VendiLogic Ltd

VendiLogic is a company that specializes in the design and development of vending machines, e.g., machines that dispense drinks, snacks, or other items. It has decided to develop a new vending machine which uses software to coordinate and control its hardware components. The vending machine will be used to dispense both (cold) water and a range of food items / snacks. The vending system has been designed and the electronic and mechanical hardware has been produced to create a prototype system. The software development, however, has suffered serious problems and delays!!

VendiLogic employed a programmer to do all the software development. Things were very good at first. Hacker Harry, as he preferred to be called, started producing code from day one. He shut himself away in a corner of the development lab and often worked late into the night. Within the first month he had something working but it wasn't quite what was required - he had hardly talked to the rest of the development team and had made some obvious mistakes. For example, he did not realize that the cup dispensing mechanism takes 0.5 seconds to dispense a cup which resulted in water being dispensed before the cup was ready. He also didn't know that cold water must be maintained at a temperature below 20 degrees Celsius, otherwise it can develop harmful bacteria. Still, Harry was confident that he could make all the necessary changes to his software and have the prototype ready for the tradeshow at the end of May 2024.

That was a month ago and things seem to have gone from bad to worse. Harry fixed the cup dispensing logic within the system but that seemed to have upset the food selection logic - although how exactly these two functions interact with one another is difficult to determine. Other problems have also surfaced. The most embarrassing was when the Managing Director came to have a look at progress and received a packet of crisps and a chocolate bar from the machine, and she had asked for peanuts!

At a meeting with the Product Development Manager, the Managing Director made it clear that she was not at all impressed and that the Product Development Manager had better get the system working or else. In a drastic move, the Product Development Manager has decided to call in another software development company to develop a second set of software at the same time as Harry, to ensure that a workable solution is produced.

That's where you come in. You are working for Software Specialists Scotland Ltd and have been given the task of collecting the user requirements and doing an initial analysis and design for the Vending Machine system. You will be using the C++ programming language to implement the system and the Visual Studio IDE (this is to ensure compatibility with existing tools). When you meet the Product Development Manager, she begins to give you the following description of the software needed…

REQUIREMENTS

Software is needed to control the vending machine. The machine is made up of the following components:

- a touch screen display panel, for displaying information about the items which can be purchased from the vending machine and/or status information.

- a card reader, for receiving vending cards (used to buy drinks), and service cards (used by service operators and maintenance operators to access the machine).
- a water dispenser, for dispensing cups and cold water. This comprises the following:
    - a cup dispenser, to dispense empty cups onto a dispensing tray.
    - a water dispenser, to dispense cold water into the cup. A large, replaceable jug of water is inserted into the machine to serve as a water supply and placed onto the water dispensing component to draw water from.
    - a refrigeration unit, which keeps the cold water at a desired temperature.
    - a dispensing tray, onto which a cup is dispensed and then removed by the user when ready.
- A food dispenser, for dispensing items of food or snacks, e.g., crisps, chocolate bars, health snacks. This comprises the following:
    - A number of shelves, to contain different food items. During the dispensing process, items are pushed off the end of the shelf into a collection drawer below. Different vending machines will have different vending capacities, i.e., the number of shelves they contain. All the VendiLogic machines will have between 4 to 12 shelves in them. Each shelf will have a product that sits on it. During the dispensing process, users will specify the shelf number of the item they wish to purchase, e.g., select shelf 2 for crisps, or shelf 7 for a chocolate bar.
    - A collection drawer, where dispensed items are dropped into and can be removed by the customer.

See Figure 1 below for a representation of how the vending machine may appear and the different components it has. The software that you will be developing will interact with individual components in the machine to control and coordinate them during the various vending machine processes. The hardware components are being developed by a separate hardware team, and they will ensure that the components can be programmatically controlled and queried by your system if you implement the functions necessary. Your software will implement functions that will be able to do the following: to issue commands to the components, e.g., 'dispense water'; to query the components for status information, e.g., 'how many cups do you have left?'; and/or to receive notifications from components about their status. Please just assume that the hardware components will be capable of doing whatever your system requires them to do, and that your system can interact with them on that basis to fulfil its tasks.

A number of products will be available to dispense. For each product, its name, cost, and shelf number will be recorded. This is so that product information can be displayed to the user, and they can specify the shelf number of the item they wish to purchase. There will be a configuration file on the hard disk of the machine which specifies the product information, so the system knows what products are available, their cost, and which shelves they are on. This file can be updated whenever products are added or removed, or when the shelf number that a product has been placed onto changes. A maintenance operator (see below) will be responsible for updating the configuration file when required during regular maintenance visits. It is expected that the Vending Machine will have limited memory available and so the size of the configuration file on disk must be kept small.

A maintenance operator will be responsible for maintaining the machine (see service details later). During routine maintenance, they will refill the products in the food dispenser, refill cups in the water dispenser, and refill the

water jug too. It is important that they place the correct items into the correct shelves in the food dispenser, otherwise, customers may not get charged the correct amount for their purchases, e.g., if a £3 luxury chocolate bar has been mistakenly put onto the shelf where a 50p snack was expected. The contents of the shelves should correctly correspond to the contents of configuration file on disk.

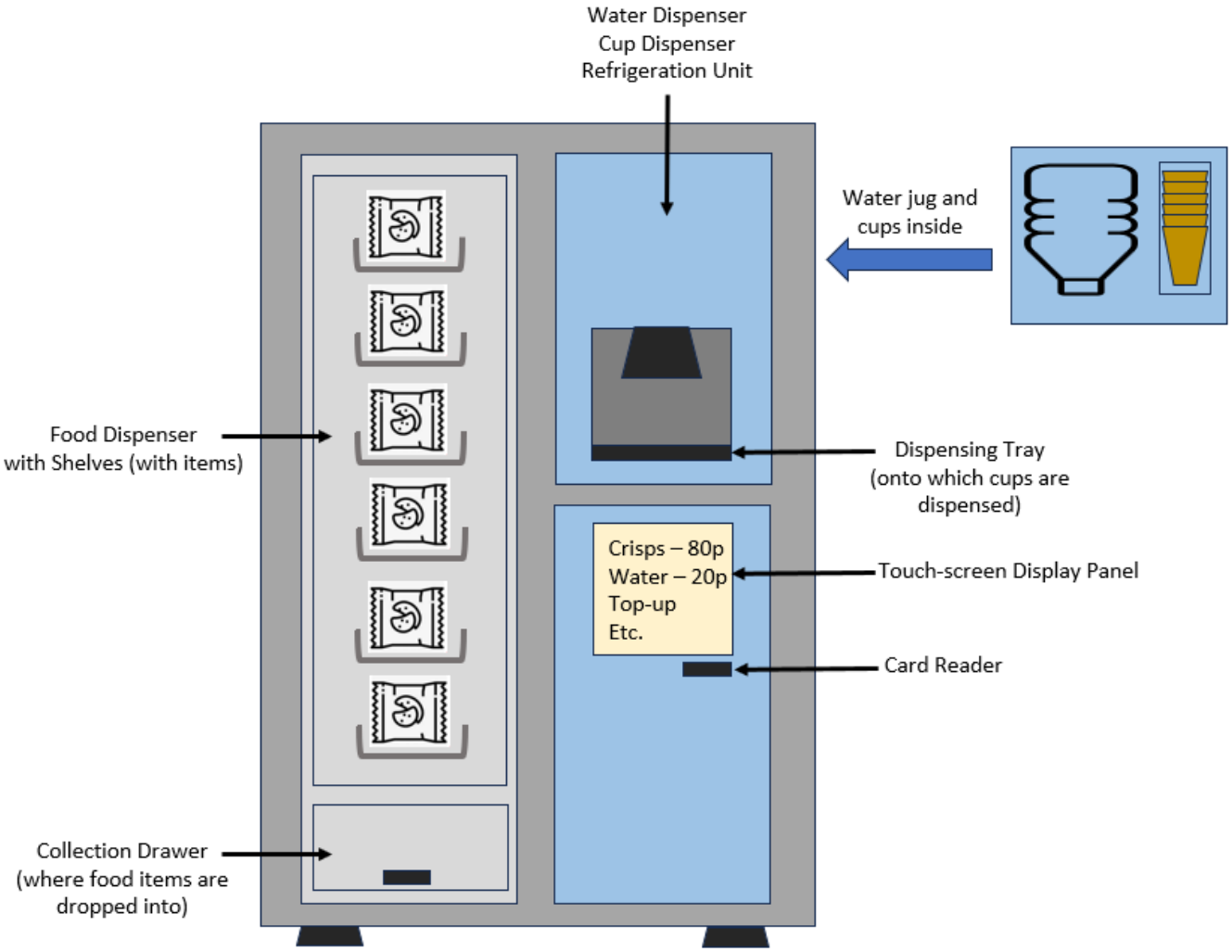

Figure 1 Artists Impression of the Dispensing Machine

The Very Good Vending Company only sells its Vending Machines to large companies and organizations who wish to have on-site vending facilities for their employees, staff, and visitors. The primary method of buying drinks will be with a vending card. Vending cards will usually be provided by a company or organization to each of its employees. The vending cards will come with an initial amount of credit preloaded (ranging from £1 to £10). When the vending card runs out of credit, it will be possible to 'top' it up (see later). The vending machine will have a card reader built into it, equivalent to those which are normally used in bank cash machines. This will be used facilitate card-related transactions.

When a vending card is inserted into the card reader, the software will read the amount of credit available on the card and display this amount to the customer. At the same time, the system will also determine which items / products are available for purchase and display those too. Only those items which are in stock, and which are affordable (based upon the credit inserted) will be displayed. Stock levels can be determined by querying the relevant component(s) for status information. The name of each item will be displayed along with its price. Customers can select the shelf number for the item they wish to purchase. See a sample display in Figure 2 below:

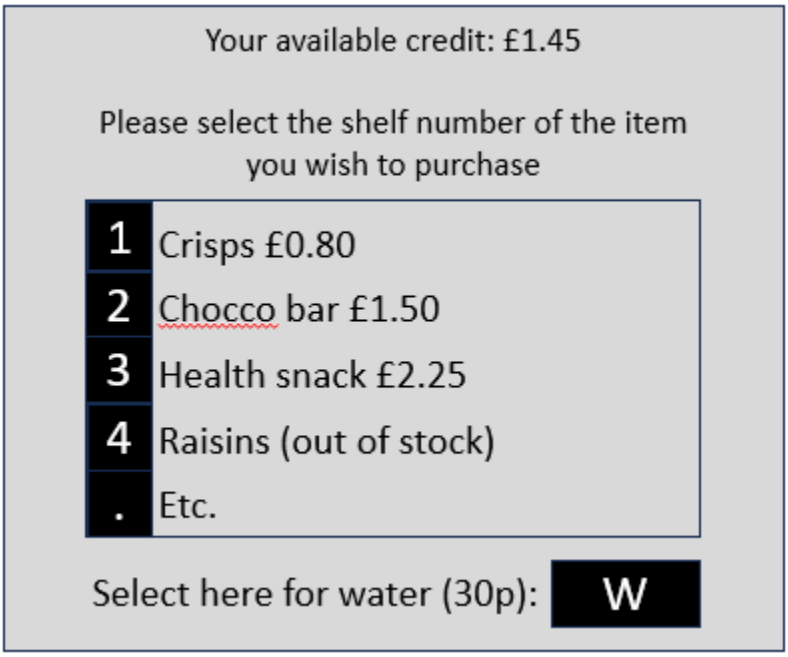

Figure 2. How the touch screen display may appear

When the customer selects one of the on-screen choices (see Figure 2), the corresponding item will be dispensed. If they select the option to dispense water, the system should do the following:

1. Dispense a cup onto the dispensing tray.
2. Dispense water into the cup.
3. Notify the customer that their drink / water is ready.
4. Deduct the cost of the water from the customer's vending card and return their card to them.

If the customer selects the option to dispense a food item, the system should do the following:

1. Instruct the food dispenser to dispense the item on the relevant shelf (the shelf selected by the customer containing the item they wish to purchase).
2. Detect that the item has fallen into the collection drawer at the bottom.
3. Instruct the customer to remove their item from the collection drawer.
4. Unlock the collection drawer to allow the customer to remove their purchased item.
5. Deduct the cost of the item from the customer's vending card and return their card to them.

It is essential that items are dispensed within an acceptable time frame to prevent customers from waiting too long.

At regular intervals, e.g., after an item has been dispensed, the vending machine will conduct stock checks. For example, to determine if the number of cups in the machine, or the number of products in the machine has fallen below a certain threshold. The relevant component(s) in the machine can be queried for this information. When it is detected that the machine has begun to run out of certain items, the software will notify a service company that maintains the vending machine. The vending machine will have a SIM card installed in it which allows it to have access to a mobile network. When low stock is detected for one or more items, the system will send a message to the service company's service notification system. The system must prepare a stock report which will contain the following: for each item in the machine, its name and current stock level; the date and time of the report; the ID of the vending machine to which the report relates (each vending machine has a unique ID / serial number which is programmed into it along with its version number). Once the stock report has been prepared, the system will send the report to the 'service notification system'. NOTE: in the future, it is anticipated that the different 'endpoints' might be used for stock notifications. For example, instead of sending stock reports to the 'service notification system', it may be required to send these to a private email address or to a private Twitter (or 'X') account instead.

Vending card top-ups

Customers will be able to top up the amount of credit on their vending card through the vending machine. A 'top up' option will be provided on the display whenever the customer inserts their vending card, alongside the standard display which shows the current items available. If this option is selected, the on-screen display will allow the customer to enter details of a bank card or credit card (card number, expiry date, CVC code) along with the amount of credit they want to add to their vending card (up to a maximum of £30). The system will use the machine's mobile network connection to communicate with the Very Good Vending Payment Server, which will authorize the transaction, process the payment, and return confirmation that it has been successful. The customer's vending card can then be topped up with the appropriate amount.

Machine maintenance and servicing

The Very Good Vending Company has a partnership with a service company who are responsible for maintaining and servicing the vending machines. At regular intervals, a maintenance operator from the service company will visit the vending machine sites to perform standard maintenance tasks, such as cleaning the exterior of the machines. Maintenance operators can also access the interior of the vending machine to fill up stock of available items. To access the machine, the maintenance operator must insert a special service card into the vending machine's card reader. The service card contains the following information: the operator's name, their employee ID, a 4-digit Personal Identification Number (PIN), and an access level (where level 1 = maintenance and level 2 = service). When the service card is inserted, the software must read the information from the card and change the display on the vending machine to allow the operator to enter their PIN. If the PIN entered by the operator correctly matches that on their card, the software will unlock a service panel on the vending machine so that it can be accessed. The operator can then perform tasks required such as refilling stock and doing any internal cleaning of the machine.

The maintenance operator can also update the details of the products which are in the machine. They will do this by copying a new configuration file onto the hard disk of the machine as described earlier.

When the maintenance has been concluded, the vending system will automatically send confirmation to the service company that the maintenance is complete. A maintenance report will be sent to the service notification system (mentioned previously) which contains the following: the employee ID of the maintenance operator; the ID of the vending machine; the current date and time.

In addition to maintenance operators there are also service operators. Service operators are responsible for conducting repairs to the vending machine if it stops working or if its components have become faulty. Service operators will visit the vending machine sites annually to perform checks on the machine hardware. In addition, if a fault is detected in the machine during the dispensing process (such as a component becoming unresponsive), the vending system will automatically send a fault report to the service company to request that a service operator should visit the machine. The fault report will contain the name(s) of the component(s) that are detected as being faulty along with the machine's ID and the date and time that the fault was detected. The fault report will be sent via the service company interface as before, e.g., to the service notification system. When a service operator subsequently arrives to service the machine, they will access the machine in the same way as a maintenance operator: they will enter a special service card. As before, the service card will contain the operator's name, their employee ID, a 4-digit Personal Identification Number (PIN), and an access level (where level 1 = maintenance and level 2 = service). Those with level 2 access can access additional components within the machine that go beyond the remit of a basic maintenance. Once they have accessed the machine, the service operator can perform whatever repairs they require. Once the service has been completed, the machine will be rebooted to allow any changes to come into effect.

When a service is in progress, the vending machine display panel will provide additional options to the service operator. For example, one initial option will be a 'Check for Updates' option. This allows a check to be made for newer versions of the vending machine software. If this option is selected, the current version number of the vending machine will be sent to the service company's 'service notification system' to determine whether any newer versions of the software are available. If a newer version is available, the relevant files will be downloaded directly to the vending machine through the mobile network connection and a message displayed to the service operator that they should restart the vending machine after the service has finished by turning the power off and on again. When the system powers up again, the newer software files will automatically come into place, and the software version number will have been updated too.