

# *Object-Oriented and Classical Software Engineering*

# REQUIREMENTS

- Determining what the client needs
- Overview of the requirements workflow
- Understanding the domain
- The business model
- Initial requirements
- Initial understanding of the domain: The MSG Foundation case study
- Initial business model: The MSG Foundation case study

- Initial requirements: The MSG Foundation case study
- Continuing the requirements workflow: The MSG Foundation case study
- Revising the requirements: The MSG Foundation case study
- The test workflow: The MSG Foundation case study
- The classical requirements phase
- Rapid prototyping

- Human factors
- Reusing the rapid prototype
- CASE tools for the requirements workflow
- Metrics for the requirements workflow
- Challenges of the requirements workflow

# The Aim of the Requirements Workflow

Slide 11.6

- To answer the question:

What must the product be able to do?

# 11.1 Determining What the Client Needs

Slide 11.7

- Misconception
  - We must determine what the client wants
- “I know you believe you understood what you think I said, but I am not sure you realize that what you heard is not what I meant!”
- We must determine what the client *needs*

# Determining What the Client Needs (contd)

Slide 11.8

- It is hard for a systems analyst to visualize a software product and its functionality
  - The problem is far worse for the client
- A skilled systems analyst is needed to elicit the appropriate information from the client
- The client is the only source of this information

# Determining What the Client Needs (contd)

Slide 11.9

- The solution:
  - Obtain initial information from the client
  - Use this initial information as input to the Unified Process
  - Follow the steps of the Unified Process to determine the client's real needs

# 11.2 Overview of the Requirements Workflow

Slide 11.10

- First, gain an understanding of the *application domain* (or *domain*, for short)
  - The specific environment in which the target product is to operate
- Second, build a business model
  - Model the client's business processes
- Third, use the business model to determine the client's requirements
- Iterate the above steps

# Definitions

Slide 11.11

- Discovering the client's requirements
  - *Requirements elicitation* (or *requirements capture*)
  - Methods include interviews and surveys
- Refining and extending the initial requirements
  - *Requirements analysis*

# 11.3 Understanding the Domain

Slide 11.12

- Every member of the development team must become fully familiar with the application domain
  - Correct terminology is essential
- Construct a glossary
  - A list of technical words used in the domain, and their meanings

## 11.4 Business Model

Slide 11.13

- A *business model* is a description of the business processes of an organization
- The business model gives an understanding of the client's business as a whole
  - This knowledge is essential for advising the client regarding computerization
- The systems analyst needs to obtain a detailed understanding of the various business processes
  - Different techniques are used, primarily interviewing

## 11.4.1 Interviewing

Slide 11.14

- The requirements team meet with the client and users to extract all relevant information

- There are two types of questions
  - *Close-ended* questions require a specific answer
  - *Open-ended* questions are posed to encourage the person being interviewed to speak out
- There are two types of interviews
  - In a *structured* interview, specific preplanned questions are asked, frequently close-ended
  - In an *unstructured* interview, questions are posed in response to the answers received, frequently open-ended

- Interviewing is not easy
  - An interview that is too unstructured will not yield much relevant information
  - The interviewer must be fully familiar with the application domain
  - The interviewer must remain open-minded at all times
- After the interview, the interviewer must prepare a written report
  - It is strongly advisable to give a copy of the report to the person who was interviewed

## 11.4.2 Other Techniques

Slide 11.17

- Interviewing is the primary technique
- A questionnaire is useful when the opinions of hundreds of individuals need to be determined
- Examination of business forms shows how the client currently does business

# Other Techniques (contd)

Slide 11.18

- Direct observation of the employees while they perform their duties can be useful
  - Videotape cameras are a modern version of this technique
  - But, it can take a long time to analyze the tapes
  - Employees may view the cameras as an unwarranted invasion of privacy

## 11.4.3 Use Cases

Slide 11.19

- A use case models an interaction between the software product itself and the users of that software product (*actors*)
- Example:

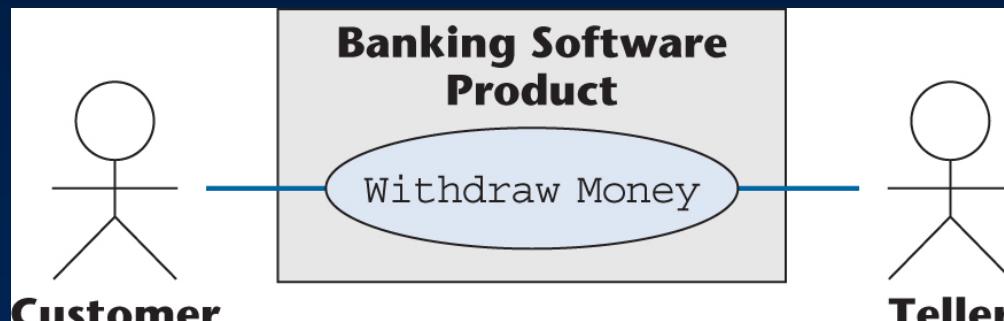


Figure 11.1

- An actor is a member of the world outside the software product
- It is usually easy to identify an actor
  - An actor is frequently a user of the software product
- In general, an actor plays a role with regard to the software product. This role is
  - As a user; or
  - As an initiator; or
  - As someone who plays a critical part in the use case

# Use Cases (contd)

Slide 11.21

- A user of the system can play more than one role
- Example: A customer of the bank can be
  - A **Borrower** or
  - A **Lender**

- Conversely, one actor can be a participant in multiple use cases
- Example: A **Borrower** may be an actor in
  - The Borrow Money use case;
  - The Pay Interest on Loan use case; and
  - The Repay Loan Principal use case
- Also, the actor **Borrower** may stand for many thousands of bank customers

- An actor need not be a human being
- Example: An e-commerce information system has to interact with the credit card company information system
  - The credit card company information system is an actor from the viewpoint of the e-commerce information system
  - The e-commerce information system is an actor from the viewpoint of the credit card company information system

- A potential problem when identifying actors
  - Overlapping actors
- Example: Hospital software product
  - One use case has actor **Nurse**
  - A different use case has actor **Medical Staff**
  - Better:
    - » Actors: **Physician** and **Nurse**

# Use Cases (contd)

Slide 11.25

- Alternatively:
  - Actor **Medical Staff** with two specializations: **Physician** and **Nurse**

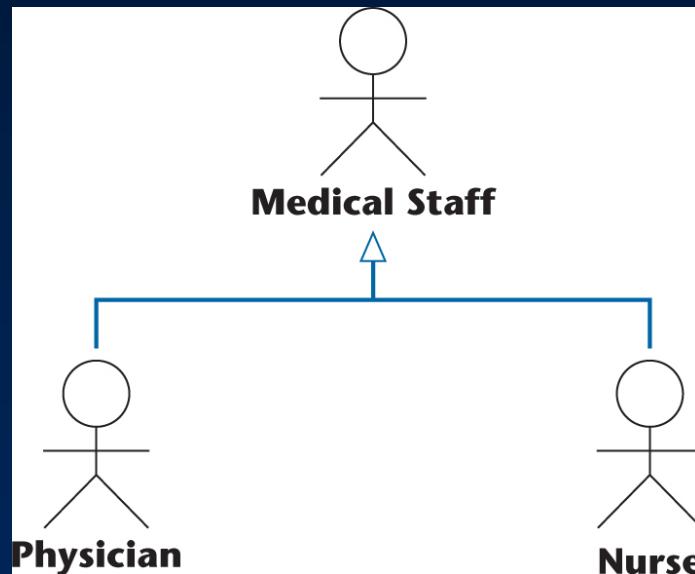


Figure 11.2

# 11.5 Initial Requirements

Slide 11.26

- The initial requirements are based on the initial business model
- Then they are refined
- The requirements are dynamic — there are frequent changes
  - Maintain a list of likely requirements, together with use cases of requirements approved by the client

- There are two categories of requirements
- A *functional requirement* specifies an action that the software product must be able to perform
  - Often expressed in terms of inputs and outputs
- A *nonfunctional requirement* specifies properties of the software product itself, such as
  - Platform constraints
  - Response times
  - Reliability

- Functional requirements are handled as part of the requirements and analysis workflows
- Some nonfunctional requirements have to wait until the design workflow
  - The detailed information for some nonfunctional requirements is not available until the requirements and analysis workflows have been completed

- The Martha Stockton Greengage Foundation (“MSG”) provides low cost mortgage loans to young couples
- The trustees commission a pilot project
  - A software product to determine how much money is available each week to purchase homes

- A *mortgage* is a loan in which real estate is used as security
- Example: House costs \$100,000
- Buyer pays a 10% deposit and borrows the balance
  - The *principal* (or *capital*) borrowed is \$90,000
- Loan is to be repaid monthly over 30 years
  - Interest rate of 7.5% per annum (or 0.625% per month)

- Each month, the borrower pays \$629.30
  - Part of this is the interest on the outstanding balance
  - The rest is used to reduce the principal
- The monthly payment is therefore often referred to as  $P & I$  (principal and interest)

# Mortgage Payments: First Month

Slide 11.32

- In the first month the outstanding balance is \$90,000
  - Monthly interest at 0.625% on \$90,000 is \$562.50
  - The remainder of the P & I payment of \$629.30, namely \$66.80, is used to reduce the principal
- At the end of the first month, after the first payment has been made, only \$89,933.20 is owed to the finance company

# Mortgage Payments: Second Month

Slide 11.33

- In the second month the outstanding balance is \$89,933.20
  - Monthly interest at 0.625% on \$89,933.20 is \$562.08
  - The remainder of the P & I payment of \$629.30, namely \$67.22, is used to reduce the principal
- At the end of the second month, after the second payment has been made, only \$89,865.98 is owed to the finance company

# Mortgage Payments: After 15 and 30 Years

Slide 11.34

- After 15 years (180 months) the outstanding balance is \$67,881.61
  - Monthly interest at 0.625% on \$67,881.61 is \$424.26
  - The remainder of the P & I payment of \$629.30, namely \$205.04, is used to reduce the principal
- After 30 years (360 months), the entire loan will have been repaid

# Insurance Premiums

Slide 11.35

- The finance company requires the borrower to insure the house
  - If the house burns down, the check from the insurance company will then be used to repay the loan

# Insurance Premiums (contd)

Slide 11.36

- The insurance premium is paid once a year by the finance company
  - The finance company requires the borrower to pay monthly insurance installments
  - These are deposited in an *escrow account* (a savings account)
- The annual premium is then paid from the escrow account

# Real Estate Taxes

Slide 11.37

- Real-estate taxes paid on a home are treated the same way as insurance premiums
  - Monthly installments are deposited in the escrow account
  - The annual real-estate tax payment is made from that account

# Borrowing Limits

Slide 11.38

- A mortgage will not be granted unless the total monthly payment (P & I plus insurance plus real-estate taxes) is less than 28% of the borrower's total income

# Other Costs

Slide 11.39

- The finance company requires a lump sum up front in return for lending the money to the borrower
  - Typically, the finance company will want 2% of the principal (“2 points”)
  - For the \$90,000 loan, this amounts to \$1,800

# Other Costs (contd)

Slide 11.40

- There are other costs involved in buying a house
  - Legal costs
  - Various taxes
- When the deal is “closed,” the closing costs (legal costs, taxes, and so on) plus the points can easily amount to \$7,000

# Initial Glossary

Slide 11.41

**Balance:** the amount of the loan still owing

**Capital:** synonym for principal

**Closing costs:** other costs involved in buying a house, such as legal costs and various taxes

**Deposit:** an initial installment toward the total cost of the house

**Escrow account:** a savings account managed by the finance company into which the weekly installments toward the annual insurance premium and annual real-estate tax payment are deposited, and from which the annual insurance premium and the annual real-estate tax payment are paid

**Interest:** a cost of borrowing money, computed as a fraction of the amount owing

**Mortgage:** a loan in which real estate is pledged as security for the loan

**P & I:** abbreviation for “principal and interest”

**Points:** a cost of borrowing money, computed as a fraction of the total amount borrowed

**Principal:** the lump sum borrowed

**Principal and interest:** an installment payment consisting of the interest plus the fraction of the principal for that installment

# 11.7 Initial Business Model: MSG Case Study

Slide 11.42

- At the start of each week, MSG estimates how much money will be available that week to fund mortgages
- Low-income couples can apply at any time

# Initial Business Model: MSG Case Study (contd)

Slide 11.43

- An MSG Foundation staff member determines
  - Whether the couple qualifies for an MSG mortgage, and
  - Whether MSG has sufficient funds on hand to purchase the home
- If so, the mortgage is granted
  - The weekly mortgage repayment is computed according to MSG rules
- This repayment amount may vary from week to week, depending on the couple's current income

# Initial Business Model: MSG Case Study (contd)

Slide 11.44

- There are three use cases

- Estimate Funds Available for Week
- Apply for an MSG Mortgage
- Compute Weekly Repayment Amount

# Estimate Funds Available for Week Use Case

Slide 11.45

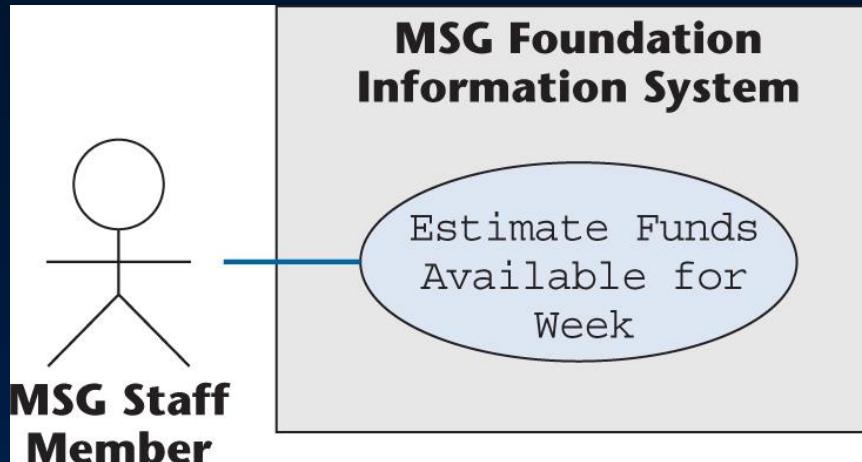


Figure 11.4

## Brief Description

The Estimate Funds Available for Week use case enables an MSG Foundation staff member to estimate how much money the Foundation has available that week to fund mortgages.

## Step-by-Step Description

Not applicable at this initial stage.

Figure 11.7

# Apply for an MSG Mortgage Use Case

Slide 11.46



Figure 11.5

## Brief Description

When a couple applies for a mortgage, the Apply for an MSG Mortgage use case enables an MSG Foundation staff member to determine whether they qualify for an MSG mortgage and, if so, whether funds are currently available for the mortgage.

## Step-by-Step Description

Not applicable at this initial stage.

Figure 11.8

# Compute Weekly Repayment Amount Use Case

Slide 11.47

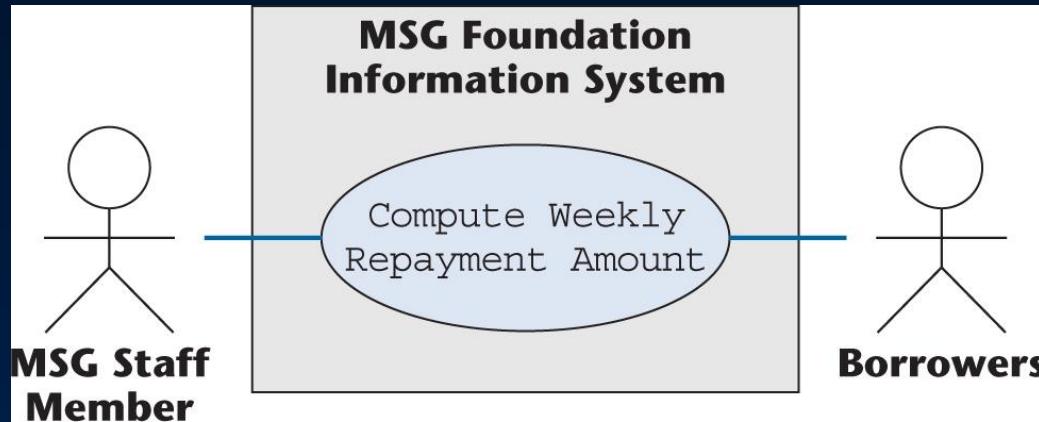


Figure 11.6

## Brief Description

The Compute Weekly Repayment Amount use case enables an MSG Foundation staff member to compute how much borrowers have to repay each week.

## Step-by-Step Description

Not applicable at this initial stage.

Figure 11.9

# Who Is an Actor?

Slide 11.48

- Why is **Applicants** an actor in use case Apply for an MSG Mortgage?
- Applicants do not interact with the software product
  - Their answers are entered into the software product by an MSG staff member

# Who Is an Actor? (contd)

Slide 11.49

- However,
  - The applicants initiate the use case
  - The applicants provide the data entered by MSG staff
  - The real actor is therefore **Applicants** — the **MSG Staff Member** is merely an agent of the applicants
- **Applicants** is therefore indeed an actor

# Who Is an Actor? (contd)

Slide 11.50

- Similarly, **Borrowers** is an actor in use case  
Compute Weekly Repayment Amount
  - Again the use case is initiated by actor **Borrowers**
  - Again the information entered by MSG staff is supplied by the borrowers
- Thus, **Borrowers** is indeed an actor in the use case

- At this stage, no details are known regarding
  - The buying and selling of investments, or
  - How investment income becomes available for mortgages
- However, use case Manage an Investment **is** an essential part of the initial business model

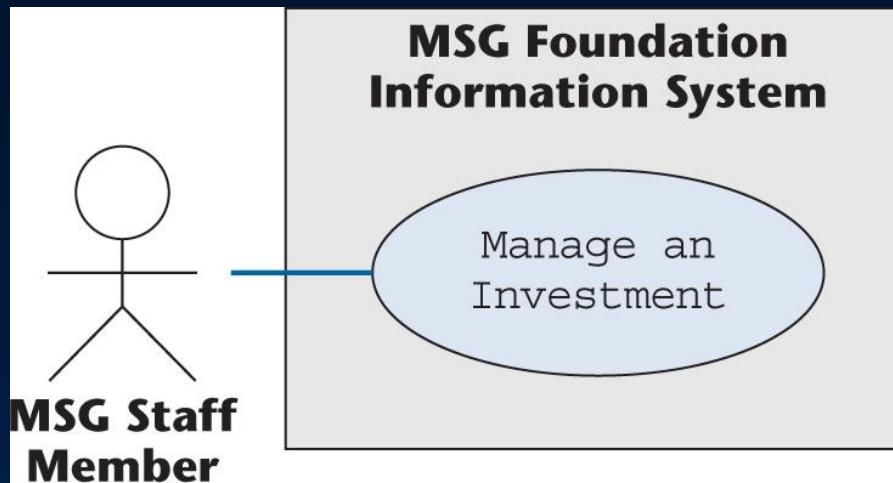


Figure 11.10

### Brief Description

The Manage an Investment use case enables an MSG Foundation staff member to buy and sell investments and manage the investment portfolio.

### Step-by-Step Description

Not applicable at this initial stage.

Figure 11.11

# Use-Case Diagram of the Initial Business Model

Slide 11.53

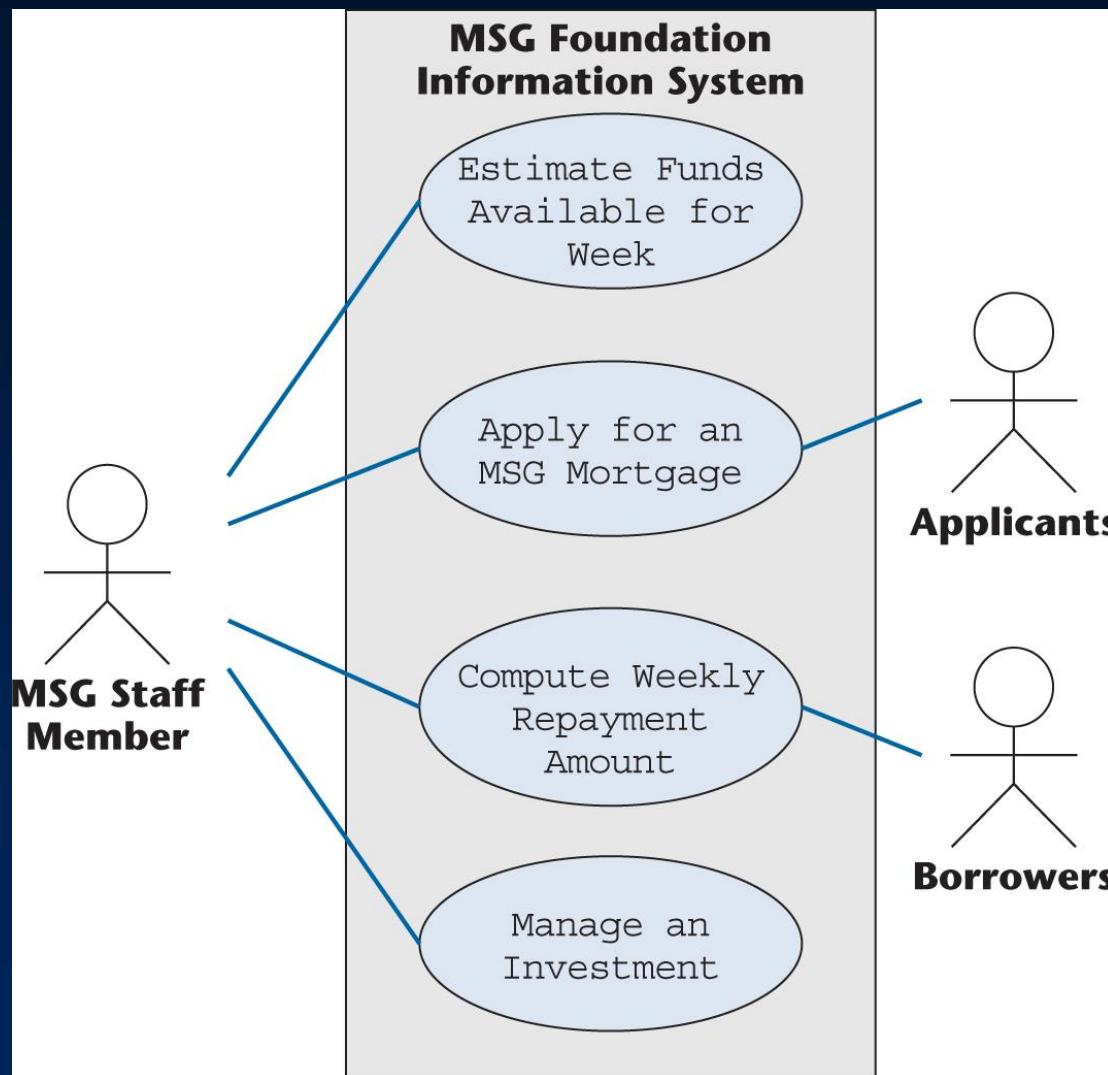


Figure 11.12

# 11.8 Initial Requirements: MSG Case Study

Slide 11.54

- It is unclear if all four use cases are all requirements of the product to be developed
  - What, exactly, is “a pilot project”?
- The best way to proceed is
  - Draw up the initial requirements on the basis of what the client wants, and then iterate

# Initial Requirements: MSG Case Study (contd)

Slide 11.55

- Consider each use case in turn:
  - Estimate Funds Available for Week **is obviously part of the initial requirements**
  - Apply for an MSG Mortgage **does not seem to have anything to do with the pilot project, so it is excluded**

# Initial Requirements: MSG Case Study (contd)

Slide 11.56

- Compute Weekly Repayment Amount, and
- Manage an Investment
  - Both appear to be irrelevant to the pilot project
- However, the pilot project deals with the “money that is available each week to purchase homes”
  - Some of that money comes from the weekly repayment of existing mortgages, and from income from investments
- The resulting use-case diagram is shown on the next slide

# Initial Use-Case Diagram: MSG Case Study

Slide 11.57

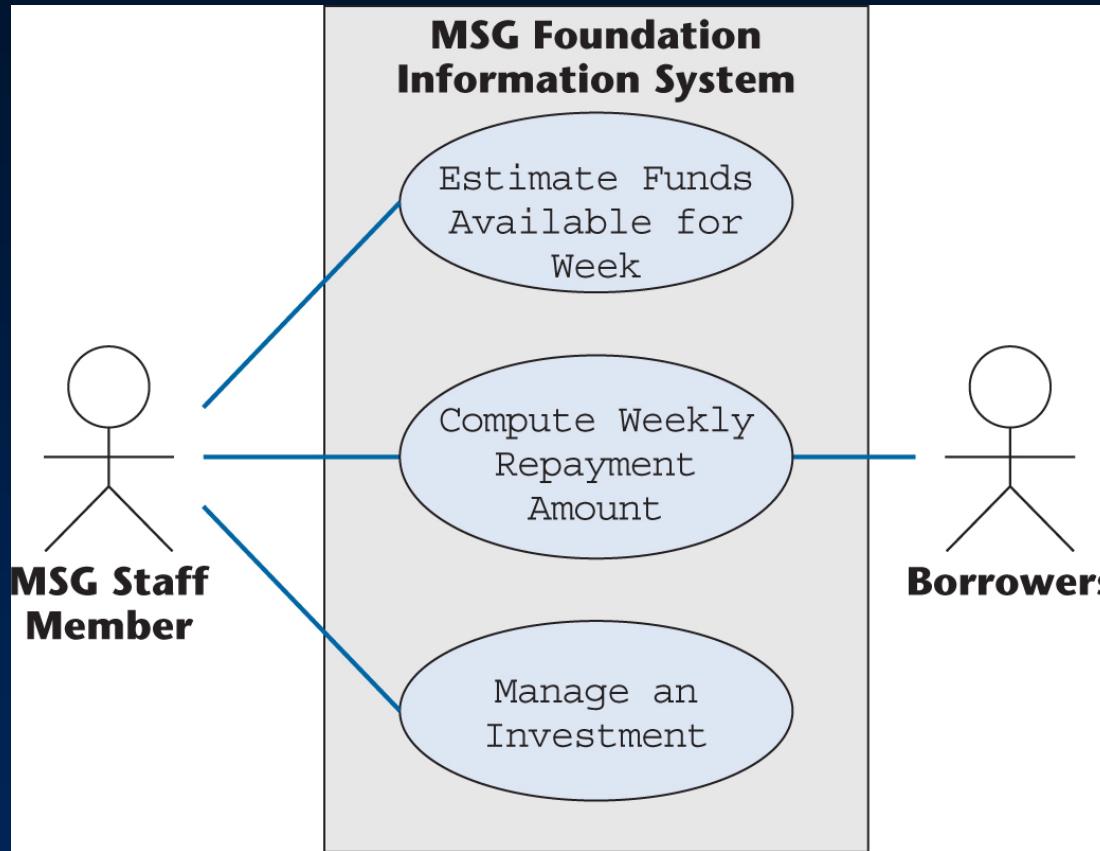


Figure 11.13

- The next step: Iterate the requirements workflow

# 11.9 Continuing the Requirements Workflow: MSG

Slide 11.58

- The systems analysts learn that the MSG Foundation grants a 100% mortgage to buy a home under the following conditions:
  - The couple has been legally married for at least 1 year but not more than 10 years
  - Both husband and wife are gainfully employed
  - The price of the home must be below the published median price for homes in that area for the past 12 months
  - Their income and/or savings are insufficient to afford a standard fixed-rate 30-year 90% mortgage
  - The foundation has sufficient funds to purchase the home

# Conditions for an MSG Mortgage (contd)

Slide 11.59

- If the application is approved, then each week for the next 30 years the couple pays MSG
  - The total of the principal and interest payment — this never changes over the life of the mortgage; plus
  - The escrow payment, which is 1/52nd of the sum of the annual real-estate tax and the annual homeowner's insurance premium
- If this exceeds 28% of the couple's gross weekly income, MSG pays the difference as a grant
  - The couple must provide proof of their current income — the weekly payment may vary from week to week

# Algorithm to Determine If Funds Are Available

Slide 11.60

- (1) At the beginning of the week, the estimated annual income from MSG investments is computed and divided by 52
- (2) The estimated annual MSG operating expenses are divided by 52
- (3) The total of the estimated mortgage payments for the week is computed

# Algorithm to Determine If Funds Are Available

Slide 11.61

- (4) The total of the estimated grants for the week is computed
- (5) The amount available at the beginning of the week is then (1) – (2) + (3) – (4)
- (6) If the cost of the home is no more than (5), funds are provided to buy the home
- (7) At the end of each week, any unspent funds are invested

# Requirements of the Pilot Project

Slide 11.62

- To keep the cost of the pilot project as low as possible, only those data items needed for the weekly funds computation will be included
- Only three types of data are therefore needed:
  - Investment data
  - Operating expenses data
  - Mortgage data

# Investment Data

Slide 11.63

- Item number
- Item name
- Estimated annual return
- Date estimated annual return was last updated

# Operating Expenses Data

Slide 11.64

- Estimated annual operating expenses
- Date estimated annual operating expenses was last updated

# Mortgage Data

Slide 11.65

- Account number
- Last name of mortgagees
- Original purchase price of home
- Date mortgage was issued
- Weekly principal and interest payment
- Current combined gross weekly income
- Date combined gross weekly income was last updated

# Mortgage Data (contd)

Slide 11.66

- Annual real-estate tax
- Date annual real-estate tax was last updated
- Annual homeowner's insurance premium
- Date annual homeowner's insurance premium was last updated

# Reports Required for the Pilot Project

Slide 11.67

- Three types of reports are needed:
  - The results of the funds computation for the week
  - A listing of all investments (to be printed on request)
  - A listing of all mortgages (to be printed on request)

# 11.10 Revising the Requirements: MSG Case Study

Slide 11.68

- The initial requirements include three use cases:
  - Estimate Funds Available for Week
  - Compute Weekly Repayment Amount
  - Manage an Investment
- In the light of the additional information received, the initial requirements can be revised

# Revising the Requirements: MSG (contd)

Slide 11.69

- Consider each element of the formula to determine how much money is available each week
- (1) *Estimated annual income from investments:*
  - Take all the investments, sum the estimated annual return on each investment, and divide the result by 52
- An additional use case, Estimate Investment Income for Week, is needed
  - (We still need use case Manage an Investment for adding, deleting, and modifying investments)

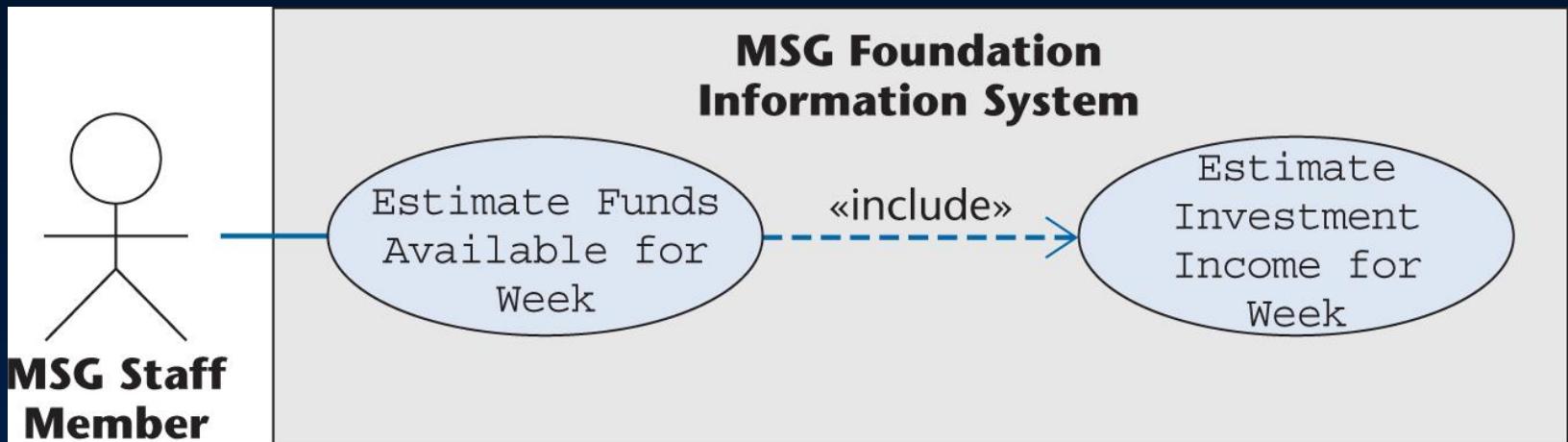


Figure 11.14

- The dashed line with the open arrowhead labeled «include» denotes that
  - ▶ Use case Estimate Investment Income for Week is part of use case Estimate Funds Available for Week

- Description of use case

### Brief Description

The Estimate Investment Income for Week use case enables the Estimate Funds Available for Week use case to estimate how much investment income is available for this week.

### Step-by-Step Description

1. For each investment, extract the estimated annual return on that investment.
2. Sum the values extracted in Step 1 and divide the result by 52.

Figure 11.15

# First Iteration of the Revised Use-Case Diagram

Slide 11.72

- New use case is shaded

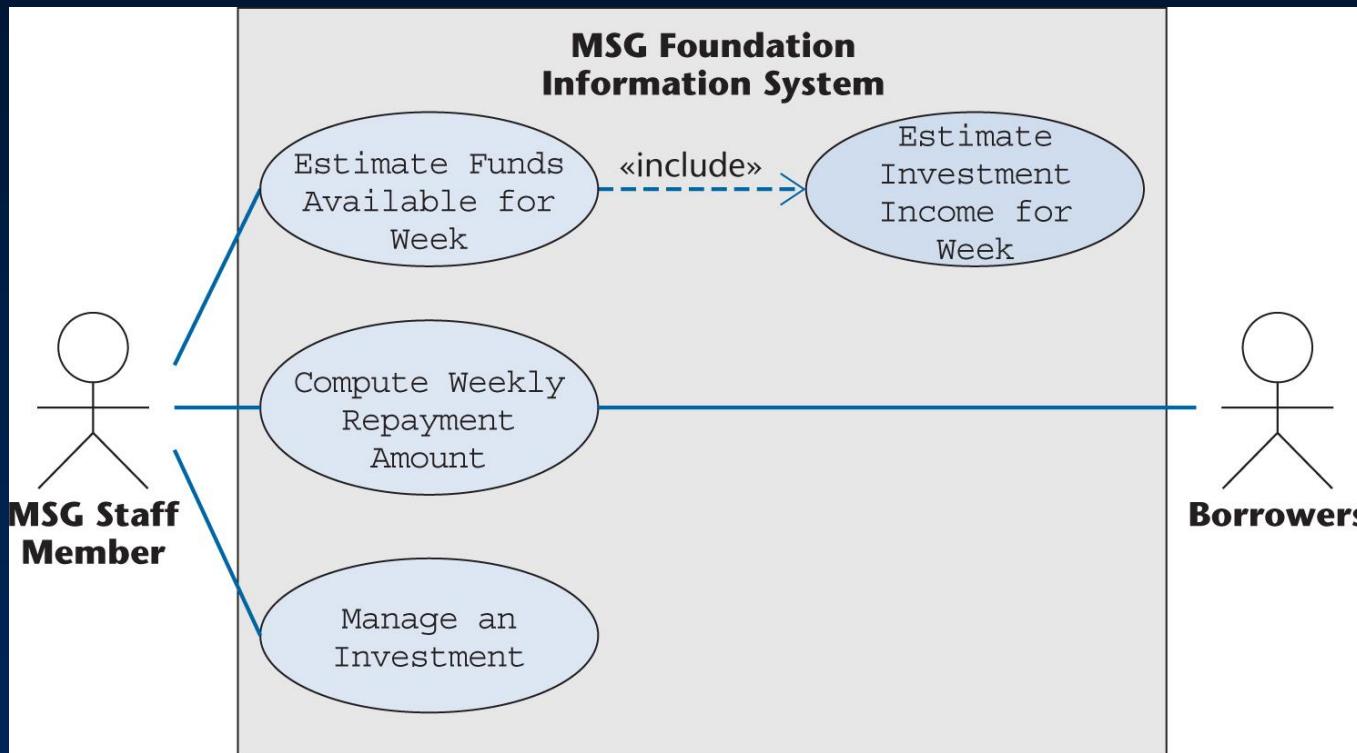


Figure 11.16

- (2) *Estimated annual operating expenses:*
- To determine the estimated annual operating expenses two additional use cases are needed
  - Use case Update Estimated Annual Operating Expenses models adjustments to the value of the estimated annual operating expenses
  - Use case Estimate Operating Expenses for Week provides the needed estimate of the operating expenses

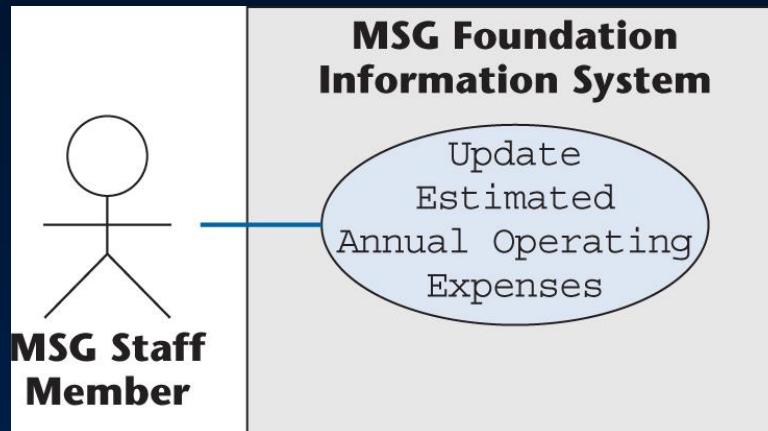


Figure 11.17

### Brief Description

The Update Estimated Annual Operating Expenses use case enables an MSG Foundation staff member to update the estimated annual operating expenses.

### Step-by-Step Description

1. Update the estimated annual operating expenses.

Figure 11.18

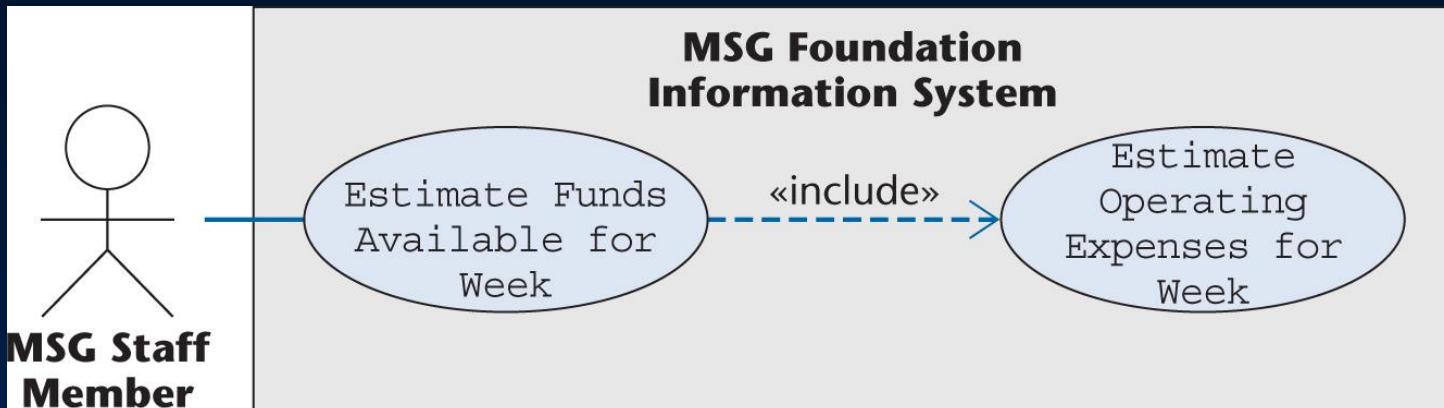


Figure 11.19

## Brief Description

The Estimate Operating Expenses for Week use case enables the Estimate Funds Available for Week use case to estimate the operating expenses for the week.

## Step-by-Step Description

1. Divide the estimated annual operating expenses by 52.

Figure 11.20

# Second Iteration of Revised Use-Case Diagram

Slide 11.76

- The new use cases are shaded

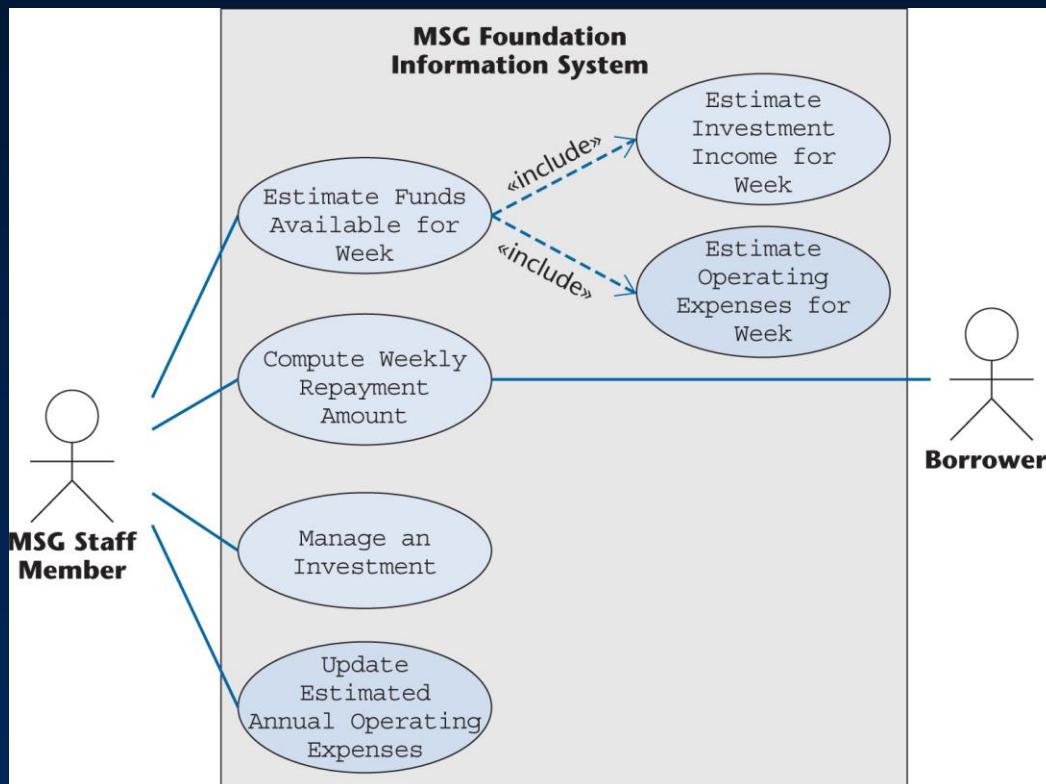


Figure 11.21

# Revising the Requirements: MSG (contd)

Slide 11.77

- (3) *Total estimated mortgage payments for the week* and
- (4) *Total estimated grant payments for the week:*
  - Use case Compute Weekly Repayment Amount models the computation of both the estimated mortgage payment and the estimated grant payment for each mortgage separately
  - Summing these separate quantities gives
    - » The total estimated mortgage payments for the week, and
    - » The total estimated grant payments for the week

# Revising the Requirements: MSG (contd)

Slide 11.78

- Now the use cases need to be reorganized
  - Use case Compute Weekly Repayment Amount also models borrowers updating their weekly income
- Split Compute Weekly Repayment Amount into two separate use cases
  - Use case Estimate Payments and Grants for Week, and
  - Use case Update Borrowers' Weekly Income

# Estimate Payments and Grants for Week Use Case

Slide 11.79

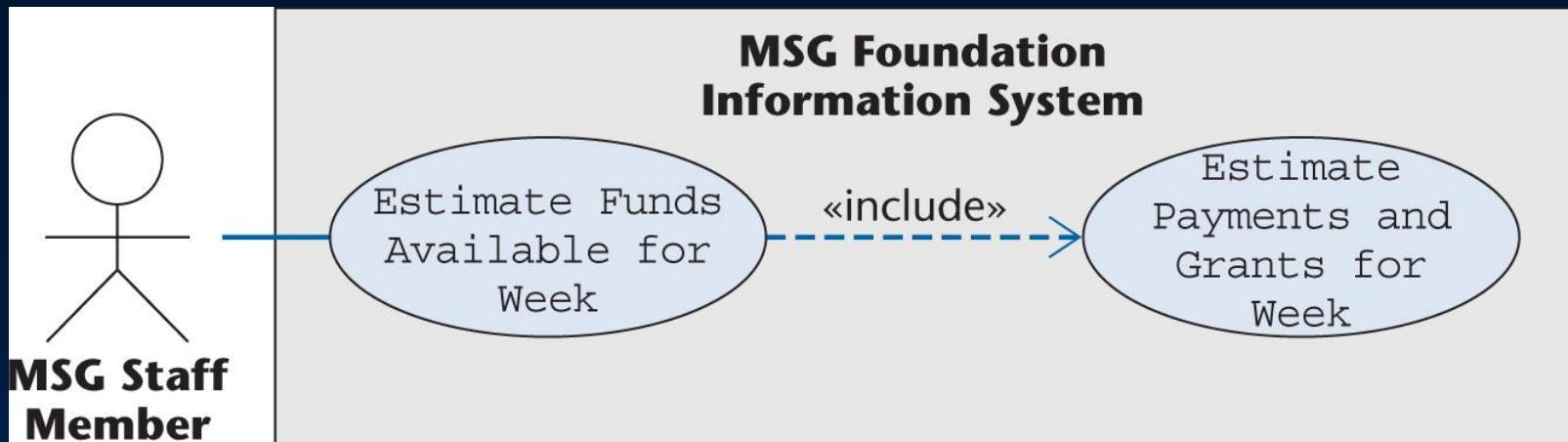


Figure 11.22

## Brief Description

The Estimate Payments and Grants for Week use case enables the Estimate Funds Available for Week use case to estimate the total estimated mortgage payments paid by borrowers to the MSG Foundation for this week and the total estimated grants paid by the MSG Foundation for this week.

## Step-by-Step Description

1. For each mortgage:
  - 1.1 The amount to be paid this week is the total of the principal and interest payment and  $\frac{1}{52}$ nd of the sum of the annual real-estate tax and the annual homeowner's insurance premium.
  - 1.2 Compute 28 percent of the couple's current gross weekly income.
  - 1.3 If the result of Step 1.1 is greater than the result of Step 1.2, then the mortgage payment for this week is the result of Step 1.2, and the amount of the grant for this week is the difference between the result of Step 1.1 and the result of Step 1.2.
  - 1.4 Otherwise, the mortgage payment for this week is the result of Step 1.1 and there is no grant this week.
2. Summing the mortgage payments of Steps 1.3 and 1.4 yields the estimated mortgage payments for the week.
3. Summing the grant payments of Step 1.3 yields the estimated grant payments for the week.

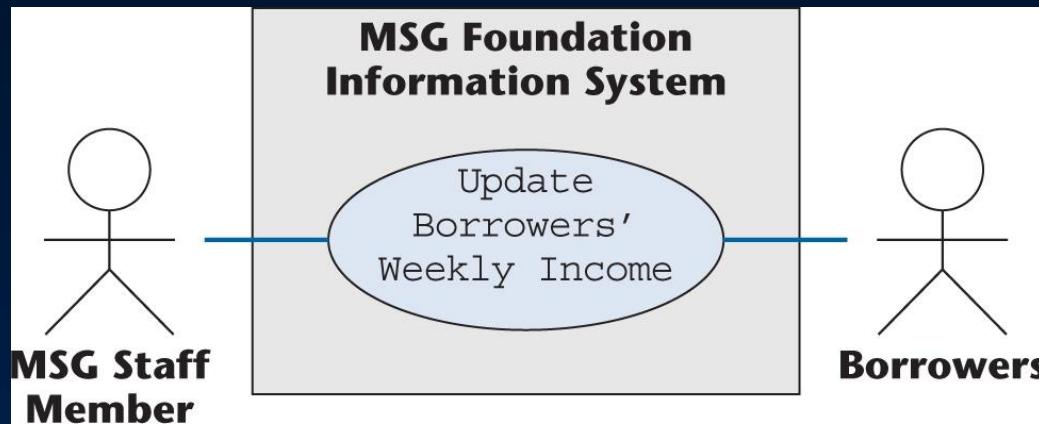


Figure 11.24

### Brief Description

The Update Borrowers' Weekly Income use case enables an MSG Foundation staff member to update the weekly income of a couple who have borrowed money from the Foundation.

### Step-by-Step Description

1. Update the borrower's weekly income.

Figure 11.25

# Third Iteration of the Revised Use-Case Diagram

Slide 11.82

- The two new use cases are shaded

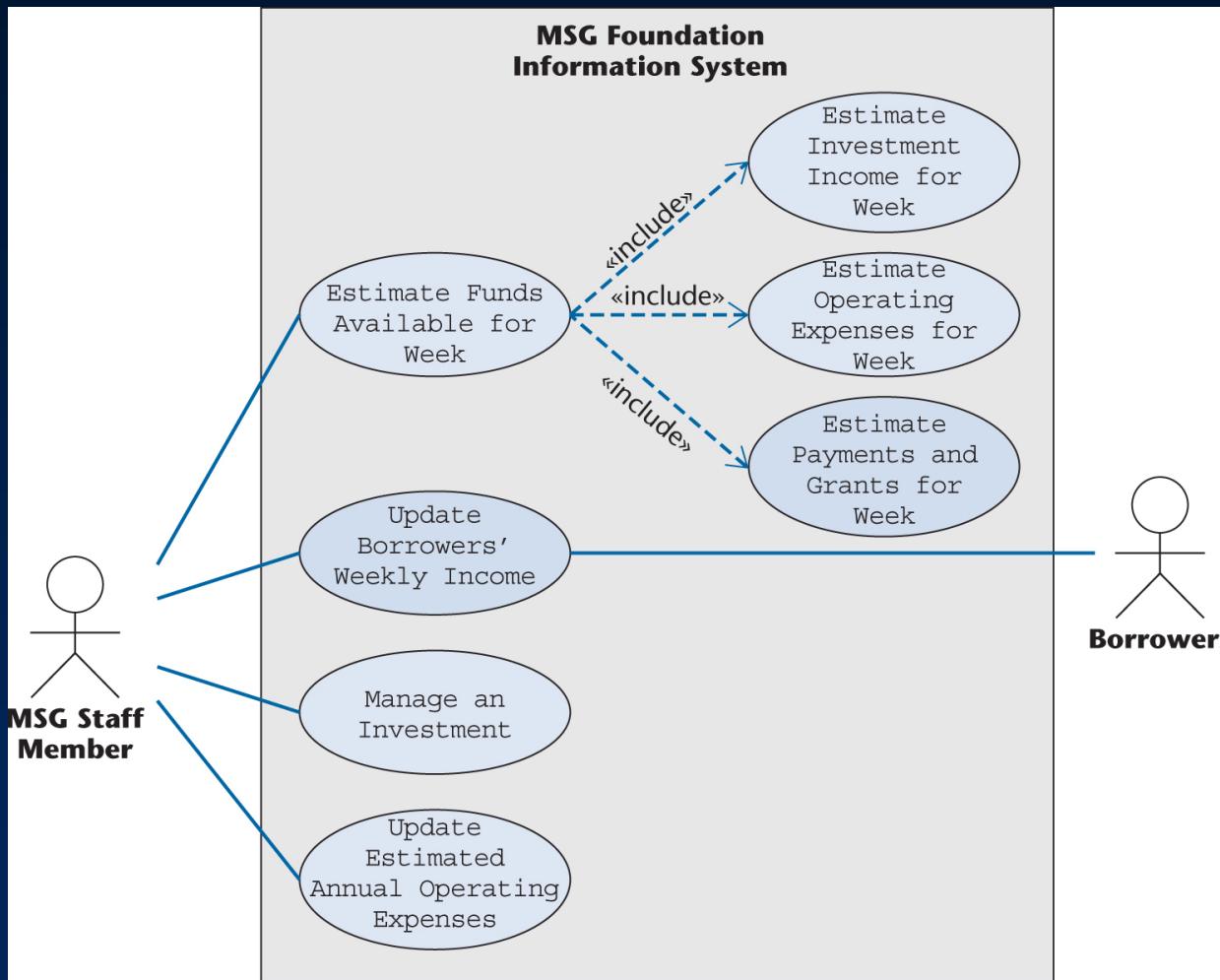


Figure 11.26

- **Use case** Estimate Funds Available for Week **models the computation that uses the data obtained from three other use cases**
  - Estimate Investment Income for Week
  - Estimate Operating Expenses for Week
  - Estimate Payments and Grants for Week

- Second iteration of use case

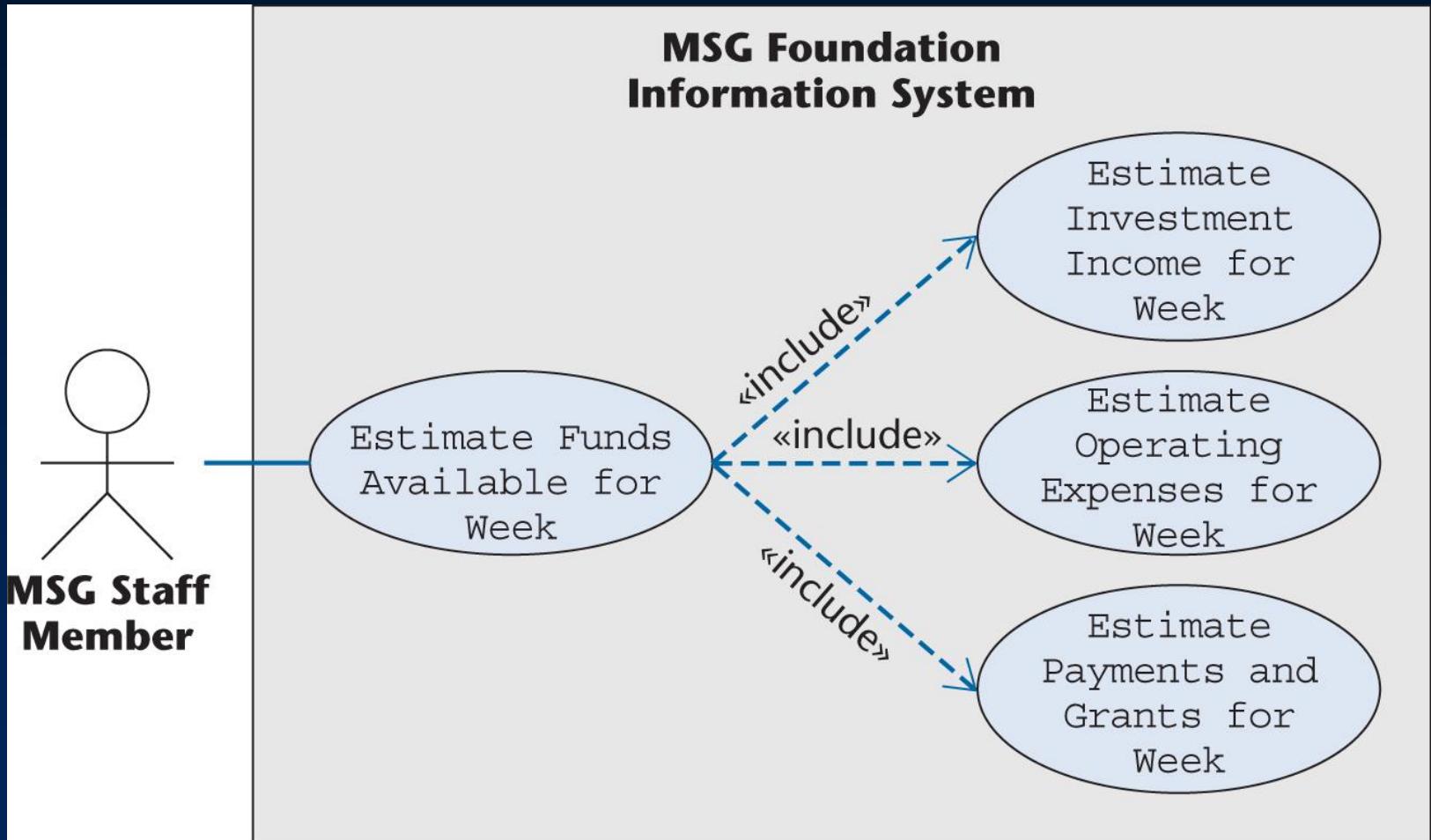


Figure 11.27

- Second iteration of description of use case

### Brief Description

The Estimate Funds Available for Week use case enables an MSG Foundation staff member to estimate how much money the Foundation has available that week to fund mortgages.

### Step-by-Step Description

1. Determine the estimated income from investments for the week utilizing use case Estimate Investment Income for Week.
2. Determine the operating expenses for the week utilizing use case Estimate Operating Expenses for Week.
3. Determine the total estimated mortgage payments for the week utilizing use case Estimate Payments and Grants for Week.
4. Determine the total estimated grants for the week utilizing use case Estimate Payments and Grants for Week.
5. Add the results of Steps 1 and 3 and subtract the results of Steps 2 and 4. This is the total amount available for mortgages for the current week.

# «include» Relationship

Slide 11.86

- Correct use case (top); incorrect use case (bottom)

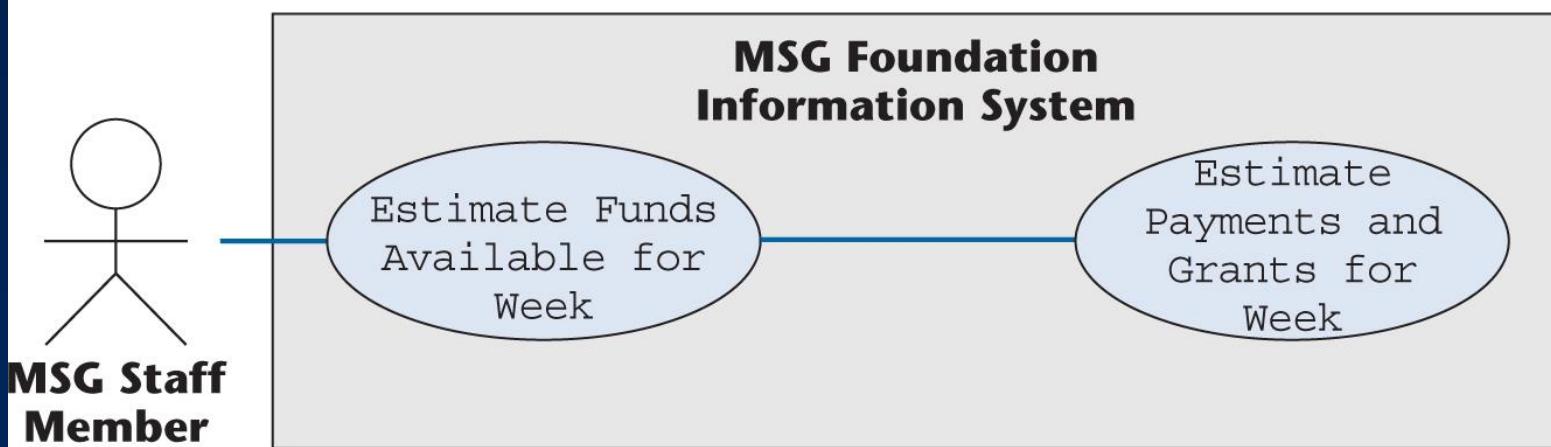
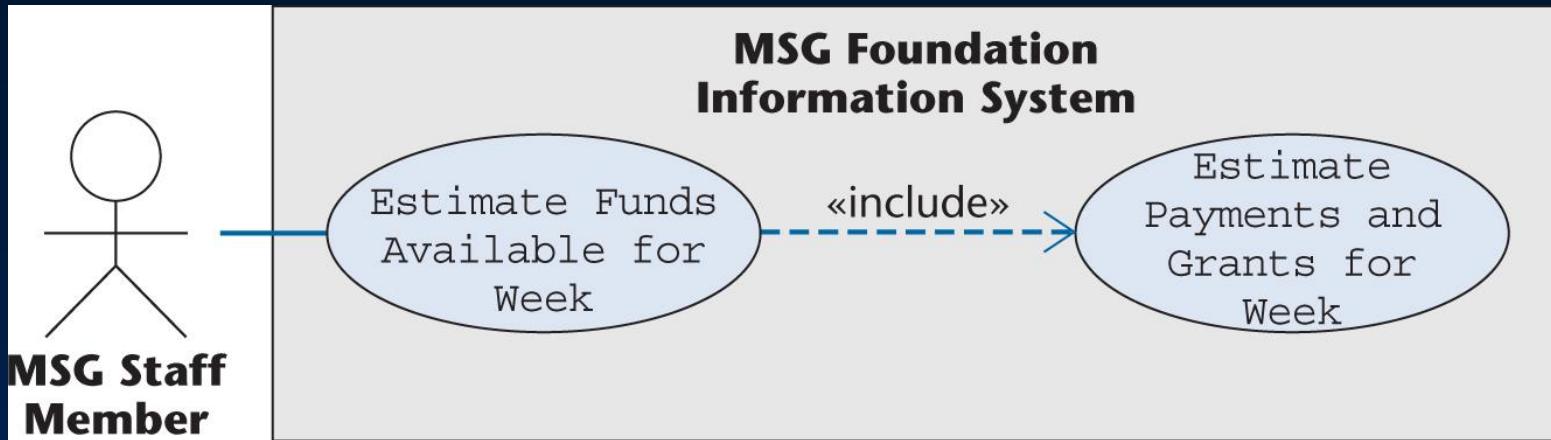


Figure 11.29

- The bottom diagram models use cases

- Estimate Funds Available for Week, and
  - Estimate Payments and Grants for Week

as two independent use cases

- However, a use case models an interaction between the product itself and users of the product (actors)

# «include» Relationship (contd)

Slide 11.88

- **Use case Estimate Payments and Grants for Week** does not interact with an actor and therefore cannot be a use case in its own right
  - Instead, it is a portion of use case Estimate Funds Available for Week, as reflected in the top diagram

# 11.11 The Test Workflow: MSG Case Study

Slide 11.89

- A common side-effect of the iterative and incremental life-cycle model
  - Details that correctly have been postponed somehow get forgotten
  - Two instances of this are described on the next slide

# The Test Workflow: MSG Case Study (contd)

Slide 11.90

- Details of use case `Manage an Investment` have been overlooked, and
- Use case `Manage a Mortgage` to model
  - The addition of a new mortgage
  - The modification of an existing mortgage, or
  - The removal of an existing mortgagehas been totally forgotten  
(Analogous to use case `Manage an Investment`)

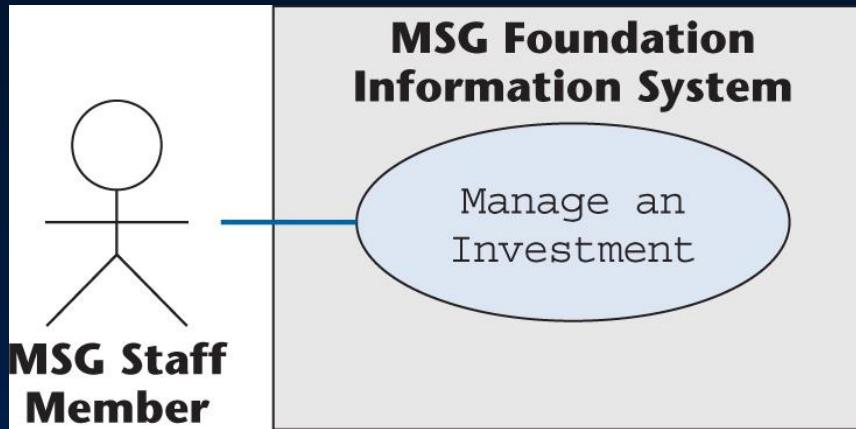


Figure 11.30

### Brief Description

The Manage an Investment use case enables an MSG Foundation staff member to add and delete investments and manage the investment portfolio.

### Step-by-Step Description

1. Add, modify, or delete an investment.

Figure 11.31

# Manage a Mortgage Use Case

Slide 11.92

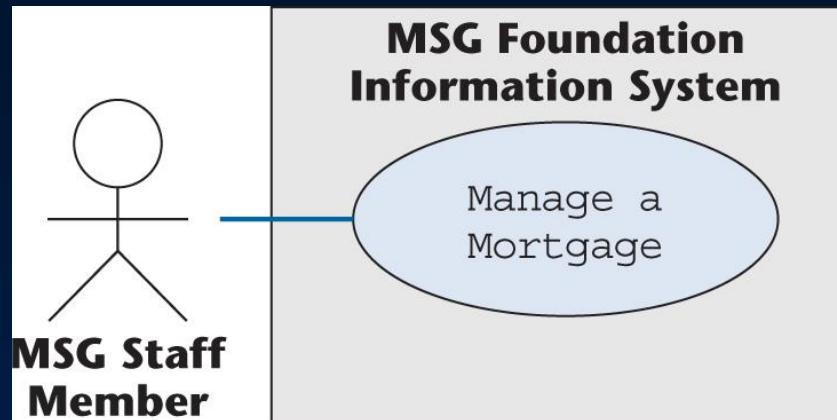


Figure 11.32

## Brief Description

The Manage a Mortgage use case enables an MSG Foundation staff member to add and delete mortgages and manage the mortgage portfolio.

## Step-by-Step Description

1. Add, modify, or delete a mortgage.

Figure 11.33

# Fourth Iteration of the Revised Use-Case Diagram

Slide 11.93

- The new use case is shaded

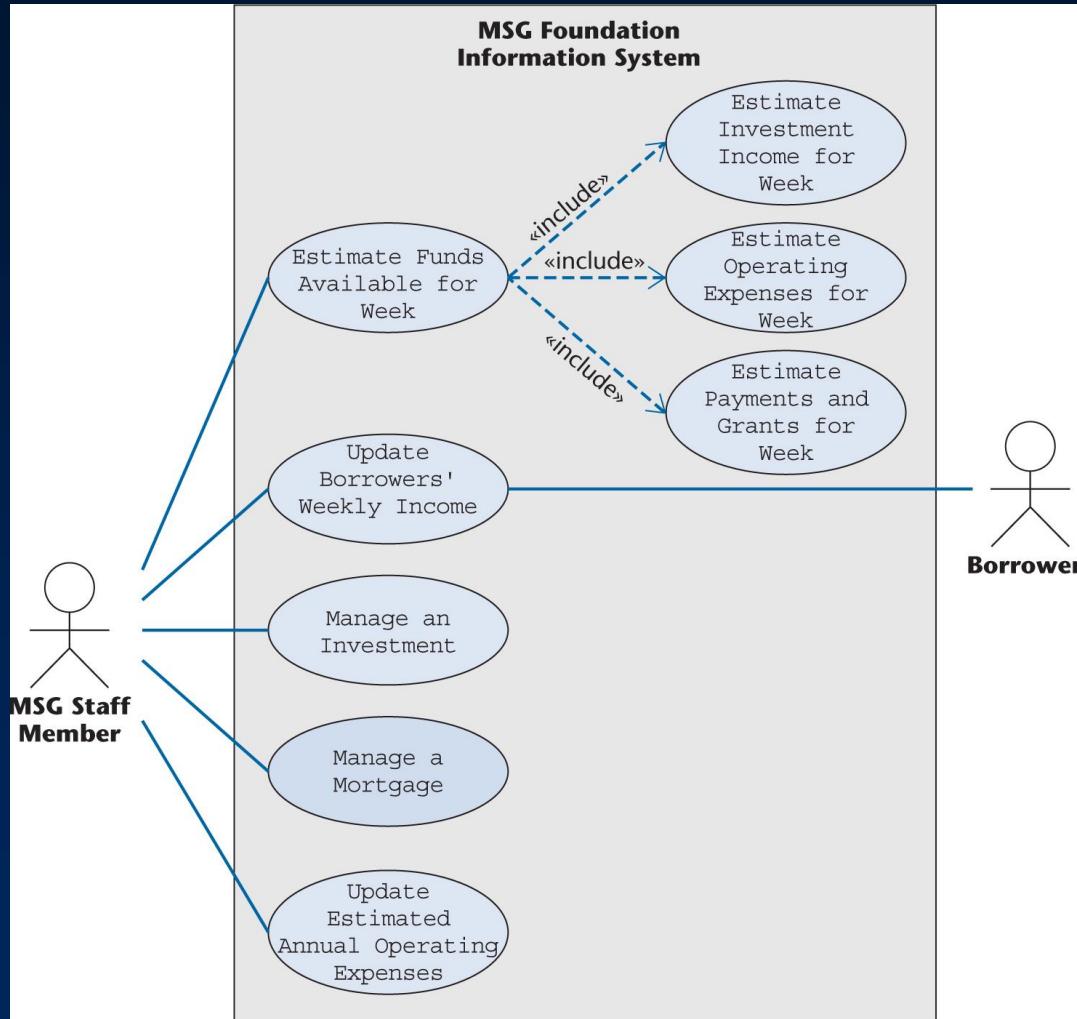


Figure 11.34

# The Test Workflow: MSG Case Study (contd)

Slide 11.94

- There is a further omission
  - Use case Produce a Report to print the three reports
    - » Investments report
    - » Mortgages report
    - » Results of weekly computation
- has also been totally forgotten

# Produce a Report Use Case

Slide 11.95

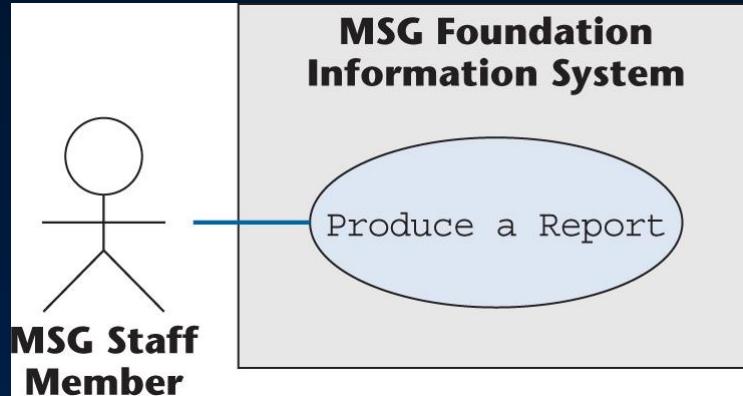


Figure 11.35

# Produce a Report Use Case (contd)

Slide 11.96

## Brief Description

The Produce a Report use case enables an MSG Foundation staff member to print the results of the weekly computation of funds available for new mortgages or to print a listing of all investments or all mortgages.

## Step-by-Step Description

1. The following reports must be generated:

- 1.1 Investments report—printed on demand:

The information system prints a list of all investments. For each investment, the following attributes are printed:

- Item number

- Item name

- Estimated annual return

- Date estimated annual return was last updated

- 1.2 Mortgages report—printed on demand:

The information system prints a list of all mortgages. For each mortgage, the following attributes are printed:

- Account number

- Name of mortgagee

- Original price of home

- Date mortgage was issued

- Principal and interest payment

- Current combined gross weekly income

- Date current combined gross weekly income was last updated

- Annual real-estate tax

- Date annual real-estate tax was last updated

- Annual homeowner's insurance premium

- Date annual homeowner's insurance premium was last updated

- 1.3 Results of the weekly computation—printed each week:

The information system prints the total amount available for new mortgages during the current week

Figure 11.36

# Fifth Iteration of the Revised Use-Case Diagram

Slide 11.97

- The new use case, Produce a Report, is shaded

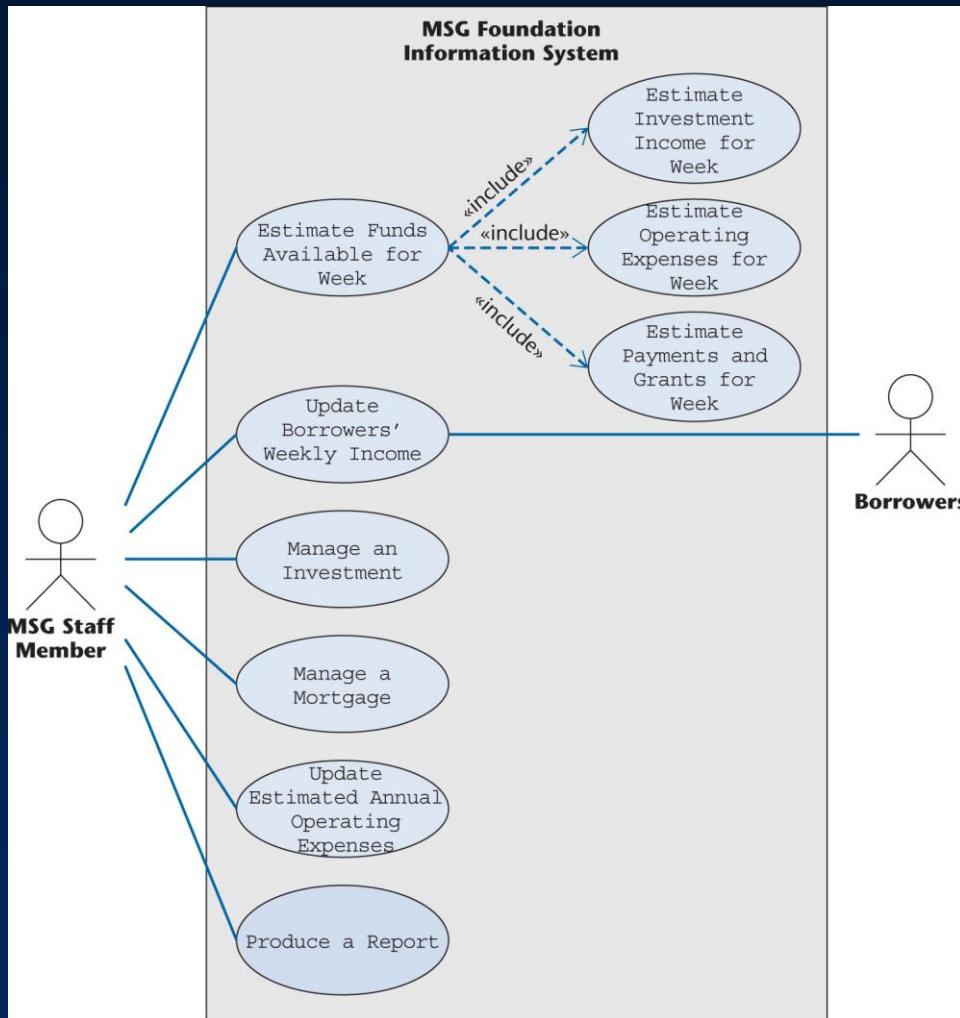


Figure 11.37

# The Test Workflow: MSG Case Study (contd)

Slide 11.98

- Rechecking the revised requirements uncovers two new problems
  - A use case has been partially duplicated
  - Two of the use cases need to be reorganized

# Partially Duplicated Use Case

Slide 11.99

- **Use case** Manage a Mortgage
  - One action is to modify a mortgage
- **Use case** Update Borrowers' Weekly Income
  - Only action is to update the borrowers' weekly income
- The borrowers' weekly income is an attribute of the mortgage
  - **Use case** Manage a Mortgage **already includes** use case Update Borrowers' Weekly Income
- Accordingly, **use case** Update Borrowers' Weekly Income is superfluous, and must be deleted

# Sixth Iteration of the Revised Use-Case Diagram

Slide 11.100

- The modified use case is shaded

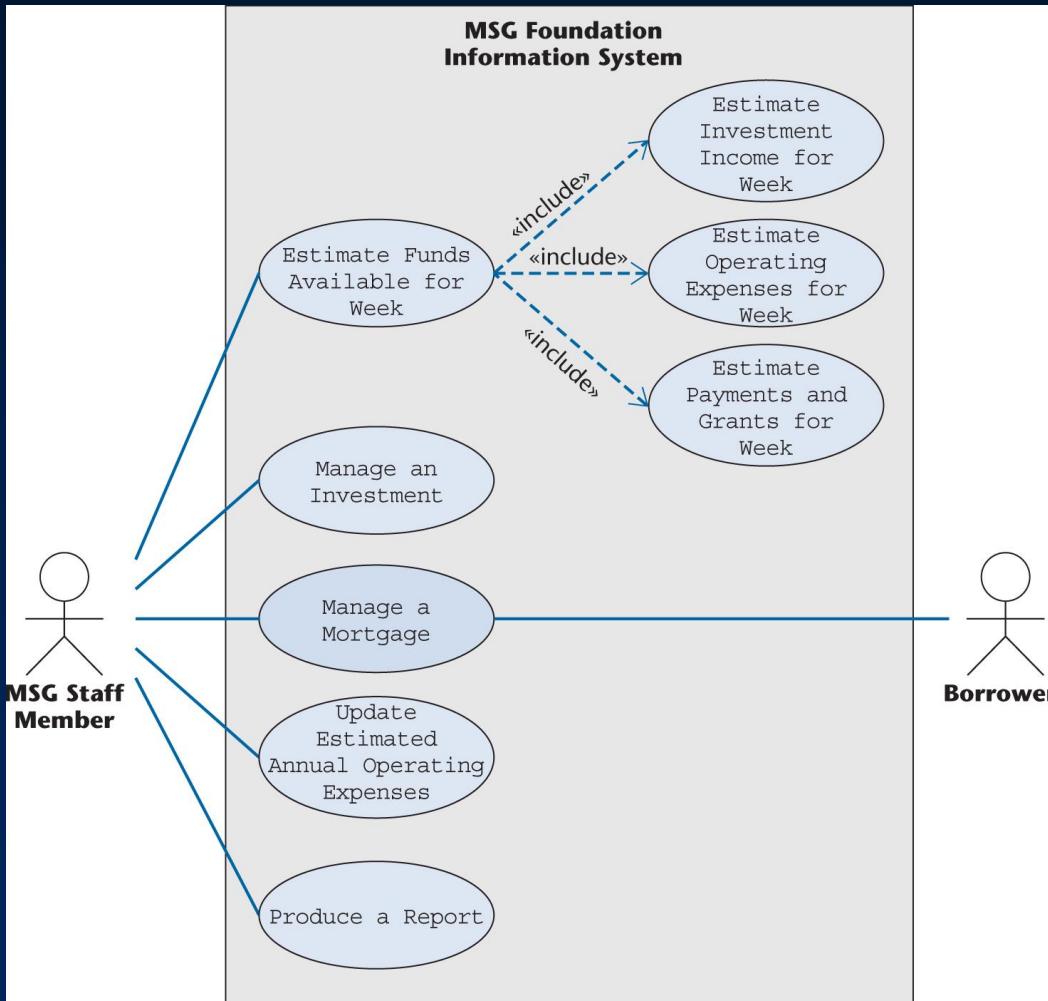


Figure 11.38

# The Test Workflow: MSG Case Study (contd)

Slide 11.101

- This iteration resulted in a decrement, not an increment
- In fact, deletion occurs often
  - Whenever we make a mistake
- Sometimes we can fix an incorrect artifact
  - More frequently we have to delete an artifact

# The Test Workflow: MSG Case Study (contd)

Slide 11.102

- However, when we discover a fault, we do not have to start the whole process from scratch
- First we try to fix the current iteration
- If the mistake is too serious for this to work, we backtrack to the previous iteration, and try to find a better way to go forward from there

# Reorganizing Two Use Cases

Slide 11.103

- Determine the funds available for the current week
  - Use case Estimate Funds Available for Week models performing the calculation
  - Step 1.3 of use case Produce a Report models printing out the result of the computation
- There is no point in estimating the funds available unless the results are printed out

# Reorganizing Two Use Cases (contd)

Slide 11.104

- The descriptions of the use cases

- Estimate Funds Available for Week, **and**
  - Produce a Report

have to be modified (the use cases do not change)

# Modified Description — Produce a Report

Slide 11.105

## Brief Description

The Produce a Report use case enables an MSG Foundation staff member to print a listing of all investments or all mortgages.

## Step-by-Step Description

1. The following reports must be generated:

- 1.1 Investments report—printed on demand:

The information system prints a list of all investments. For each investment, the following attributes are printed:

Item number

Item name

Estimated annual return

Date estimated annual return was last updated

- 1.2 Mortgages report—printed on demand:

The information system prints a list of all mortgages. For each mortgage, the following attributes are printed:

Account number

Name of mortgagee

Original price of home

Date mortgage was issued

Principal and interest payment

Current combined gross weekly income

Date current combined gross weekly income was last updated

Annual real-estate tax

Date annual real-estate tax was last updated

Annual homeowner's insurance premium

Date annual homeowner's insurance premium was last updated

Figure 11.39

# Modified Description — Estimate Funds Available for Week

Slide 11.106

## Brief Description

The Estimate Funds Available for Week use case enables an MSG Foundation staff member to estimate how much money the Foundation has available that week to fund mortgages.

## Step-by-Step Description

1. Determine the estimated income from investments for the week utilizing use case Estimate Investment Income for Week.
2. Determine the operating expenses for the week utilizing use case Estimate Operating Expenses for Week.
3. Determine the total estimated mortgage payments for the week utilizing use case Estimate Payments and Grants for Week.
4. Determine the total estimated grants for the week utilizing use case Estimate Payments and Grants for Week.
5. Add the results of Steps 1 and 3 and subtract the results of Steps 2 and 4. This is the total amount available for mortgages for the current week.
6. Print the total amount available for new mortgages during the current week.

Figure 11.40

# The Test Workflow: MSG Case Study (contd)

Slide 11.107

- The usual reason for an «include» relationship is where one use case is part of two or more other use cases
  - Example: U.S. tax forms—avoiding triplication

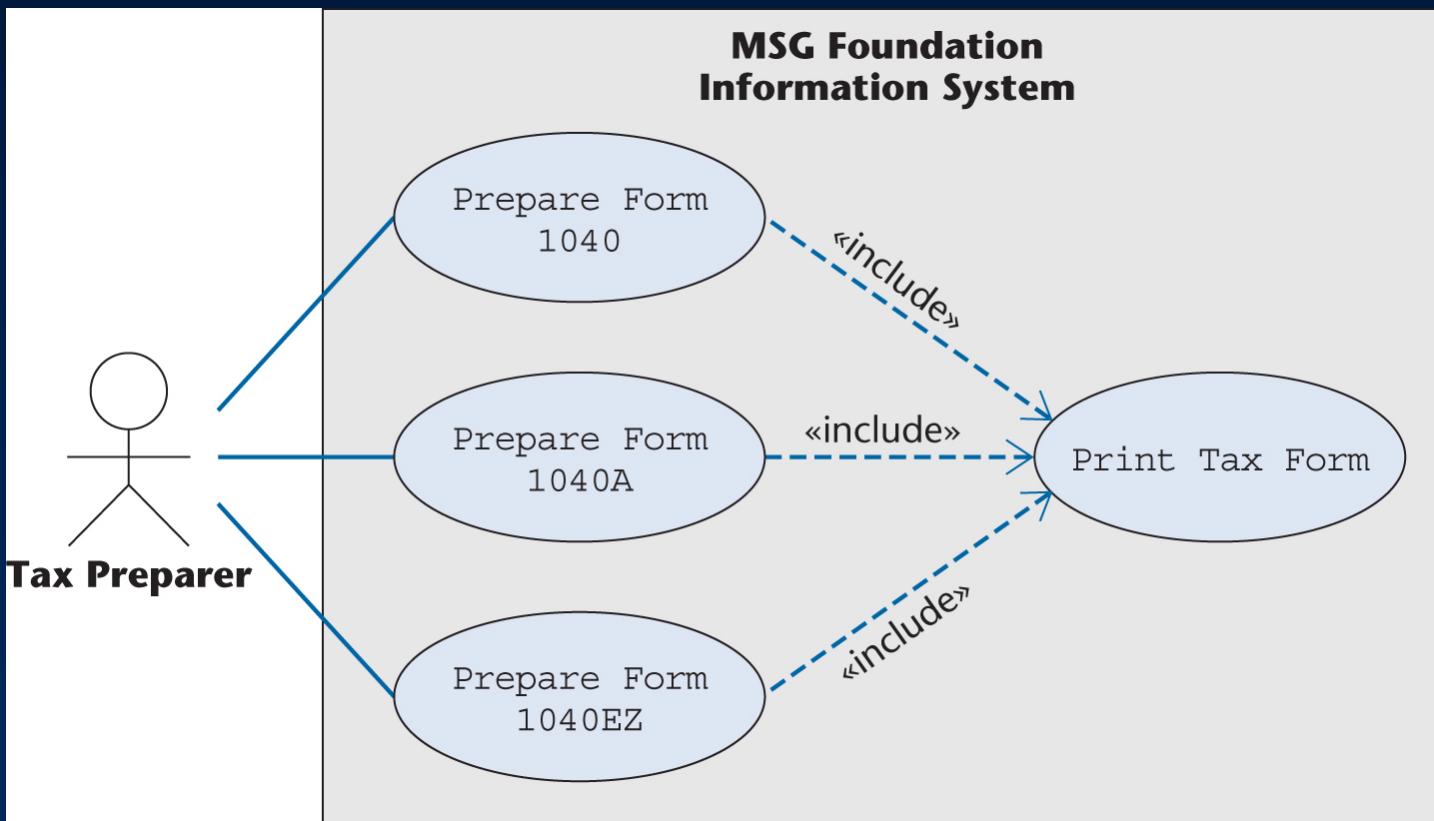


Figure 11.41

- For the MSG Foundation case study
  - All of the included use cases are part of only one use case,  
Estimate Funds Available for Week
- Incorporate those three «include» use cases into use case  
Estimate Funds Available for Week
  - The resulting use-case diagram is on the next slide

# Seventh Iteration of Revised Use-Case Diagram

Slide 11.109

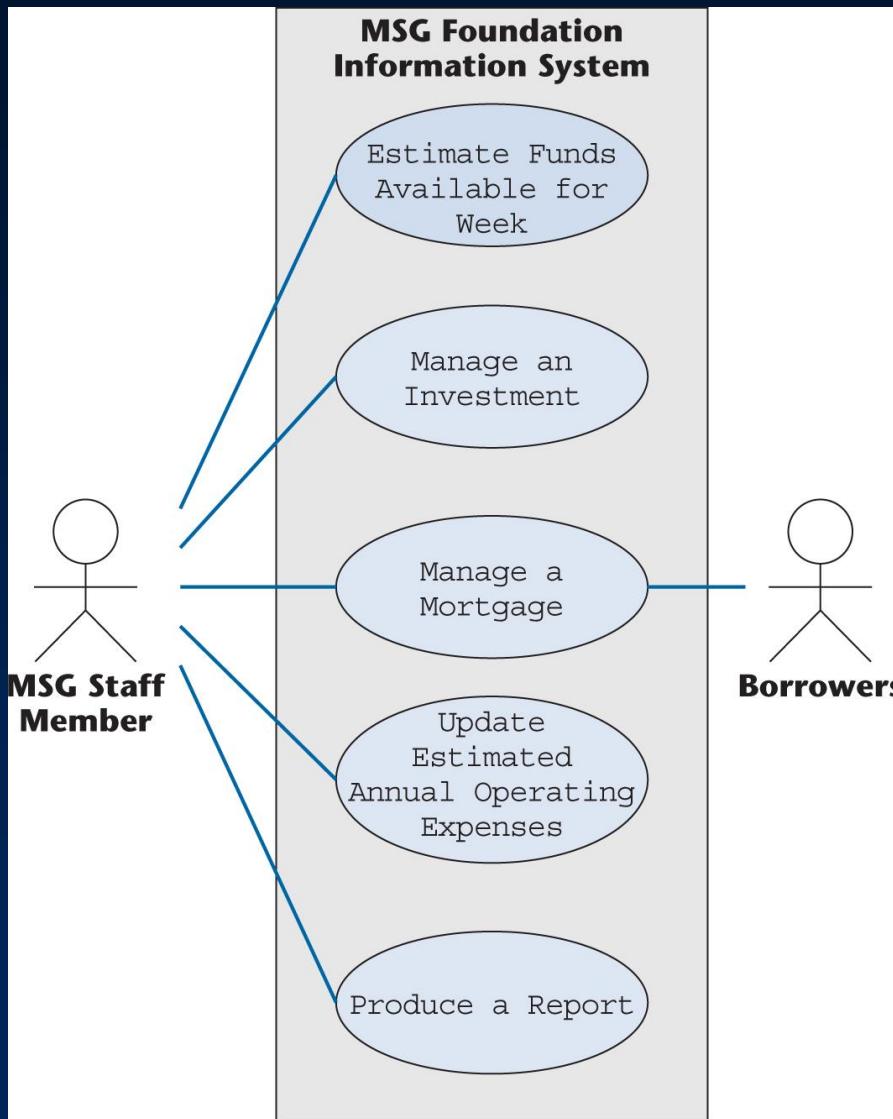


Figure 11.42

## Brief Description

The Estimate Funds Available for Week use case enables an MSG Foundation staff member to estimate how much money the Foundation has available that week to fund mortgages.

## Step-by-Step Description

1. For each investment, extract the estimated annual return on that investment. Summing the separate returns and dividing the result by 52 yields the estimated investment income for the week.
2. Determine the estimated MSG Foundation operating expenses for the week by extracting the estimated annual MSG Foundation operating expenses and dividing by 52.
3. For each mortgage:
  - 3.1 The amount to be paid this week is the total of the principal and interest payment and  $\frac{1}{52}$ nd of the sum of the annual real-estate tax and the annual homeowner's insurance premium.
  - 3.2 Compute 28 percent of the couple's current gross weekly income.
  - 3.3 If the result of Step 3.1 is greater than the result of Step 3.2, then the mortgage payment for this week is the result of Step 3.2, and the amount of the grant for this week is the difference between the result of Step 3.1 and the result of Step 3.2.
  - 3.4 Otherwise, the mortgage payment for this week is the result of Step 3.1, and there is no grant this week.
4. Summing the mortgage payments of Steps 3.3 and 3.4 yields the estimated total mortgage payments for the week.
5. Summing the grant payments of Step 3.3 yields the estimated total grant payments for the week.
6. Add the results of Steps 1 and 4 and subtract the results of Steps 2 and 5. This is the total amount available for mortgages for the current week.
7. Print the total amount available for new mortgages during the current week.

Figure 11.43

# The Test Workflow: MSG Case Study (contd)

Slide 11.111

- Now the requirements appear to be correct
  - They correspond to what the client has requested
  - They appear to satisfy the client's needs
  - There do not seem to be any more faults
- For now, everything seems to be fine

# 11.12 The Classical Requirements Phase

Slide 11.112

- There is no such thing as “object-oriented requirements”
  - The requirements workflow has nothing to do with how the product is to be built
- However, the approach presented in this chapter is
  - Model oriented, and therefore
  - Object oriented

# The Classical Requirements Phase (contd)

Slide 11.113

- The classical approach to requirements
  - Requirements elicitation
  - Requirements analysis
  - Construction of a rapid prototype
  - Client and future users experiment with the rapid prototype

# 11.13 Rapid Prototyping

Slide 11.114

- Hastily built (“rapid”)
  - Imperfections can be ignored
- Exhibits only key functionality
- Emphasis on only what the client sees
  - Error checking, file updating can be ignored
- Aim:
  - To provide the client with an understanding of the product

# Rapid Prototyping (contd)

Slide 11.115

- A rapid prototype is built for change
  - Languages for rapid prototyping include 4GLs and interpreted languages

# 11.14 Human Factors

Slide 11.116

- The client *and intended users* must interact with the user interface
- Human-computer interface (HCI)
  - Menu, not command line
  - “Point and click”
  - Windows, icons, pull-down menus

- Human factors must be taken into account
  - Avoid a lengthy sequence of menus
  - Allow the expertise level of an interface to be modified
  - Uniformity of appearance is important
  - Advanced psychology vs. common sense?
- Rapid prototype of the HCI of every product is obligatory

# 11.15 Reusing the Rapid Prototype

Slide 11.118

- Reusing a rapid prototype is essentially code-and-fix
- Changes are made to a working product
  - Expensive
- Maintenance is hard without specification and design documents
- Real-time constraints are hard to meet

# Reusing the Rapid Prototype (contd)

Slide 11.119

- One way to ensure that the rapid prototype is discarded
  - Implement it in a different language from that of the target product
- Generated code can be reused
- We can safely retain (parts of) a rapid prototype if
  - This is prearranged
  - Those parts pass SQA inspections
  - However, this is not “classical” rapid prototyping

# 11.16 CASE Tools for the Requirements Workflow

Slide 11.120

- We need graphical tools for UML diagrams
  - To make it easy to change UML diagrams
  - The documentation is stored in the tool and therefore is always available
- Such tools are sometimes hard to use
- The diagrams may need considerable “tweaking”
- Overall, the strengths outweigh the weaknesses

- Graphical CASE environments extended to support UML include
  - System Architect
  - Software through Pictures
  
- Object-oriented CASE environments include
  - IBM Rational Rose
  - Together
  - ArgoUML (open source)

# 11.17 Metrics for the Requirements Workflow

Slide 11.122

- Volatility and speed of convergence are measures of how rapidly the client's needs are determined

# Metrics for the Requirements Workflow (contd)

Slide 11.123

- The number of changes made during subsequent phases
- Changes initiated by the developers
  - Too many changes can mean the process is flawed
- Changes initiated by the client
  - Moving target problem

# 11.18 Challenges of the Requirements Phase

Slide 11.124

- Employees of the client organization often feel threatened by computerization
- The requirements team members must be able to negotiate
  - The client's needs may have to be scaled down
- Key employees of the client organization may not have the time for essential in-depth discussions
- Flexibility and objectivity are essential

# Overview of the MSG Foundation Case Study

Slide 11.125

Initial understanding of the domain	Section 11.6
Initial glossary	Figure 11.3
Initial business model	Section 11.7
Initial use-case diagram	Figure 11.12
Initial requirements	Sections 11.8, 11.9
Revised requirements	Section 11.10
Second iteration of the use-case diagram	Figure 11.21
Third iteration of the use-case diagram	Figure 11.26
Test workflow	Section 11.11
Fourth iteration of the use-case diagram	Figure 11.34
Fifth iteration of the use-case diagram	Figure 11.37
Sixth iteration of the use-case diagram	Figure 11.38
Seventh iteration of the use-case diagram	Figure 11.42
	Figure 11.44