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Robert Biddle

Victoria University of Wellington, robert@mcs.vuw.ac.nz

James Noble

Victoria University of Wellington, kjx@mcs.vuw.ac.nz

Ewan Tempero

Victoria University of Wellington, ewan@mcs.vuw.ac.nz

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Role-play and Use Case Cards for Requirements Review

Robert Biddle, James Noble and Ewan Tempero

School of Mathematical and Computing Sciences
Victoria University of Wellington, Wellington, New Zealand
robert@mcs.vuw.ac.nz, kjx@mcs.vuw.ac.nz, ewan@mcs.vuw.ac.nz

Abstract

This paper presents a technique that uses role-play and index cards to review use cases and to assist in making use case development more accessible and better guided. The technique is based on the established CRC card technique used for object-oriented design. In our technique, essential use cases are recorded on index cards, and role-play is used for development and review. The paper presents the technique, and outlines our experience in applying it.

Keywords

Object-Oriented Approach, Information Requirements Determination Activities, Object-Oriented Analysis

INTRODUCTION

We have been exploring ways to improve the techniques we use in the early stages of object-oriented development. In particular, we have been investigating how to better determine use cases that capture requirements and can drive design. Determining whether or not a set of use cases capture the requirements requires that they be *reviewed*, and so we have been interested in how to effectively review use cases.

A use case describes a sequence of interactions between a user and a system. Identification and employment of use cases is now common practice in software development, and the use case is now a recognised concept in development processes. As with many other aspects of object-oriented analysis, however, use cases require understanding and experience before they begin to deliver their potential. A review process can help those new to the concept gain this understanding and experience.

To our knowledge, there are no review techniques specific to use cases. We were looking for techniques that would ensure active engagement by team members, provide more operational guidance, and also make the techniques more accessible to learners and system stakeholders. Moreover, these activities need techniques that are lightweight, inclusive, and flexible, so to best ensure insight and agreement about desirable system behaviour. In this paper, we present a technique for reviewing use cases that we believe has these properties. It is based on the successful CRC cards technique in that our technique also uses index cards and role-play.

The paper is organised as follows. In the next section we provide some background, discussing use cases and their role in object-oriented development, and also reviewing the CRC card design technique we adapted to use cases. In the next sections, we describe the technique itself, review our experience, and explain our use of *essential* use cases and the implications. In the final section we present our conclusions.

BACKGROUND

Use Cases

Ivar Jacobson et al. (1992) define a use case as “a behaviorally related sequence of transactions in a dialogue with the system”. The general idea is to represent intended sequences of interaction between a system, even if not yet implemented, and the world outside that system. This idea is very powerful, for several reasons.

In the early stages of development, use cases help to focus on interactions as a way of eliciting intended or desirable system behaviour and so capture requirements and help determine specifications. This technique is effective because interactions can be described in forms very easy for people to recall or imagine, such as narratives or dialogues.

In the later stages of development, use cases help again because of the focus on interactions. The interactions can now be regarded as the embodiment of the functional specifications that the system must meet. In design and implementation, a structure must be determined and created that will meet these specifications. In review and testing, use cases can be used to drive system behaviour for examination.

Use cases are based on sequences of interaction, and desirable interactions typically follow a structure of coherent progression, on a limited scale, toward a goal or sub-goal. This allows a useful partitioning of specifications. The partitioning into use cases is helpful in overall management throughout development, because individual use cases can be organised by selecting, grouping, filtering, prioritising, and so on.

CRC Cards

When looking for a technique to make use cases more accessible, we were inspired by a technique that addresses a later activity in object-oriented development. This technique is CRC (class-responsibility-collaborator), which uses cards and roleplay to facilitate designing a system as a set of collaborating objects (Beck and Cunningham 1989, Bellin and Suchman Simone 1997, Wilkinson 1996). Each class is represented by an index card, and members of a design team play the roles of classes, verbally simulating the behaviour of the system. The cards themselves are used to record the responsibilities and collaborators of the class. A responsibility is an abstract idea of what the class should know or do, and the notion of responsibility is used as a heuristic to distribute intelligence in the system.

CRC cards were originally written up as a way of learning about design, where the cards helped make the idea of objects more concrete, and the roleplay fostered an awareness of object collaboration. CRC cards are now widely regarded as a sensible design technique in general, and not only something for beginners. Bellin and Suchman Simone (1997) refer to CRC as a “meta-cognitive” process, where the operational nature of the technique assists thinking about key issues in the design:

Each person on the team literally takes on the role of a class and, using the CRC card as a script, acts out the system. The value of this strategy is that the act of pretending to “be a class” and figuring out what you have to do triggers the same responses as brainstorming. Playing with the cards triggers unanticipated insights. Role play does this successfully because it makes team members active participants.

USE CASE CARDS AND ROLE-PLAY

We have used and admired CRC cards for some time, and, when looking for a way to make use cases more accessible, we decided to take a similar approach. Our basic idea was to use index cards for use cases, and to somehow involve roleplay as well.

Use cases describe interaction with a system, but there are several ways to describe interaction. We chose the form of a dialogue between a user and the system. We particularly hoped this would facilitate roleplay, because a use case in dialogue form resembles a script. The script has two roles, user and system, so use case roleplay can simply involve two people, each with a part in the script.

We decided that each use case card should represent a single use case, should show the name of the use case, and the steps of the dialogue script. To easily distinguish the two roles, we split the card with a vertical line down the centre, and write the user's lines on the left, and the system's lines on the right, as shown in figure 1. This layout resembles the two-column format used by Wirfs-Brock (1993). This kind of layout is especially good for functional requirements because it highlights how the system is used, and how the system behaves.

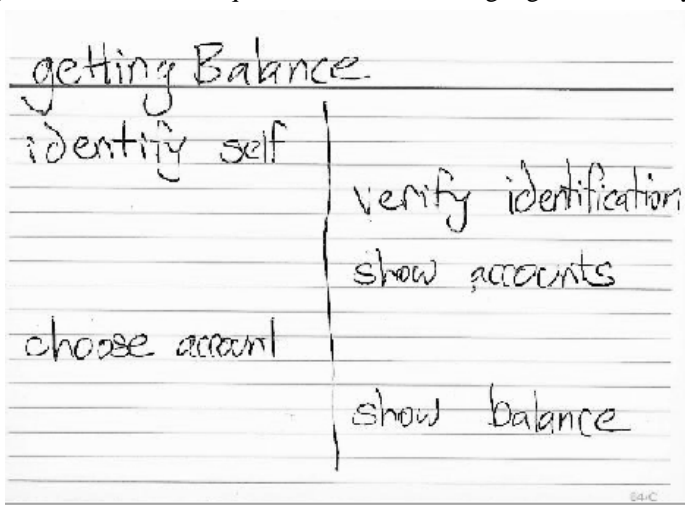


Figure 1: A use case card describing an essential use case for a banking system.

In general, use cases do not help address non-functional requirements. Non-functional requirements sometimes do, however, concern particular use cases, and brief notes can be made on use-case cards at the bottom of the cards, or on the reverse sides.

Use case cards and roleplay assist primarily in elaborating use case “bodies”, determining the steps of the interaction. Before that can happen it is first necessary to identify the use cases. This initially involves background analysis to come up with suggestions for the different ways users may interact with the system. In large system development, even use case identification can constitute an activity of significant size and scope. We use analysis techniques to identify a wide variety of candidate use cases, and then prioritise them, selecting a few “focal” use cases that represent critical interactions that will be necessary even in early prototypes.

We then start to work on these focal use cases by elaborating their steps with cards and roleplay. We generally suggest doing this with a small team of 3 to 6 people, similar to that recommended for CRC cards. We begin to work with cards by writing brief names for the focal use cases on the cards. For example, a banking system might have focal use cases called *depositing cash*, *checking account balance*, and *withdrawing cash*.

We then select a card and begin to work out the dialogue. We select people for the roles of user and system, and use an exploratory kind of roleplay rehearsal. The team works together on determining the steps in the dialogue. When ideas seem reasonable, the roleplayers “play-act” through the script, as shown in figure 2. The rest of the team audit, and afterwards the dialogue is discussed and improved where necessary. Increasing availability of document cameras means cards can easily be projected on a large screen for larger groups to follow. This process is applied iteratively until the team is satisfied the dialogue represents the way the user and the system should interact. Sometimes it helps to leave one use case and work with another, returning later to improve the earlier one.



Figure 2: A team performing use case roleplay while others review the dialog.

One use of roleplay is for exploratory and iterative development of the use cases. We also use roleplay as a way of presenting use cases for review. Such reviews may be conducted by peer developers, by people working on other aspects of a project, or by stakeholders or experts in the system domain.

After the index cards and roleplay have helped determine the use case bodies, the full details may be recorded in requirements documentation or in CASE tool databases. The use cases can be used to drive system design and review, and again later in system testing and demonstration. The cards and roleplay may still prove useful in some later activities, where their immediate and lightweight nature support rapid review and exploration of interaction alternatives.

EXPERIENCE

We have now observed many teams applying use case cards and roleplay. We have used the approach in working with more than twenty teams in industry, where the teams typically included non-technical staff such as

business analysts and line managers. We have also introduced the approach in teaching and project mentoring at our university, especially in our undergraduate courses in object-oriented development and software engineering. Our experience has been very positive. In both our industry and university work, we introduced this approach where the participants had already become familiar with the basic concepts of object-oriented systems and UML notation.

We had explicitly sought active and immediate engagement by team members, and that has happened as expected. As with CRC cards, the concrete element of the index cards, together with the behavioural element of the roleplay, together focus attention and command active participation. This alone is valuable because it ensures a focus on determining requirements that involves the whole team.

The index cards also help in a way that, as with CRC cards, relates to their simple nature as cards: they are discrete and concrete, and only a lightweight investment. Cards can be arranged or prioritised on a table top, needed cards can be selected while leaving others, and cards can be held during roleplay. A card can be changed or discarded easily without disturbing others, and the change can be made immediately.

The advantages of roleplay go deeper. People, even non-developers, are good at following dialogue. Moreover, they are familiar with the dramatic device of roleplay and the willing suspension of disbelief on which drama depends. People are typically able to watch roleplay, and imagine the interaction with the finished system with real understanding. This is a form of fast prototyping, and it allows fast review and feedback that allows iterative improvement.

Bellin and Suchman Simone (1997) point out that CRC roleplay leads to unanticipated insights, and the same thing happens in use case roleplay. In CRC roleplay, the insights typically concern how best to distribute intelligence among a set of collaborating objects. In use case roleplay, the insights relate to how best to communicate across the boundary of the system.

The cards and roleplay technique themselves are not always sufficient in themselves to determine whether use cases are reasonable or not. There are many aspects to use cases, and developers need to be aware of the issues. In particular, developers need to be aware of studies about how use cases model functional requirements (Armour and Miller 2001, Rosenberg and Scott 1999), and studies of what makes use cases actually useful (Cockburn 2001). Wirfs-Brock (1994) discusses how good use cases resemble “meaningful conversations”, and this especially relates to our technique. Roleplay makes the conversations come to life, and makes it easier to assess how meaningful they really are.

However, we must acknowledge that systems must also accommodate non-functional constraints (such as response time, transaction rate, information volume, reliability). Use cases are not ideal for detecting non-functional requirements because of their focus on interaction. This means that non-functional requirements must be assessed in some other way than our technique. However, use cases do form a convenient starting point for requirements review, and often do lead to discussion of non-functional issues.

In our experience, one critical issue in determining requirements is simply determining the boundary of the system, distinguishing what the system should do from what it should not do. It can be very difficult to reach the agreement necessary to make such distinctions while involving all the people involved, analysts and stakeholders.

Use case cards and roleplay have proven very useful in determining the system boundary. Our approach is to apply an approach familiar in design: we regard the system as a “black-box”. The internal workings are not specified, but the way the system is used is specified by the use cases. The two-column dialog form of each use case card clearly shows the role of the user distinct from the role of the system, and the line dividing these roles is the boundary of the system.

There are several ways in which use case roleplay assists to determine the system boundary. In early exploratory roleplay, it can quickly become clear if team members differ in their understanding about what the system is required to do. People reading the same analysis documents can come up with different interpretations, and it is especially common for differences to arise between technical designers and business analyst or domain experts. It is important to detect and resolve such differences early, and determining actual interaction sequences for roleplay tends to expose these differences.

The exploratory roleplay can also expose unreasonable assumptions about both the user and the system roles. For the user, it can become apparent that actions specified in a use case are inconsistent with how an actual user is likely to behave. For the system, it can become apparent the required behaviour is not possible because critical information will not be available. Figure 3 illustrates anomalies can be detected while roleplaying. Actually play-acting the roles seems to make such anomalies more obvious than if the use case was just read carefully.

Take 1:

User:

I say which performance I want and the system shows me the performance details.

System:

Hey! It's the my job to say what the system does.

CUT! -- This is often just an error made by the role-player, but can also indicate confusion as to where the system boundary is. Note how the person playing the system "protects their turf."

Take 2:

User:

I say which performance I want.

System:

I display the performance details and say whether or not the seats are available.

Audience:

Wait, the seats haven't been specified yet.

CUT! -- This indicates missing information in the use case. Here the audience keeps the players honest.

Take 3:

User:

I say which performance I want.

System:

I display the performance details.

User:

I specify which seats I want. Except that's not what I want to do. If I do that, and they're not available, I'll have to keep picking seats until I find some that are available. It would be easier if the system showed me what seats are available.

CUT! -- Here the user has immersed herself in the role and identified an inadequacy in the current version of the use case.

Take 4:

User:

I say which performance I want.

System:

I display the performance details and list the currently available seats.

User:

I choose which seats I want.

System:

I mark those seats as unavailable, print the tickets, and...Hmmm, perhaps I should compute how much they cost and collect the money before printing the tickets?

CUT!

Take 5: And so on ...

Figure 3: A sample dialogue from roleplay of a use case in a theatre booking system, illustrating how roleplay leads to early detection of use case difficulties.

To resolve such anomalies, the use case steps may have to be modified, or the use case may need to be structured in a different way. Such changes may require modifications made to other use cases, and may even

require even creation of new use cases. The important result is that problems can be identified and fixed at this early point, rather than at later more expensive points in development.

Roleplay also makes use case interaction understandable to observers outside a development team. This is especially useful in presenting use cases to busy stakeholders. Roleplay is quick, immersive, and very accessible. Without heavy investment, it makes is possible to discuss issues, compare alternatives, and possibly detect flaws.

To support use case roleplay and discussion about the system boundary, we have found use case diagrams helpful. We use a UML (Rumbaugh et al. 1998, OMG, 2000) use case diagram that shows actors (the UML term for users) as stick figures and their involvement with use cases as ellipses. We also explicitly show the system boundary, depicted as a box surrounding the use cases, with the lines between the actors and the use cases crossing the boundary, as shown in figure 4. The convention of showing the system boundary in use case diagrams was used by Jacobsen et al. (1992) but does not typically feature in UML, although it is an optional part of the UML use case diagram. The depiction of the system boundary is helpful in visualising the system as a unit, and the boundary line is consistent with the line dividing the user and the system on the use case cards.

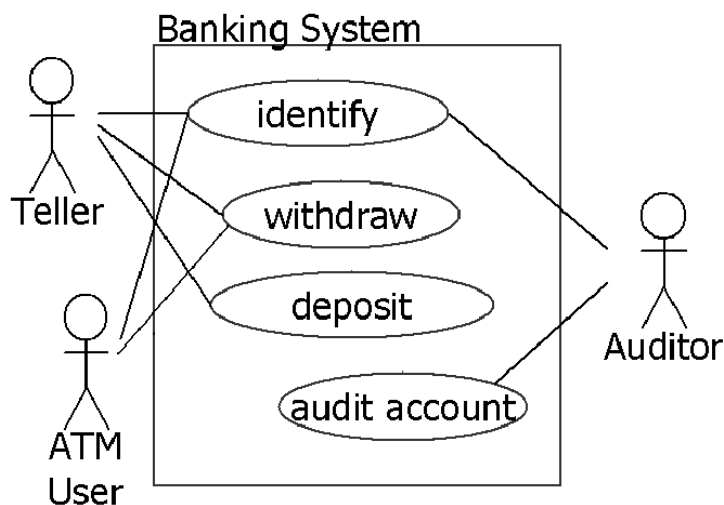


Figure 4: A use case diagram, explicitly showing the boundary around the system.

ESSENTIAL USE CASES

While we have described the cards and roleplay as involving use cases, we in fact typically work with a refinement of use cases known as *essential use cases*. This refinement was developed by Constantine and Lockwood (1997) and is part of “Usage-Centered Design”, a process for developing user interfaces. They make an important observation:

“In particular, conventional use cases typically contain too many built-in assumptions, often hidden or implicit, about the form of the user interface that is yet to be designed.”

Constantine and Lockwood define essential use cases as “a simplified and generalized form of use case”. They use the term *essential* because these use cases: “are intended to capture the essence of problems through technology-free, idealized, and abstract descriptions”.

The abstraction in an essential use case does not relate to the use case as a whole, but more to the steps of the use case. In this way an essential use case does specify a sequence of interactions, but a sequence with abstract steps. For example, figure 5 shows an ordinary use case for a banking system, detailing specific concrete steps in the dialogue such as *insert card* and *read magnetic stripe*. Figure 6 shows an equivalent essential use case that begins with the more abstract “identify self”. Also, note that the ordinary use case labels the roles “user action” and “system response”, stressing an actual concrete interaction. The essential use case instead takes a more abstract yet also richer approach, by casting the user part of the dialogue as “intention”, and the system part as “responsibility”.

gettingCash	
<i>User Action</i>	<i>System Response</i>
insert card	read magnetic stripe request PIN
enter PIN	verify PIN display transaction menu
press key	display account menu
press key	prompt for amount
enter amount	display amount
press key	return card
take card	dispense cash
take cash	

Figure 5: An ordinary use case for getting cash from an automatic teller system. (From Constantine and Lockwood.)

gettingCash	
<i>User Intention</i>	<i>System Responsibility</i>
identify self	verify identity offer choices
choose	dispense cash
take cash	

Figure 6: An essential use case for getting cash from an automatic teller system. (From Constantine and Lockwood.)

We have adopted this form of use case for our cards and roleplay for several reasons. The abstraction keeps essential use cases brief, and so able to fit on an index card. Also, the abstraction helps avoid unnecessary debate about irrelevant implement details, so allowing more rapid progress to be made. The focus on intention and responsibility also has important consequences.

Our experience with essential use cases has shown that the simple benefits are realised, and there are also more profound effects. As we had hoped, the abstraction does keep the use cases brief enough for an index card, and also helps avoid premature debate about implementation.

On a deeper level, we have seen there is heuristic merit in casting the user role as expressing “intention”, and the system role as expressing “responsibility”. Together, these lead to use case dialogues that better reflect the real motivation of the user, and better capture the requirements of the system, while at the same time avoiding premature design decisions.

We have found there are some adjustments needed in working with essential use cases. One adjustment is that use case roleplay will itself be abstract, and so not as realistic as if it involved specific interface details. In our experience this has not been problematic, although teams do find it helpful to sometimes consider concrete enactments of the use case to check their understanding.

The origin of essential use cases is in user interface design. In typical practice, the system responsibilities are limited to responsibilities directly concerning interaction. The semantics of deeper responsibilities for system behaviour are typically left unexplored. We have found, however, that it is possible to include these deeper responsibilities where helpful. For example, the use case in figure 5 might well involve responsibilities to maintain account balance integrity and to audit trail entries.

The focus on the system part of the dialogue as documenting responsibilities has interesting and far-reaching implications for system development. When use cases have been determined, one of the later activities in object-oriented development is the design of the system as a set of collaborating classes and objects. One approach to determining this set is to focus on responsibilities: this is a key part of using CRC cards, and is used more thoroughly in responsibility-driven design (Wirfs-Brock and Wilkerson 1989, Wirfs-Brock et al. 1990).

Essential use cases capture the system role as a set of responsibilities. This means that when all the use cases are determined, we also have the set of responsibilities for the whole system. We can regard the system as a single object, and the responsibilities as the specification for the object. We can design as set of collaborating objects as a decomposition of the system object, with the system responsibilities distributed appropriately.

Techniques such as CRC and responsibility-driven design already address how to distribute responsibility. But these techniques begin with responsibilities associated with objects and classes identified using domain analysis. Essential use cases deliver a set of responsibilities specific to the system being designed, which presents valuable opportunities.

Ultimately, the system responsibilities and the object set responsibilities must match. There are two major implications. Firstly, we can begin CRC or responsibility-driven design with responsibilities informed by the essential use case responsibilities, as well as the results of domain analysis. Secondly, we can check the set of object responsibilities at any time to see if they indeed will meet the system requirements. Even if we rapidly explore design alternatives, or consider existing reusable design assets such as patterns, frameworks, or components, we will always be able to check that the objects work together to fulfill the responsibilities specified by the use cases. The first implication means better operational guidance in beginning design. The second implication means better traceability between design and requirements.

Related Work

In this section we review the published work from the literature that has influenced our approach.

Use cases themselves were introduced as a key focus of Object-Oriented Software Engineering (OOSE) (Jacobson et al., 1992). There are many forms for use cases, and we have been influenced especially by Wirfs-Brock discussing use cases as “conversations” (Wirfs-Brock, 1993 and 1994). The particular kind of use case we adopt in practice is the “essential use case”, developed originally for analysis in the development of user interfaces (Constantine and Lockwood, 1999). Cockburn (2001) presents a survey of issues and approaches involving use cases.

OOSE suggested how to employ use cases in the context of system development. Use cases also feature strongly in more modern development processes, such as the Rational Unified Method (Jacobson, Booch, and Rumbaugh, 1999). Use Cases are also treated explicitly in notations such as UML (Rumbaugh, Jacobson and Booch, 1998, OMG, 2000). We have also been influenced by studies of how to model requirements with use cases (Rosenberg and Scott, 1999, and Armour and Miller, 2001). Extreme Programming (Beck, 1999) works with individual “user stories” (like use cases but written completely concretely), and emphasises the importance of reviews involving developers and stakeholders. The OPEN Toolbox of Techniques (Henderson-Sellers, Simons, and Younessi, 1998) provides a comprehensive survey of techniques and includes discussion and guidance for both use cases and CRC cards.

The CRC card technique, involving both cards and roleplay, influenced the form of our technique. CRC was originally presented as an educational technique (Beck and Cunningham, 1989). However, more recent practice and study suggests that CRC cards have significant benefits as a general design technique (Wilkinson, 1996, and Bellin and Suchman-Simone, 1997). Also, the CRC card technique and essential use cases both involve the strong use of “responsibility” as a guiding heuristic. Our use of this heuristic is also influenced by the process known as “Responsibility-Driven Design” (Wirfs-Brock and Wilkerson, 1989, Wirfs-Brock, Wilkerson and Wiener, 1990).

As a review technique, our approach also reflects other work in software quality assurance. Requirements have traditionally been checked either quite informally, or part of a precise formal “software inspection” (Fagan, 1979). Our approach is not entirely formal but still provides a useful structure, so resembling “walkthroughs” as described by Yourdon (1989), but addressing use cases rather than designs or implementations.

CONCLUSIONS

We have presented our technique involving index cards and role-play to review use cases, and so help develop good use cases. We based our technique on the established CRC card technique used for object-oriented design.

There are just two roles in the role-play: the user and the system. These come from representing use cases using a dialog format such as used in essential use cases.

Our technique is lightweight and low in formality, which means it has low cost of entry, especially to beginners or stakeholders. This is especially important as it makes it easy for stakeholders to participate in the review process, which almost certainly leads to higher quality.

We found that the technique is effective in exposing potential flaws and anomalies in use cases, and was especially helpful in determining the system boundary since this corresponds exactly to the separation of the two roles. Furthermore, the use of essential use cases may have other benefits with respect to object-oriented design, which will lead to better traceability between design and requirements.

REFERENCES

- Frank Armour and Granville Miller. (2001) *Advanced Use Case Modeling: Software Systems, Volume 1*. Addison-Wesley.
- Kent Beck and Ward Cunningham. (1989) A laboratory for teaching object-oriented thinking. In *Proc. of OOPSLA-89: ACM Conference on Object-Oriented Programming Systems Languages and Applications*, pages 1-6.
- David Bellin and Susan Suchman-Simone. (1997) *The CRC Card Book*. Addison-Wesley.
- Alistair Cockburn. (2001) *Writing effective use cases*. Addison-Wesley.
- Larry L. Constantine and Lucy A. D. Lockwood. (1999) *Software for Use: A Practical Guide to the Models and Methods of Usage Centered Design*. Addison-Wesley.
- Michael E. Fagan. (1986) Advances in Software Inspection. *IEEE Transactions on Software Engineering*, pages 744-751, July.
- Brian Henderson-Sellers, Anthony Simons, and Houman Younessi. (1998) *The OPEN toolbox of techniques*. Addison-Wesley.
- Ivar Jacobson, Grady Booch, and James Rumbaugh. (1999) *The Unified Software Development Process*. Addison-Wesley.
- Ivar Jacobson, Mahnus Christerson, Patrik Jonsson, and Gunnar Overgaard. (1992) *Object-Oriented Software Engineering*. Addison-Wesley.
- OMG Object Management Group. (2000) Unified Modeling Language (UML) 1.3 specification.
- Doug Rosenberg and Kendall Scott. (1999) *Use case driven object modeling with UML: A practical approach*. Addison-Wesley.
- James Rumbaugh, Ivar Jacobson, and Grady Booch. (1998) *The Unified Modeling Language Reference Manual*. Addison-Wesley.
- Nancy Wilkinson. (1996) *Using CRC Cards - An Informal Approach to OO Development*. Cambridge University Press.
- Rebecca Wirfs-Brock and Brian Wilkerson. (1989) Object-oriented design: A responsibility-driven approach. In Norman Meyrowitz, editor, *Proc. of OOPSLA-89: ACM Conference on Object-Oriented Programming Systems Languages and Applications*, pages 71-75.
- Rebecca Wirfs-Brock, Brian Wilkerson, and Lauren Wiener. (1990) *Designing Object Oriented Software*. Prentice Hall.
- Rebecca J. Wirfs-Brock. (1993) Designing scenarios: Making the case for a use case framework. *The Smalltalk Report*, 3(3).
- Rebecca J. Wirfs-Brock. (1994) The art of meaningful conversations. *The Smalltalk Report*, 4(5).
- Ed Yourdon. (1989) *Structured Walkthroughs*, Prentice Hall/Yourdon Press.
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