CHAPTER 4: BUSINESS PROCESS AND FUNCTIONAL MODELING

In this chapter, we introduced how business processes are identified, modeled, and documented using the functional models of the UML. Specifically, we described how the functional requirements of business processes are identified by use cases and use-case diagrams. We described how activity diagrams model business processes and we described how use-case descriptions are used to more fully document the business processes. Finally, we described how to verify and validate the evolving representations of the business processes contained in the functional models. The basic functional and non-functional requirements for the CD Selections Internet Sales System were developed previously. At this point in time, you should go back and carefully review these requirements (see Figures 2-A, 2-B, 2-C, 2-E, 3A, 3B, and 3-C). In this installment of the CD Selections case, we see how Alec and Margaret work through all of these topics with regard to the Web-based solution that they hope to create.

Business Process Identification with Use-Cases and Use-Case Diagrams

As a first step toward developing a model of the functional requirements, Alec and his team decided to model these high-level business processes as use cases and to draw a use case diagram showing the interaction between business processes and the systems environment and how the business processes interact among themselves. To begin the business process identification process, Alec and the team went back and reviewed the requirements definition (see Figure 3-A).

The first business process identified in the requirements definition was Maintain CD Information. The Distribution System triggers this business process when it distributes new information for use in the CD database. Besides the Distribution System, another stakeholder was identified: EM Manager. Vendors trigger the second business process, Maintain CD Marketing Information, when CD Selections receive new marketing materials. An again, it seemed to the project team that the Electronic Marketing (EM) Manager would be an interested stakeholder. The third business process, Place Order, is much more interesting. In this case, the customer triggers the process. Again, the EM Manager is an interested stakeholder. This process has many more inputs. The final business process, Fill Mail Orders, seems to deal with the distribution system, customers, a credit card center, and the EM Manager. Furthermore, unlike the other business processes, it is unclear what exactly triggers its execution.

Once the team felt comfortable with their understanding of the requirements, they began the modeling process by setting the scope of the project. To begin with, they felt that the subject boundary should be drawn in such a manner that anything that is not part of CD Selections' Internet Sales System, such as the vendors, credit card center, and customers should be identified as primary actors. Therefore, these were considered outside of the scope of the system. The other potential actors identified could be the distribution system, EM Manager, and the current CD Selections stores. Upon closer review of Figure 3-A, Alec and Margaret felt that the distribution system and the current CD Selections stores should be outside the scope of the Internet Sales system. Consequently, they also should be identified as primary actors. In the case of the EM Manager, Alec and Margaret believed that the EM Manager should be considered as part of the Internet Sales System and therefore should not be identified as a primary actor. Remember, primary actors are only those that can be viewed as being outside of the scope of the system. The decision on whether the EM Manager, the current CD Selections stores, or the distribution system is inside or outside of the system is somewhat arbitrary. From a customer's perspective, the distribution system

and the current CD Selections stores could be seen as being inside of the overall system and it could be argued that the EM Manger is a primary user of the Internet Sales System. At this point in the process, it was important to make a decision and to move on. During the process of writing the detailed use cases, there would be ample opportunities to revisit this decision to determine whether the set of use cases identified are necessary and sufficient to describe the requirements of the Internet Sales System for CD Selections. As you can see, based on the above, finding the systems boundaries and listing the primary actors are heavily intertwined.

Based on the above, Alec and his team decided that the four high-level business processes should be modeled as use cases. However, upon closer review of and reflection on the Place Order process, the team felt that the Fill Mail Order business process seemed to be best treated as a part of the Place Order process instead of a separate business process (see Point 3.6 of the Functional Requirements in Figure 3-A). Based on these decisions, Alec created a first cut use case diagram of the Internet Sales System. He followed the guidelines in the textbook. First, he decided where to place the use cases on the diagram and drew them. Second, based on the actors that would interact with the different use cases, he decided where to place them in the diagram and drew them there. Third, he drew the subject boundary to portray the scope of the system. And finally, he drew the associations between the actors and the use cases to portray the interactions between the system processes and the systems environment. Figure 4-A portrays the first cut use case diagram created by Alec.

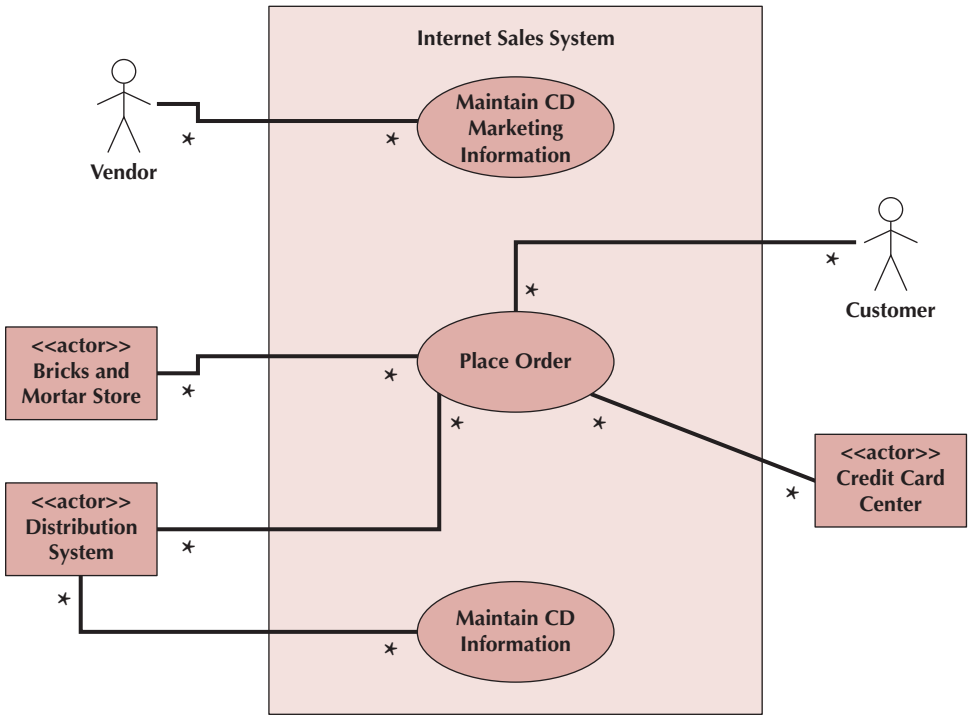

FIGURE 4-A
First-Cut Use Case Diagrams for CD Selections

At this point in the process, the project team began writing the overview use cases for the three high-level business processes: Maintain CD Information, Maintain CD Marketing Information, and Place Order. Remember, that an overview use case only has five pieces of information: use case name, ID number, primary actor, type, and a brief description. Having drawn the use case diagram, the team has already identified the primary actors and has associated the actors with the three use cases. Furthermore, since they are just beginning the development process, all three use cases type will be Overview and Essential. Since the ID numbers are simply used for identification purposes (i.e., they act as a key in a database), their values can be assigned in a sequential manner. This only left the team with two pieces of information for each use case to write. The use case name should be an action verb/noun phrase combination (e.g., Make Appointment). In the CD Selections Internet Sales situation, Maintain CD Information, Maintain CD Marketing Information, and Place Order seem to capture the essence of each of the use cases. Finally, a brief description was written to describe the purpose of the use case or the goal of the primary actor using the use case. Even though the description can range from a sentence to a short essay, the team only wanted to capture the primary issues in the use case and to make them explicit. Finally, the team carefully reviewed the current set of use cases. Take a moment to review the use cases and make sure you understand them. Based on the descriptions of all three use cases, the team felt that these three were a good basic representation of the primary business processes in the system. Figure 4-B portrays the overview, essential use cases for the Maintain CD Information, Maintain CD Marketing Information, and Place CD Orders use cases.

Business Process Modeling with Activity Diagrams

Reviewing the functional requirements described in Figure 3-A, the overview, essential use cases and the first cut Use Case Diagram, Alec sat down with Margaret to prioritize the three use cases. Based on their meeting, it was decided that the development team should focus on the most difficult and largest of the use cases first: Place Order. Consequently, Alec and the development team decided to carefully review point 3 of the functional requirements (see Figure 3-A). Upon doing this, the team identified a set of additional sub-processes that needed to be addressed: Search/Browse CDs (see point 3.1), Checkout (see point 3.2), Verify Credit Card Information (see point 3.3), Place in Store Hold (see point 3.4), Place Special Order (see point 3.5), and Fill Mail Order (see points 3.6 and 4). By carefully reviewing these sub-processes, the team realized that there needed to be a sub-process associated with the Checkout process that would support the creation of new customers. Upon further discussion and reflection, the team also decided to fold the Verify Credit Card Information sub-process back into the Checkout sub-process. The logic behind this decision was that this sub-process was really simply an action in the Checkout sub-process that simply sent a message to a Credit Card Center. Consequently, it did not make sense to factor it out as a separate sub-process. After the team had completed this process, Alec decided to create an activity diagram that portrayed the logical flow through the Place CD Order use case (business process). Following the process to draw an activity diagram described in the textbook, Alex decided to model the six sub-processes (Search/Browse CDs, Checkout, Create New Customer, Place in Store Hold, Place Special Order, and Fill Mail Order) as activities. Next, he identified the three decisions that needed to be modeled (to place an order or not, to create a new customer or not, and whether the customer wanted to place a special order, an in store hold, or a mail order). He then identified the control flows necessary to link the activities and control nodes together. The resulting activity

Use Case Name: Maintain CD Information	ID: 1	Importance Level: High
Primary/Actor: Distribution System	Use Case Type: Overview, Essential	
Stakeholders and Interests:		
Brief Description: This adds, deletes, and modifies the basic information about the CDs we have available for sale (e.g., album name, artist(s), price, quantity on hand, etc.).		
Trigger: Type:		
Relationships: Association: Distribution System Include: Extend: Generalization:		

Use Case Name: Maintain CD Marketing Information	ID: 2	Importance Level: High
Primary/Actor: Vendor	Use Case Type: Overview, Essential	
Stakeholders and Interests:		
Brief Description: This adds, deletes, and modifies the additional marketing material.		
Trigger: Type:		
Relationships: Association: Vendor Include: Extend: Generalization:		

Use Case Name: Place Order	ID: 3	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:		
Brief Description: This supports the customer searching and browsing the web site, and creating and placing order through the web site.		
Trigger: Type:		
Relationships: Association: Customer, Bricks and Mortar Store, Distribution System, Credit Card Center Include: Extend: Generalization:		

FIGURE 4-B Overview of the three Major Use Cases (Business Processes) for CD Selections

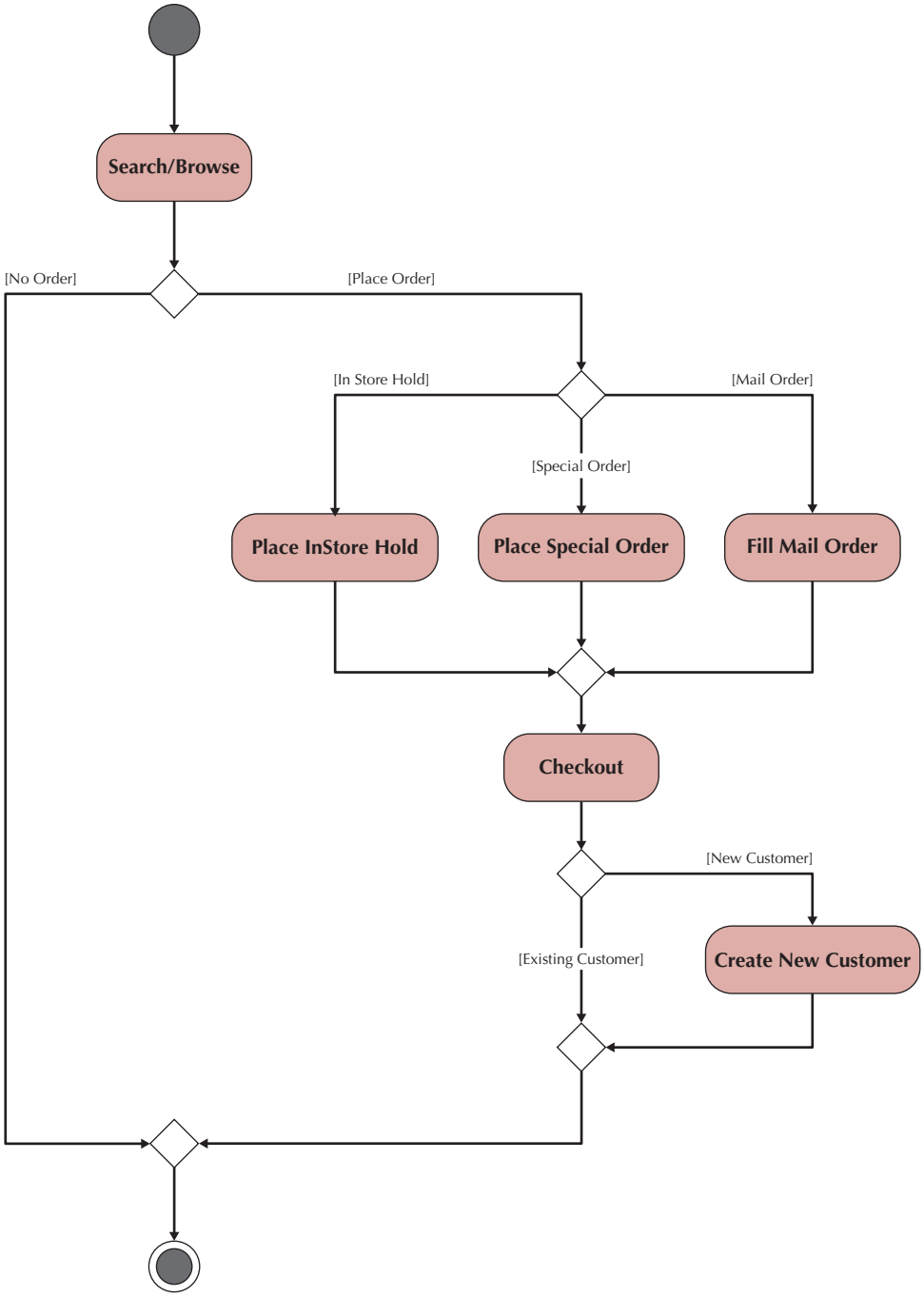

FIGURE 4-C Activity Diagram for the Place Order Use Case for CD Selections

diagram representing the Place Order use case (business process) is portrayed in Figure 4-C. Finally, the team decided to go back and modify the Use Case diagram to reflect these changes. In this case, the team decided to model each of the sub-processes as a separate use case (see Figure 4-D). This then required the team to go back and

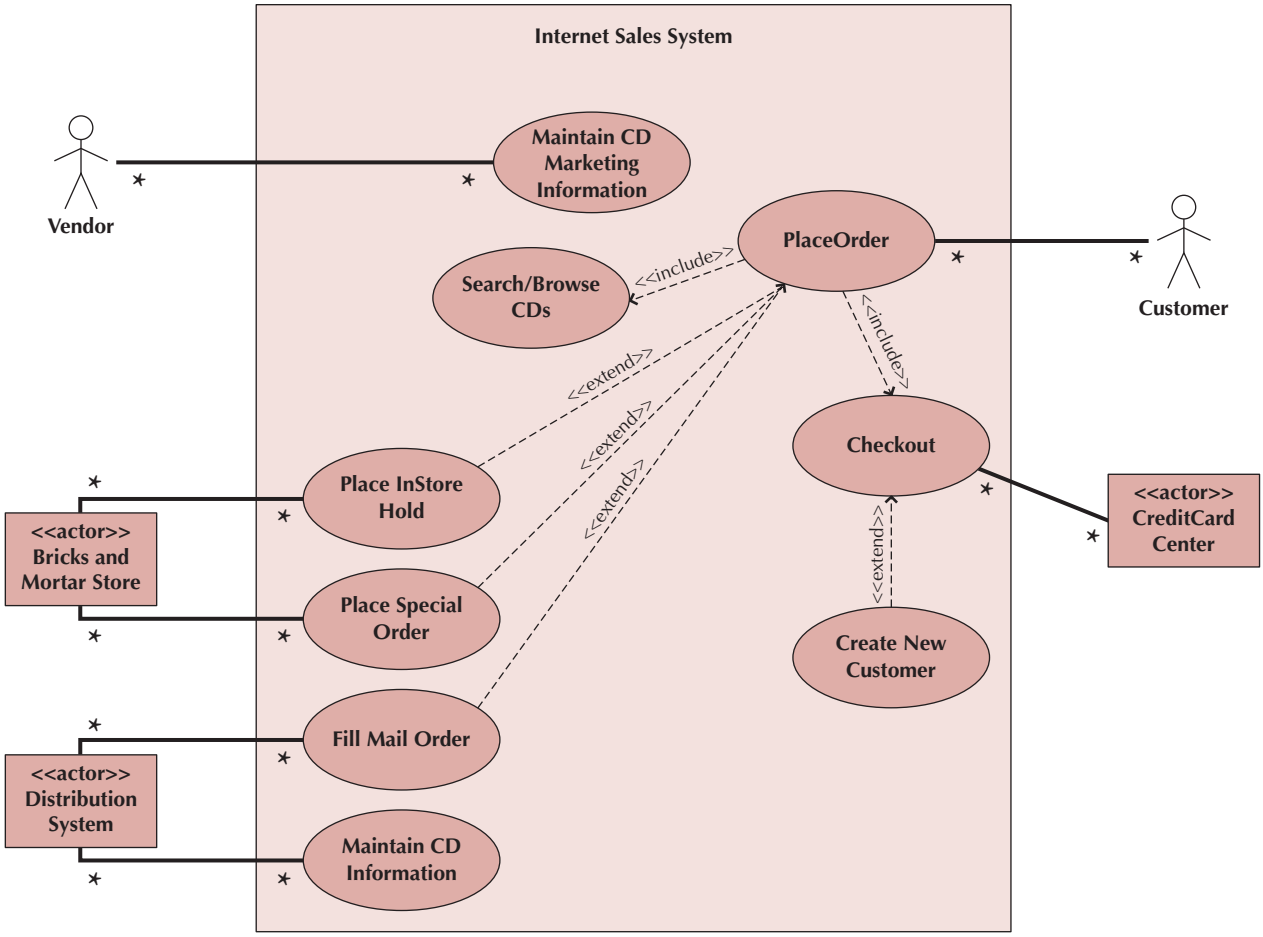

FIGURE 4-D Use Case Diagram for CD Selections

create an overview, essential use case description for each of the newly identified use cases (see Figure 4-E).

Business Process Documentation with Use Cases and Use Case Descriptions

Based on their review of the overview, essential use case descriptions, the project team decided that the Place Order use case was the most interesting. Based on this decision, the team began the conversion of the overview essential use case description to a detail, essential use case description. At this point in time, in addition to the information already contained in the overview, essential use case description (see Figure 4-B), the project team had the information necessary to fill in the stakeholders and interests and the trigger and type. In this case, the stakeholders were the customer actor and the EM Manager. The trigger was the customer visiting the web site to place an order. Since the customer is an actor, the type of trigger would be external. If the EM Manager had triggered the use case, the type would have been internal since the EM Manager was deemed earlier to be part of the system, i.e., the EM Manager is possibly an internal actor. Finally, it is possible for temporal triggers to exist where the use case would be triggered by the system's clock.

Use Case Name: Search/Browse CDs	ID: 5	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:	Customer - wants to be able to find CDs to purchase EM Manager - wants to ensure that the customer finds the CDs to purchase	
Brief Description:	The Customer searches and/or browses through the available CDs contained in the database to identify potential CDs to purchase.	
Trigger:	Customer initiates a search of the CD database.	
Type:	External	
Relationships:	Association: Include: Extend: Generalization:	

Use Case Name: Checkout	ID: 6	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:	Customer - wants to be finalize the order Credit Card Center - wants to provide effective and efficient service to CD Selections EM Manager - wants to maximize order closings	
Brief Description:	This describes the checkout process that closes the customer's order including credit card authorization.	
Trigger:	Customer signals the system they want to finalize their order.	
Type:	External	
Relationships:	Association: Credit Card Center Include: Extend: Generalization:	

Use Case Name: Create New Customer	ID: 7	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:	Customer - wants to be able to purchase CDs from CD Selections EM Manager - wants to increase CD Selections customer base	
Brief Description:	This describes how a new customer is added to the customer database.	
Trigger:	An unknown customer attempts to checkout.	
Type:	External	
Relationships:	Association: Include: Extend: Checkout Generalization:	

FIGURE 4-E Overview of the Six Newly Identified Use Cases for CD Selections

Use Case Name: Place Special Order	ID: 8	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:	Customer - wants to be able to place a special order of CDs for in store pickup EM Manager - wants to increase sales associated with the Internet Sales System Bricks and Mortar Store Manager - wants to increase sales associated with the store	
Brief Description:	This describes how a customer places a special order using the Internet Sales System.	
Trigger:	Customer selects CD on order for a special order at a bricks and mortar store.	
Type:	External	
Relationships:		
Association:	Bricks and Mortar Store	
Include:		
Extend:	Place Order	
Generalization:		

Use Case Name: Place In Store Hold	ID: 9	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:	Customer - wants to be able to place an in store hold on a CD for in store pickup EM Manager - wants to increase sales associated with the Internet Sales System Bricks and Mortar Store Manager - wants to increase sales associated with the store	
Brief Description:	This describes how a customer places an in store hold using the Internet Sales System.	
Trigger:	Customer selects CD on order for an in store hold to be picked up at a bricks and mortar store.	
Type:	External	
Relationships:		
Association:	Bricks and Mortar Store	
Include:		
Extend:	Place Order	
Generalization:		

Use Case Name: Fill Mail Order	ID: 10	Importance Level: High
Primary/Actor: Customer	Use Case Type: Overview, Essential	
Stakeholders and Interests:	Customer - wants to be receive order in a timely manner EM Manager - wants to maximize order throughput Distribution System - wants to complete order processing in a timely manner	
Brief Description:	This describes how a customer places a mail order using the Internet Sales System. This includes mail orders are moved from the Internet Sales System into the distribution system and how order status information is updated by the distribution system.	
Trigger:	Customer selects CD on order for a mail order to be completed by the distribution system.	
Type:	External	
Relationships:		
Association:	Distribution System	
Include:		
Extend:	Place Order	
Generalization:		

The project team then needed to gather and organize the information needed to define the Place Order use case in more detail. Specifically, they needed to begin writing the Normal Flow of Events (see Figures 4-11 and 4-14 for examples). This was done based on the results of the earlier analyses described in Chapter 3, as well as through a series of JAD meetings with the project sponsor and the key marketing department managers and staff who would ultimately operate the system.

The goal at this point is to describe how the chosen use case operates: Place Order. Using the activity diagram as a starting point, Alec and the team decided to visualize placing a CD order over the Web and to think about how other electronic commerce Web sites work–that is, role play. As they role played the Place Order use case, they realized that after the customer connected to the Web site, they probably begin searching, perhaps for a specific CD, perhaps for a category of music, but in any event, they entered some information for their search. The Web site then should present a list of CDs matching their request along with some basic information about the CDs (e.g., artist, title, and price). If one of the CDs is of interest to them, they might seek more information about it, such as the list of songs, liner notes, reviews, etc. Once they found a CD they like, they will add it to their order and perhaps continue looking for more CDs. Once they are done–perhaps immediately–they will "check out" by presenting their order with information on the CDs they want and giving additional information such as mailing address, credit card, etc.

When the team wrote the use case's Normal Flow Of Events, they paid close attention to the seven guidelines described in the textbook. Alec realized that that the first step was to present the customer with the home page or a form to fill in to search for an album. Even though this is technically correct, this type of step was very "small" compared to the other steps that followed[3]. It was analogous to making the first step "hand the user a piece of paper." At this point, the team was only looking for the three to seven major steps. Based on the role playing and the application of the earlier principles (see Figure 4-12), the team successfully identified a set of steps (see Figure 4-F)

The first major step performed by the system is to respond to the customer's search inquiry, which might include a search for a specific album name or albums by a specific artist. Or, it might be the customer wanting to see all the classical or alternative CDs in stock. Or, it might be a request to see the list of special deals or CDs on "sale." In any event, the system finds all the CDs matching the request, and shows a list of CDs in response. The user will view this response, and perhaps will decide to seek more information about one or more CDs. He or she will click on it, and the system will provide additional information. Perhaps the user will also want to see any extra marketing material that is available as well. The user will then select one or more CDs for purchase, decide how to take delivery of each CD, and perhaps continue with a new search. These steps correspond to events 1 through 7 in 4-F.

The user may later make changes to the CDs selected, either by dropping some or changing the number ordered. At some point the user will "checkout" by verifying the CDs he or she has selected for purchase, and providing information about him or herself (e.g., name, mailing address, credit card). The system will calculate the total payment, and verify the credit card information with the credit card center. At this point in the transaction, the system will send an order confirmation to the customer, and the customer typically leaves the web site. Figure 4-F shows the use case at this point. Note that the Normal Flow of Events has been added to the form, but nothing else has changed. At this point in time, the Place Order use case had eight events. Given the purpose of this use case, this seemed to be a reasonable number of events.

[3]Since it is so small, it violates the fourth principle (see Figure 4-12).

Use Case Name: Place Order	ID: 3	Importance Level: High
Primary Actor: Customer	Use Case Type: Detail, Essential	
Stakeholders and Interests: Customer – wants to search Web site to purchase CD EM manager – wants to maximize customer satisfaction		
Brief Description: This supports the customer searching and browsing the web site, and creating and placing order through the web site.		
Trigger: Customer visits Web site and places order. Type: External		
Relationships: Association: Customer Include: Search/Browse CDs, Checkout Extend: Generalization:		
Normal Flow of Events: 1. Customer executes the Search/Browse CDs use case. 2. The System provides the Customer a list of recommended CDs. 3. The Customer chooses one of the CDs to find out additional information. 4. The System provides the Customer with basic information and reviews on the CD. 5. The Customer iterates over 3 through 4 until done shopping. 6. The Customer executes the Checkout use case. 7. The Customer leaves the Web site.		
SubFlows:		
Alternate/exceptional Flows:		

FIGURE 4-F Normal Flow of Events of Places Order Use Case

The next step in writing a use case deals with alternate or exceptional flows. (Note: Remember the Normal Flow of Events only captures the typical set of events that end in a successful transaction.) With the Place Order use case, the development team defined success as a new order being placed. However, the team identified two sets of events that were exceptions to the normal flow. First, event 3 assumed that the list of recommended CDs were acceptable to the customer. However, as one of the team members pointed out, that is an unrealistic assumption. As such, two exceptional flows have been identified and written (3a-1 and 3a-2 in Figure 4-G) to handle this specific situation. Second, a customer may want to abort the entire order instead of going through the checkout process. In this case, exceptional flow 6a was created. Next, the team carefully reviewed the detailed, essential use case description for the Place Order use case (see Figure 4-G). The final step that Alec and the team performed was to repeat the entire process for each of the remaining use cases.

Once the team had completed evolving the overview, essential use cases to detail, essential use cases, Alec and his team had to go back through all of the functional representations of the business process to guarantee that the functional model was consistent, i.e., they had to verify and validate the business processes and functional models. Using Figure 4-16 as a

Use Case Name: Place Order	ID: 3	Importance Level: High
Primary Actor: Customer	Use Case Type: Detail, Essential	

Stakeholders and Interests: Customer – wants to search Web site to purchase CD.
EM manager – wants to maximize customer satisfaction.

Brief Description: This supports the customer searching and browsing the web site, and creating and placing order through the web site.

Trigger: Customer visits Web site and places order.

Type: External

Relationships:

- Association: Customer
- Include: Search/Browse CDs, Checkout
- Extend:
- Generalization:

Normal Flow of Events:

1. Customer executes the Search/Browse CDs use case.
2. The System provides the Customer a list of recommended CDs.
3. The Customer chooses one of the CDs to find out additional information.
4. The System provides the Customer with basic information and reviews on the CD.
5. The Customer iterates over 3 through 4 until done shopping.
6. The Customer executes the Checkout use case.
7. The Customer leaves the Web site.

SubFlows:

Alternate/exceptional Flows:

3a-1. The Customer submits a new search request to the system.
3a-2. The Customer iterates over steps 2 through 3 until satisfied with search results or gives up.
6a. The Customer aborts the order.

FIGURE 4-G Places Order Use Case with Alternate/exceptional Flows

guideline, Alec and his team checked each activity diagram against the use case descriptions and use case diagram and they checked the to be sure that each use case in the use case diagram had a completed use case description.

Finally, based on the current functional model, Alec revised the workplan again and he worked with Margaret and the folks in marketing to review the feasibility analysis and update it where appropriate. Furthermore, Alec and Margaret realized that the number of use cases had changed. Consequently, they went back and revised the project effort estimation (see Figure 4-H). At this point in time, the effort estimation went from about over 20 person months to approximately 24 months. Based on this new estimate, both Alec and Margaret were glad that Alec had originally doubled the estimation of 12 months. As Alec told Margaret, "sometimes it is better to be lucky, then to be good." Given the fact that the team has never built this type of system before, they were indeed lucky. In the future, Alec and Margaret realized that they would have to do a better job at estimating. But, with experience they felt that they would indeed be better in being able to estimate the number and complexity of the actors and use cases in this type of system. And that this would improve their estimation ability without having to revert to Alec's let's double the estimate approach.

Unadjusted Actor Weighting Table:

Actor Type	Description	Weighting Factor	Number	Result
Simple	External System with well-defined API	1	2	2
Average	External System using a protocol-based interface, e.g., HTTP, TCT/IP, or a database	2	1	2
Complex	Human	3	2	6
			Unadjusted Actor Weight Total (UAW)	**10**

Unadjusted Use Case Weighting Table:

Use Case Type	Description	Weighting Factor	Number	Result
Simple	1–3 transactions	5	3	15
Average	4–7 transactions	10	1	10
Complex	>7 transactions	15	5	75
			Unadjusted Use Case Weight Total (UUCW)	**100**

Unadjusted use case points (UUCP) = UAW + UUCW 110 = 10 + 100

Technical Complexity Factors:

Factor Number	Description	Weight	Assigned Value (0–5)	Weighted Value	Notes
T1	Distributed system	2.0	5	10.0	
T2	Response time or throughput performance objectives	1.0	5	5.0	
T3	End-user online efficiency	1.0	5	5.0	
T4	Complex internal processing	1.0	4	4.0	
T5	Reusability of code	1.0	3	3.0	
T6	Easy to install	0.5	3	1.5	
T7	Ease of use	0.5	5	2.5	
T8	Portability	2.0	4	8.0	
T9	Ease of change	1.0	3	3.0	
T10	Concurrency	1.0	3	3.0	
T11	Special security objectives included	1.0	5	5.0	
T12	Direct access for third parties	1.0	5	5.0	
T13	Special User training required	1.0	3	3.0	
			Technical Factor Value (TFactor)	**58.0**	

Technical complexity factor (TCF) = 0.6 + (0.01 * TFactor) 1.18 = 0.6 + (0.01 * 58)

Environmental Factors:

Factor Number	Description	Weight	Assigned Value (0–5)	Weighted Value	Notes
E1	Familiarity with system development process being used	1.5	1	1.5	
E2	Application experience	0.5	2	1.0	
E3	Object-oriented experience	1.0	0	0.0	
E4	Lead analyst capability	0.5	3	1.5	
E5	Motivation	1.0	4	4.0	
E6	Requirements stability	2.0	4	8.0	
E7	Part time staff	−1.0	0	0.0	
E8	Difficulty of programming language	−1.0	4	−4.0	
			Environmental Factor Value (EFactor)	**12.0**	

Environmental factor (EF) = 1.4 + (−0.03 * EFactor) 1.04 = 1.4 + (−.03 * 12)
Adjusted use case points (UCP) = UUCP *TCF *ECF 134.992 = 110 * 1.18 * 1.04
Person hours multiplier (PHM) PHM = 28
Person hours = UPC * PHM 3,779.776 = 134.992 * 28

FIGURE 4-H Use-Case Points Estimation for the Internet Sales Systems