the process, if well supported with strong reasons from the candidate's experience or view, will be acceptable.
2 marks for an idea, 5 marks for a defended and contextualised idea.

c) Type of standard is either product or process. A 'product' Risk Management standard would, for example, be a document that defined the activities. A 'process' standard would be descriptions of *how to do* Risk Management for this Design-Build-Test set of activities.
3 marks for bilateral comparison, 1 mark for a simple suggestion.

What's expected is a process standard with details descriptions of three elements, as outlined in the table above. If the candidate offers a product standard, it would need to describe three elements of content to an equal level of detail as expected for a process standard. 7 marks

Examiners Guidance Notes

Part (a) posed a standard question (about risk management) but then set the scenario as a Design-Build-Test environment. Many students recited Risk Management strategy without placing their answer in the context of the scenario given. Others chose to ignore the context, and describe the operation of Risk Management across a complete requirements-to-maintenance life cycle. Still others selection one of Design, or Build, or Test, and proceeded accordingly. The answer specifically sought how risk management was applied to software-specific activities.

Part (b) asked candidates to make a critical choice and defend it. Many candidates asserted that there were two or even three ‘one’ areas, and by hedging their broad set of answers lost the marks for a single strong answer that illustrated critical choice.

Part (c) asked for an application of risk knowledge to address a particular problem, that of a company standard. Many answers gave a recitation of risk management’s steps without applying them to software-specific activities or events. How this could act as a company standard escapes the examiner. It’s like describing how to clean windows as ‘use water and check afterwards.’ What’s absent is how and what to do; domain knowledge.

Question 2

You are asked to create a software quality training programme for a software company of 20 people who use Open Source tools. Your observations of their processes ahows them to be between Level 1 and Level 2 on the SEI maturity scale; that is, they have some procedures and plans but these are mainly about configuration control and testing because their development model is Build-and-Synchronise. Mainly, they react to events.

a) Giving your reasons fully, explain how you would create this Training Programme. **(5 marks)**

b) Giving your reasons fully, identify in outline what it would contain, how the material would be sequenced, and how long it would run. **(20 marks)**

Answer Pointers

a) To create the Training Programme means having a target results and an outline curriculum. From the question, the aim is SEI Level 2 and the curriculum will be procedures for whole-project planning activities, executing them and checking/monitoring satisfactory completion. This is also given in the question. The monitoring of effectiveness is not so much formal training as mentoring of staff engaged with testing to check that success compliances are increasing, else the training programme has been ineffective. This, or similar focused and credible plan. 5 marks, lesser answer pro rata.

b) Curriculum material should contain models for design activities, build activities and test activities. These models should relate to the practices of the company in so far as the company staff recognize what the models do, and so how to comply with them. 5 marks, lesser answer pro rata.

Sequencing is dependent on availability of company staff and perceived priority. It is suggested to start from the top with design models, because that is the easiest place to begin particularising into detail for coding and testing. However, any sequence if well reasoned is acceptable. 10 marks, lesser answer pro rata.

Duration of training should be whatever fits the available staff time, but the essential part is continuing in some way to monitor the effectiveness of the training. This seems easiest done with a system of mentoring or other way of measuring reductions in test cost or test time.

5 marks, lesser answer pro rata.

Examiners Guidance Notes

The context given here again asked candidates to make critical choices. The phrase 'Open Source Tools' was pounced on by several candidates who implied that quality training depended on the brand of tools in use. The answer has nothing to do with Open Source. The phrase was inserted to test candidates abilities to ignore irrelevant information. Again, a specific context of Build-and-Synchronise was given but this did not stop optimistic and fruitless offerings of quality training for requirements capture.

In Part (a), the context gave the background of the company, so candidates who stated that this needed to be researched did not gain any marks thereby.

In Part (b), there were many answers that did not give specific software processes as objects of quality training. Again, critical choice was expected in this application of a general topic to specific activities. Mentoring as a technique for teaching adults was rarely mentioned despite its importance to our profession. Testing outcomes as a way of measuring effectiveness was also largely ignored.

Question 3

You are engaged to consult on the software testing of an Engine Management System (EMS) for diesel engines, consisting of the Engine control unit (ECU) with software and algorithms as we as a set of input-output sensors.

The aim of you testing is the Smoke Limitation Map as shown in Figure 1 below. This is a data map used by the EMS software to decide how much fuel to inject into the engine. It is controlled by two inputs – charge-air pressure and engine speed. The output is the maximum permissible injected fuel quantity.

The fuel quantities are measured in millilitres, from   0.1 to 2.0 ml.
The air pressure is measured in BAR, from 0.5 to 10.0
The engine speed is measured in revolutions per minute, 800 to 4800
The main surface is partitioned into 99 unequally-sized segments in a 9 by 11 grid.

a) What testing strategy would you employ to test the Smoke Limitation map? Give your reasons. **(5 marks)**
b) Give example of three different types of test you would design to test the Smoke Limitation map. **(20 marks)**

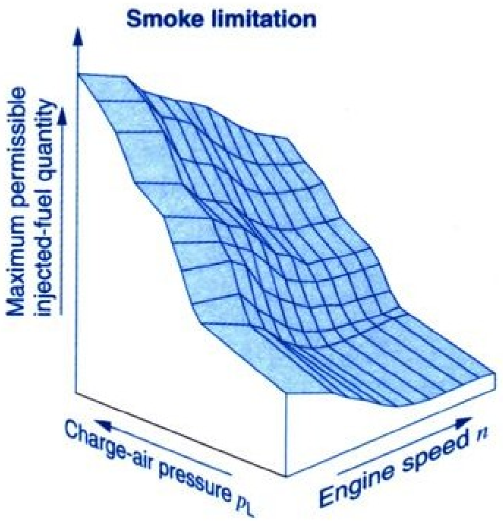

Figure 1: Engine Management Systems software map

Answer Pointers

a) What's wanted here is a strategy that is holistic over all outputs. Suitable models are Equivalence Partitioning to group data elements together, and Boundary Value Analysis to check the extremes. A simple Black Box approach does not address the 'holistic' need.
5 marks, lesser answer pro rata.

b) Partitioning is important to model the test data because the data spaces are unequal in area. From the diagram of Figure 1, a suitable partitioning might be:

Charge-air pressure - 0.5 to 10 BAR in 9 steps	**Engine speed - 800 to 4800 in 11 steps**
0.5 to 2.0	800-2000
2.0 to 2.5	2000-2200
2.5 to 3.5	2200-2500
3.5 to 4.0	2500-2700
4.0 to 5.0	2700-2900
5.0 to 6.5	2900-3200
6.5 to8.0	3200-3600
8.0 to 9.0	3600-3900
9.0 to 10.0	3900-4200
	4200-4500
	4500-4800

These test values approximate to the unequal areas of the fuel-response map. Candidates need not get these exact arithmetical results, as long as they show sensitivity to the unequal areas of the map and attempt to model test values at this level of detail.

The expected outcomes are the 99 values of fuel quantity to be injected. This suggests 99 partitioning tests, taking a value from each partition of Charge-Air Pressure with a value form each partition of Engine Speed. Each output value should sit in the sector identified from the map.
15 marks, lesser answer pro rata.

And four additional Boundary value tests should result in 'error' or 'no-compute' outputs.

- (low charge-air less than 0.5 BAR, low engine speed less than 800 revs/minute),

- (less than 0.5 Bar, more than 4800 rpm),
- (greater than 10 BAR, less than 800 rpm), and
- (greater than 10BAR, more than 4800rpm).

5 marks, lesser answer pro rata.

Examiners Guidance Notes

This question created a scenario for the application of testing. It was the third most-popular question, after Q5 and Q1. However, candidates did not use the detail given in the question and so the application they produced was deficient in several areas. In particular, the diagram clearly shows that the test variables Speed and Pressure are dependent one on the other. A change of value in one will produce a consequent change of value in the other. Many answers treated these variables as independent. Further, some answers treated fuel quantities as test inputs despite the question which said ‘the ***output*** is the maximum permissible inject fuel quantity’.

In Part (a), the principles of functional testing are required. Many candidates succeeded very well to describe the principles.

In Part (b), a problem for applying the principles is given. Part (b) was less well done.

Question 4

A Media company has asked you to develop a web application for supporting collaborative working, with the proviso that their existing legacy systems will remain fully operational until the new system has been proven by its users and customers.

Discuss and justify the software development toolset, which you might usefully employ in this project from the initial stages, through to the commissioning of the new system itself.

(25 marks)

Answer Pointers

A good answer should be structured in the following manner:

a) Identify the stages of the software life cycle and recognise their differing task and tool requirements; and

b) provide a justification for a prototyping/incremental approach to development, given the nature of the application and the constraints;

c) Justify the need for tools where possible to be integrated. However, there are issues of cost and compatibility with the existing legacy systems. Thus, individual tools could be considered for:

  - Project management
  - Prototyping (End-user) tools (4GL) can aid in requirements elicitation;
  - reverse engineering tools for legacy software
  - CASE tools supporting design, coding, testing tasks will provide documentation and audit trails
  - Configuration management tools to support the maintenance function

c) Discuss:
  - how the application will be tackled with the tools available today and

  - the impact of client imposed constraints, including concerns re changeover.

Examiners Guidance Notes

This question assesses the candidate’s knowledge and awareness of the range and benefits of methods and tools available to the software engineer during the lifetime of a business application.

This was the third most popular question. Disappointingly, it had the worst pass rate. Whether it was poor time management resulting form the extra question, or the last question completed by most candidates, is not clear. However, what is clear from the answers submitted was a general lack of knowledge of the software life cycle phases as applied to the scenario described, and the tools that can be usefully employed by the engineer at each stage. In particular, many had knowledge of one phase or one tool, but few had knowledge of multiple stages and their respective tools.

Further, a significant group of candidates in some centres provided answers around the keywords in the scenario described without reference to the question that was being asked.

It is hoped that in future candidates will have a better appreciation of the software development lifecycle for applications generally and the tools of practicing professionals.

Question 5
A local government office requires an integrated web-enabled bill payment system for its residents. Discuss and evaluate the suitability of the RAD and Spiral process models, in terms of their approach and potential for success in delivering the system requested.

(25 marks)

Answer Pointers

A good answer should be structured in the following manner:

INTRODUCTION. Highlight issues in relation to system requirements such as ambiguity, and missing or imprecise statements of delivery date, functionality and target technology. Key words include "integration" with other systems; "web-enabled" access; and "resident" as user and usability issues.

DISCUSSION OF METHODS:

i) RAD emphasis: to radically decrease system development time through: user involvement; prototyping; and integrated case tools. It is more of a strategy rather than a methodology. Similarly,

ii) Spiral. Emphasis on a continuous process where risks are explicitly specified and assessed throughout. Each cycle moves closer to the product, effecting objective setting, risk assessment and reduction, development and validation, and planning.

EVALUATION OF METHODS:
Both are effective: in instances where requirements are unclear, RAD emphasis on early product delivery, Spiral early risk assessment and reduction; incremental approach making monitoring and progress reporting visible; in small to medium-scale projects.

The bill payment system, characterised as being of relatively low customer risk, a user community that is geographically dispersed, and of varied educational background, the immediacy of the customer need, and the use of unproven (modern) technology in this application domain, provide ample justification for adopting the RAD approach.

Examiners Guidance Notes

This question assesses a candidate's knowledge of specific process models and his or her ability to apply aspects of the model to the outline scenario presented.

This was the most popular question with the second highest pass rate. It was clear from the answers submitted that many candidates had a good knowledge of one of the methods and was able to demonstrate understanding of certain aspects of its application. However, where many of the answers could be improved is in the areas of producing answers that have far less description of models, and more text of a discursive and evaluative nature.