GX1327

Ollscoil *na* hÉireann, Gaillimh
National University of Ireland, Galway

SUMMER EXAMINATIONS 2000

B.E. DEGREE (Electronic Engineering)

CT407. APPLIED SOFTWARE ENGINEERING

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(Time allowed: 3 hours)
Answer **five** questions in all.
Answer at least **two** questions **from each section.**
Use **separate answer books** for each section.
All questions carry **equal marks.**

SECTION A

1. (a). In Functional design what procedural description methods are used to specify algorithmic detail ? Describe the basic constructs found in structured specification and illustrate your answer using conventional flowcharting notation. Give a clear example for each construct.

   (b). For the restaurant described in the following narrative, construct a structured specification to describe the inventory management function:

   The Kampus Kitchen is a busy student restaurant catering for up to 3,000 meals each day, as well as snacks, sandwiches and beverages. The catering manager now wishes to automate the inventory control function and is working with a software development consultancy to develop a specification of his requirements. The re-ordering process is complex and firstly depends upon whether or not the food item is perishable. If an item is perishable (such as meat, vegetables, salad, dairy products), a pre-specified quantity is supplied each week-day from the wholesalers. At week-ends only 20% of this quantity is supplied, i.e. on Saturdays and Sundays. For non-perishable goods (such as plastic cutlery, bottled/canned beverages, napkins, straws, etc.), an order is placed when the stock on-hand in the restaurant stores reaches a critical pre-determined minimum quantity (i.e. the re-order point); a fixed re-order quantity is then ordered from the wholesalers. Recognising the seasonality of his business, the catering manager has set lower order quantities for the off-peak Holiday Period (Summer Months and Christmas); this is seta at half the normal quantities for both perishable and non-perishable goods.

2. (a) For the Vending Machine system described in the following narrative, construct environmental and behavioural models (using DFDs), ensuring that all processes, data flows, stores and external entities are correctly annotated and that external events are clearly identified.

   (b) Illustrate how *event partitioning* might yield a different first-cut behavioural model than *functional decomposition.*

   (c) Describe the operation of the *coin validation and acceptance sub-system* using Structured English.

Vending Machine

The client started by outlining to the analysts that he is faced with crooks as customers who try putting junk into the coin slots of his vending machines hoping to get something for nothing. Some even try to enter coin-like slugs to fool the machines. They also try to vandalise

the selection register to get products free. These are major problems for the vending machine operators because they do business on a narrow margin, which disappears very quickly.

The machine is to do the following:

- *Accept objects from the customer in payment for their purchase.*
- *Check each object to make sure it is not a slug. This is to be done by validating the size, weight, thickness, and serrated edges.*
- *Accept 10p, 20p, 50p and £1 coins only. Any other coins are to be treated as slugs and returned to the customer.*
- *Only initiate payment computation or product selection process after a valid coin is detected. The system is to be difficult for people to trick.*
- *Accept product selection from the customer. The machine provides a selection of hot drinks and allows the customer to select Strength (Weak, Medium, Strong), Milk and Sugar options.*
- *Check to see whether the selected product is available (check product dispenser to make sure it is not empty), and if not available, then return coins automatically and notify the customer.*
- *Accept a variety of products, which will change from time to time. Hence, as a maintenance feature, the product prices should be changeable.*
- *Return the customer's payment on request if he or she decides not to make a selection.*
- *Dispense the product to the customer if it is available and the amount is sufficient.*
- *Return the correct change if the amount deposited is greater than the product price.*
- *Disable the product selection after the product is dispensed and until the next validated coin is received (remember those crooked customers).*
- *Make deposited coins available for change.*

3. (a) For the system described in the following narrative, construct an ER model, showing all relevant entities, relationships and cardinalities. Use Relational Notation to describe the data entities, attributes and likely primary keys in the systems database.

A contract manufacturing firm, "Manufacturing Solutions", builds components and systems for the Computer and Telecommunication industries. A Shop-floor Management System (SMS) controls execution of all manufacturing jobs, allocating operators and materials to specific machines on the production lines, and keeps track of the progress of jobs through the plant until completed products are placed in the finished-goods warehouse to await despatch. The system's Manufacturing Database holds up-to-date information relating to:

- *the assignment of operators to machines and jobs;*
- *the routing of products through the production lines (i.e. which machines the product is directed to – each product may pass through a number of machines);*
- *allocation of job numbers to batches of each product;*
- *batch sizes;*
- *start and end times for each job;*
- *product descriptions and type;*
- *operator profiles, including names, skill types, and grade;*
- *time-spent by operators on a job;*
- *machine characteristics, including type, rating, cost and make/model.*

(b) Convert the un-normalised table shown below into a set of Third Normal Form relations. Clearly show your assumptions, identifying how functional dependencies and the relevant normalisation rules apply at each stage.

Operator ID	Operator Name	Product Number	Job ID	Product Description	Machine ID	Machine Type	Machine Rating	Machine Cost
1234ABC	J. Bloggs	XX-2311	JB-6543	Modem_01	SMT_01	Surface mount	50k pitch	850,000
		XY-1111	JB-6543	WAP_card	SMT_01	Surface mount	50k pitch	850,000
123DEF	T. Jones	XX-2311	JB-6544	Modem_01	SWAVE	Solder	100 ppm	450,000
		XY-1111	JB-6545	WAP_card	SWAVE	Solder	100 ppm	450,000

4. (a) In the design of real-time systems, what are the main characteristics of External Events and illustrate your answer with examples;
   (b) What are the limitations of conventional data flow modelling techniques in the analysis and design of real-time systems. Explain, with the use of appropriate data flow diagrams, how control and sequence are modelled in the analysis of real-time systems.
   (c) For the Defect Inspection System illustrated in the following schematic, construct an annotated State-transition Diagram to illustrate its operation.

Defect Inspection System

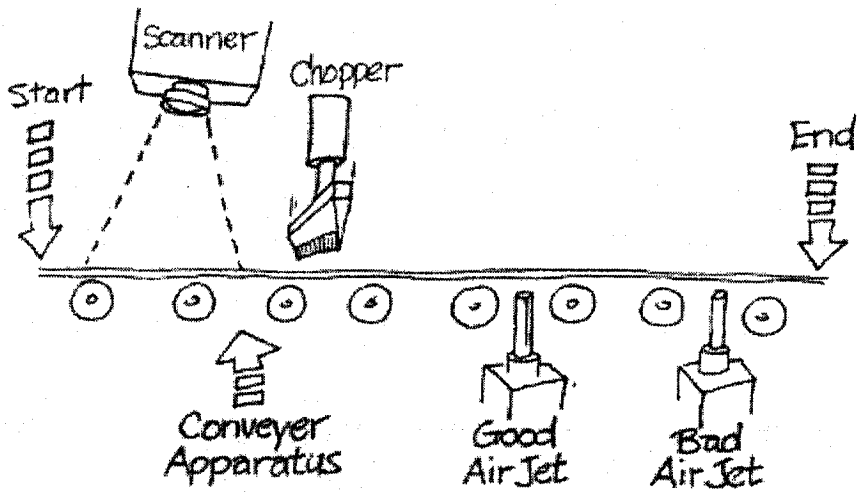
The purpose of the defect inspection system is to chop rolls of metal foil into sheets and to sort the sheets into two bins according to a pre-selected product standard Those that meet the standard go into one bin, those that do not go into another. The system is run by a supervisor and a number of operators. The supervisor is responsible for the overall running of the system including selecting product standards, configuring each of the production surfaces, and selecting sheet sizes.

The four production surfaces are monitored by the operators; presently each operator is responsible for two surfaces. The operators can start and stop a production surface. They also wheel out full bins and replace them with empty ones. Each production surface is equipped with a scanner, a chopper, and two air jets. Any configuration of this equipment is workable, so long as both air jets follow the chopper. The supervisor tells the system which configuration has been set up on each surface.

The scanner operates by reading the amount of light reflected from the foil. A large percentage of the reflected light for squares scanned by the scanner must be between certain values, as defined by the product standard, for the foil to be deemed "good," otherwise the sheet must be rejected as "bad." Irregularities in the foil will tend to produce values outside the specific range. The scanner returns data for each of the squares by organising what it "sees" into lanes that run perpendicular to the direction of travel of the foil. Data is produced for each square in the lane, preceded by the lane numbers.

A chopper for each surface can be commanded to drop, thus cutting the roll into sheets. The chopper raises itself automatically once it has chopped the foil. The chopper must be controlled to chop the foil into sheets of constant size for a particular run. The foil may be chopped before it is scanned. There are two air jets; one pushes the foil to the left, the other to the right. By custom, good foil is always thrown to the right.

The foil is moved along the production surface by a conveyer belt system that can be started and stopped by the operator (to start or stop the production surface is, in fact, to start or stop the conveyer system). A shaft encoder is connected to the drive roll in the belt system; each quarter revolution of the drive roll will produce a pulse from the shaft encoder. The resolution of the system is sufficient to be able to cut sheets to lengths measured in units of shaft encoder pulses.



Event List

Sheet enters system.
Edge of sheet is under scanner.
Edge of sheet is under chopper.
Edge of sheet is under good air-jet.
Edge of sheet is under bad air-jet.
Supervisor defines product standard for production run.
Supervisor configures inspection surface.
Operator starts system.
Operator stops system.
Supervisor changes sheet size.

SECTION B

5. (a) Design a container class *AccountManager* that manages *Account* objects. Each *Account* has a number and a balance, and may be debited or credited. Represent the design as a class diagram, and provide a sample implementation.

   (b) Extend the solution from part (a) to include a class that provides a global point of access to the *AccountManager*. This new class should (1) create a single instance of *AccountManager*, and (2) only allow one instance of itself to be created. Provide a sample implementation of this new class.

6. (a) Discuss the advantages and disadvantages of inheritance as a design technique.

   (b) Design an extendible solution for the *Employee Information System* defined below. State all design assumptions made.

   On a salary scale for software developers, there are four kinds of employee: software engineer, senior software engineer, principal software engineer and consultant engineer. Each employee can have one or more qualifications (date, institution, title and result). A list of projects that an employee has worked on is also stored. Project information includes a project code, description, start and finish date. An employee can participate on many projects, and each project can have more than one employee working on it. The start date and finish date for employees on each project should be stored. Employee address details are stored (house, street, town and county), and employees can be promoted from one grade to the next at any time.

7. (a) Construct object diagrams to represent the following class associations:

   - A patient (rsi number, name) is assigned to a room (code, floor)
   - A student (id, name, date of birth) enrolls in a degree (code, description)
   - A student (id, name, date of birth) studies subjects (code, description), where each subject can be studied by many students.

   (b) For the second class association defined in part (a) of this question (i.e. student enrolls in degree):

   - Draw a class diagram.
   - Provide a sample implementation.

8. From the description below, produce:

   - A Use-Case diagram.
   - Collaboration diagrams.
   - An initial class diagram that includes an *Application* class (used to startup the system).
   - A refined design, based on object-oriented design principles, which ensures that the design can be easily modified and extended at some future point.

   Two key transactions have been identified for a fantasy football system.

   (1) Add Owner, where an owner is described by: id, name, e-mail address and date of birth.
   (2) Add a team, where a team has a code and a name, and is linked to one (already defined) owner.