4M21 Software Engineering and Design 2024/2025

Solutions

Version: EP2/POK2

Question 1

(a)

Autonomy The user volunteers and inputs information about their own goals.

Competence The app provides regular updates on progress.

Relatedness Progress can be shared with family and friends.

It is also possible to critique the app from these perspectives but this is not required. For example, in terms of competence the app could proactively suggest steps to lose weights and link these with data, goal-setting could be refined to improve autonomy, and so on.

[30%]

(b)(i)

Contextual inquiry is form of semi-structured interview where the researcher observes the user carry out. activities that are important to them and talk to them about those activities.

[10%]

(b)(ii)

Context The researcher needs to be close to the user while they make use of the app and other activities, such decisions to eat (and what to eat), and exercise.

Partnership There has to be a bond between the user and researcher. The user must be willing to actively try to teach the researcher about their chosen behaviour.

Interpretation The user has to be willing to confirm findings with the researcher and work with the researcher to ensure there is a correct understanding of findings.

Focus The researcher has to be able to probe deep into issues. Hence, the user has to be willing to invest significant time and effort in engaging with the user research.

[20%]

(b)(iii)

While contextual inquiry could be useful, as the method has the benefit of realism, it would be a challenging method to apply for this design problem. First, it would be a very expensive method of user research that require a single researcher to follow a user for several days, possibly weeks, to understand their habits, needs, wants, values, progress, barriers, and obstacles. Second, while the method has high realism, findings are still isolated to the individuals that are studied, so there is a risk of poor generalisability of findings. Third, weight loss is a very personal activity connected with exercise, eating habits, mental health, social life, stress, and so on. There is a high risk of a form of a say/do problem where the user does not tell the truth, choose to withhold information, or does not willing engage as a partner to aid in correct interpretation of findings. Fourth, as weight loss is an activity that has to be sustained over a long period of time and involves factors that occur sporadically throughout a day, the user must be willing to fully devote to this research throughout many days. It is not realistic to be able to persuade people to take part in such research. Contextual inquiry is usually deployed to find out about how people carry out work activities.

[20%]

(c)

By *research through design*, we mean that design can in itself produce new knowledge, such as new perspectives on a problem, new insights, and so on. This can be done by creating a new prototype app that demonstrates new ways of engaging with the weight loss programme.

[20%]

Question 2

(a)

“Create a system that uses augmented reality to provide real-time manual guided assembly support for the task of manual assembly of control panels subject to frequent changes in a factory environment”, which can be reduced to “Design a guided assembly system for the manual assembly of control panels”.

[10%]

b)

Naïve physics An augmented reality based system uses people’s common sense knowledge of the physical world involved in manual assembly.

Body awareness and skills An augmented reality based system can allow users to move their arms, fingers, and their hand, as well direct their gaze, when interacting with both digital and physical artefacts, as they do in the physical world.

Environment awareness and skills Users will use augmented reality in an environment they are familiar with the augmented reality display will enable them to navigate in this environment in way that is familiar to them.

Social awareness and skills Augmented reality retains the ability to observe and interact with co-workers.

[20%]

c)

Mental workload The mental workload can be assessed through regular survey instruments asking the user to rate their perceived workload, by measuring time and quality of assemblies, or by taking regular measurements of blood pressure, etc.

Situation awareness Situation awareness is very important in factory environment. This can be studied by examining gaze patterns provided by the glasses or by tracking movement and responses of co-workers in the factory.

Complacency Complacency can be studied by tracking quality incidents over time.

Skill degradation Like complacency, skill degradation has to be studied over time. Skill degradation manifests itself in over reliance on the guided assembly system. It can be tracked through regular observations of manual assembly or by intervention studies that test users’ ability to engage in unassisted manual assembly.

Automation reliability The ability of the guided assembly system to correctly interpret a situation and suggest an appropriate action can be studied in offline studies with representative data or by carrying out experiments in the deployment context and track the performance of the automated system.

Costs of decision and action outcomes The risk of incorrect suggested instructions can be studied by engaging in risk analysis, such as engaging in a structured what-if technique risk analysis exercise.

[30%]

d)

There are two primary threats to validity. The first is *construct validity* since the Lego task does not possess the same characteristics as the task of assembling a complex control panel, giving rise to the risk that findings intrinsically linked to the task itself do not transfer to the deployment context. The second is *external/ecological validity* as the task now involves non-expert university students outside the factory environment. Both their non-expertise and the fact that they are not studied in the deployment context of a factory gives rise to factors that may prevent the findings from being relevant to the actual deployment context.

[20%]

e)

Appropriation is likely as the designers are unlikely to fully understand the complete context of the guided assembly of complex control panels and because the assembly itself frequently changes as the control panel design frequently changes. This gives rise to situations where the system is unlikely to achieve the user's goal unless the user is able to plan ad-hoc strategies that the system is not designed to support.

There are many possible answers. Two solutions to support appropriation of this system is to (1) provide visibility of system functions and status to allow the user to build appropriations based on a correct understanding of the system's understanding of a current situation; and (2) allow easy sharing of appropriations so that co-workers can share their workarounds with each other.

[20%]

Question 3

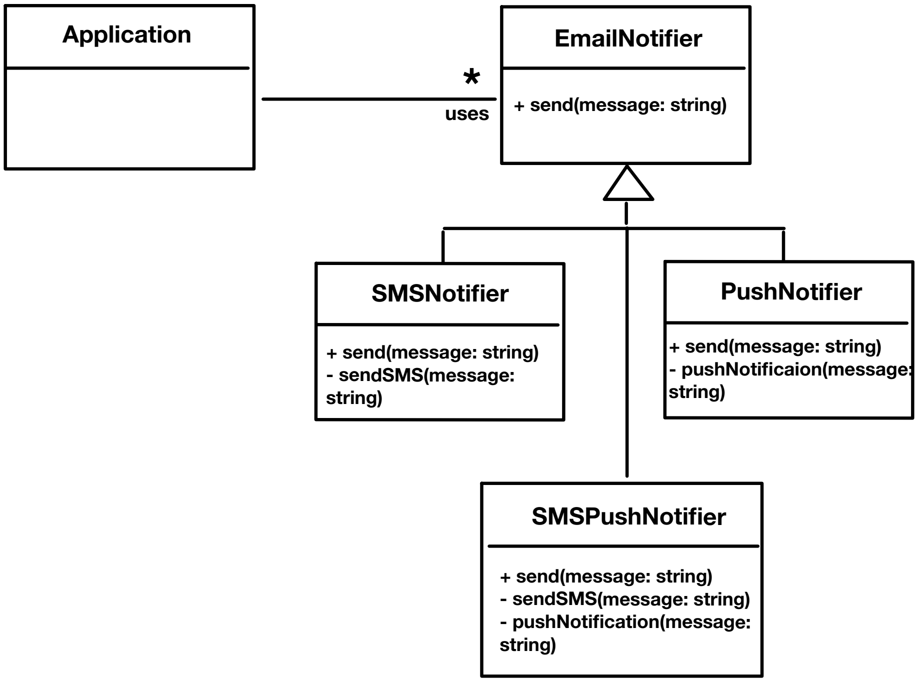
a)

Encapsulation is a concept used in object oriented design. It involves bundling data and methods into units ('capsules') to conceal inner workings. It gives increased control over data, allows to hide complex details that do not matter for someone using code and only expose what is necessary, protect information. Some of the benefits include easier code evolution over time (easier to make changes to the code without breaking compatibility) and easier code maintenance (easier to test/debug or develop/extend encapsulated units independently).

[10%]

b) (i)

One of the possible solutions is presented below.



[15%]

b) (ii)

Objects: *anApplication* of class Application;
and *anSMSPushNotifier* of class SMSPushNotifier, where SMSPushNotifier is subclass of EmailNotifier.

Series of calls: 1. *anApplication* calls send(message) in *anSMSPushNotifier*;
2. *anSMSPushNotifier* calls
- a parent method `send(message)`
- the method returns
- a private method `sendSMS(message)` in itself
- the method returns
- a private method `pushNotification(message)` in itself
- the method returns

3. `send(message)` method called by anApplication returns and is completed

[15%]

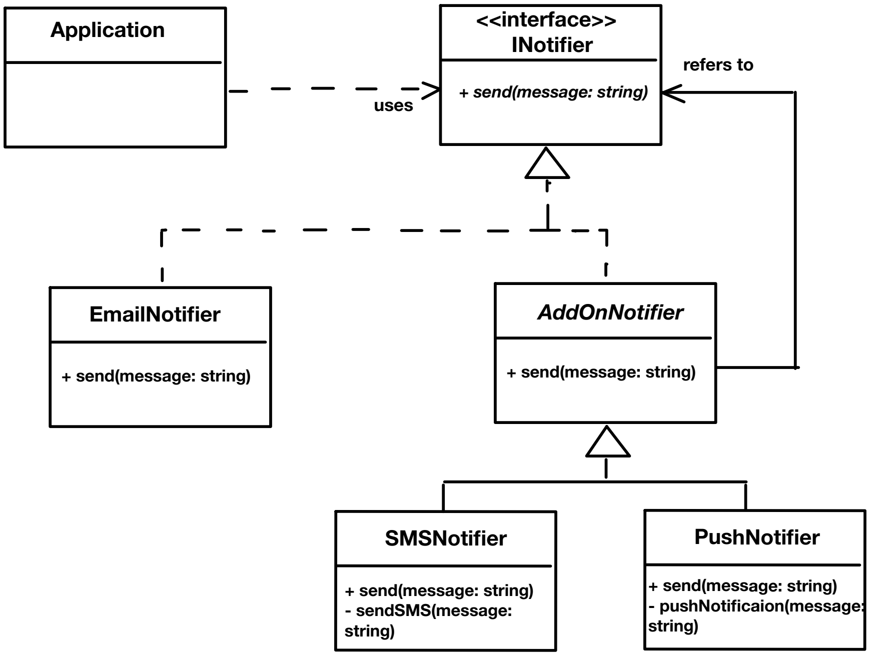
b) (iii)

Advantages: simple and adequate for the case.

Disadvantages: high proliferation in classes particularly if the number of communication methods keeps growing;
an existing object cannot be changed at runtime (need to replace the whole object with another one that is created from another subclass).

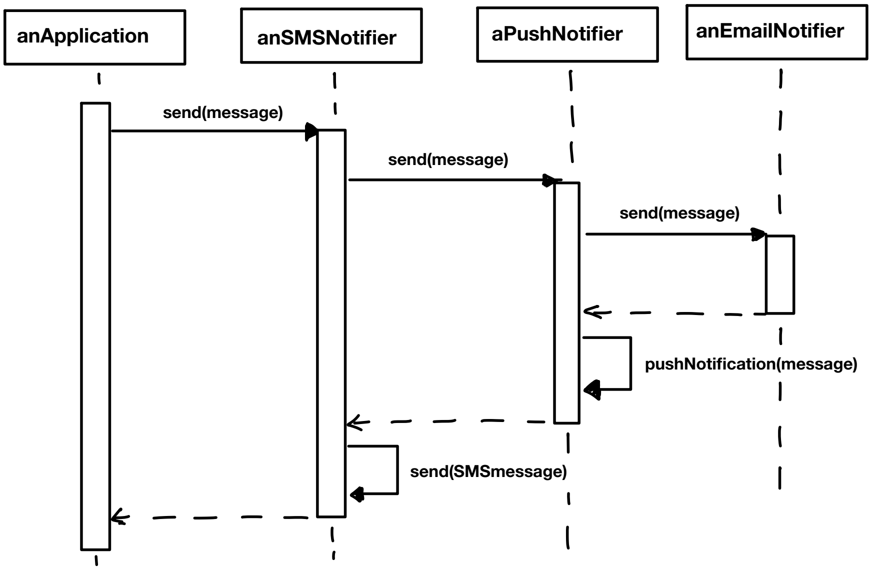
[10%]

c) (i)



[25%]

c) (ii)



[10%]

c) (iii)

Advantages: allows to add optional functionality without changing the code for either the base class or any of its subclasses
allows to add extra behaviour to objects at runtime
allows to combine multiple behaviours

Disadvantages: if there are not too many communication methods it might be more convenient just to add attribute in EmailNotifier class to specify which, if any, additional communication means to use
could be hard to resolve the identity of the objects one is dealing with as we might have a long chain of small objects pointing to each other.

[15%]

Question 4

One of the possible solutions is presented below.

a)

Architect: defines the overall architecture, module structure and all major interfaces; responsible for specification and high level design.

Project manager: responsible for scheduling the work, tracking progress and completion on time and on budget.

Lead programmer: manages programmers and testers (30% time) and implements.

Programmer: implements specific modules and may implement test procedures for modules.

Tester: designs test and validation procedures for the overall process, may implement some test procedures.

[15%]

b)

Application that calculates how much fuel to load onto a commercial aircraft is **safety critical** (potential loss of life).

- It is possible and important to understand, clarify and define all requirements prior to the start of the project.
- These requirements are unlikely to change during duration of the project.

⇒ Traditional **waterfall model** is most likely to be used.

The **key stages** of the waterfall model are analyses, design, implementation, testing, deployment and maintenance.

Advantages:

- early clarification of requirements
- works well with management tools, well documented for compliance, quality assurance, risk management, meeting regulatory requirements purposes.

[25%]

c)

The waterfall model, if it was followed, is not the most suited for the development of the community website. It is difficult to specify the system requirements in advance, and neither it is critical. 'Right' today for a community web site might not be 'right' tomorrow; it is not clear how popular the system would become, one may need to experiment with different features, keep evolving and changing the system so iterations are important.

The waterfall model does not allow for iterations, by the time the product is released there is very limited resource left for any changes or extensions, changes become very costly and would take a long time - by the time they are actually implemented a completely different set of changes might already be required.

⇒ One of the agile methodologies is more suitable.

[25%]

d)

Main risks and appropriate tests to mitigate these risks could be identified by either following the software engineering process or by using 'testing quadrants' tools.

Taking into account the nature of the software such as

- not critical to the main business/operations of the company,
- purpose to increase customer engagement, collect and analyse service feedback,
- limited negative impact on the brand,
- higher fault tolerance as not critical for users,
- potentially limited budget (marketing)

points to note are:

High number of iterations is expected: might warrant investment in setting up automated system to cover practical number of testing such as unit tests, regression tests - need to keep an eye on not over-investing as operation of the website is not critical for main business of the company (only light repetitional damage);
might use beta testing/exploratory testing to groups of users when new features are introduced.

Usability is important: community members (large variety of age groups and experience) may not find the system easily usable, resulting in a large number of customer service enquiries (expensive) or giving up before they even had a chance to find out all the benefits it provides ⇒ quick usability tests with limited number of users (to limit costs), web site analytics, make it obvious to the users how to provide feedback if errors/feature requested to use 'users as testers';

Real-life conditions: failure of functionality/performance in certain real-life conditions (for example, specific browsers, following updates)
⇒ deployment tests in variety of environments, resource exhaustion/recovery testing, ease of issue reporting for users

Other: website might suddenly become very popular and fail ⇒ basic performance testing, stress testing and testing under load;
basic security/privacy etc. non-functional tests to limit the potential of reputation damage.
[35%]