

**Modeling a Business Process and Querying the Resulting Database:
Analyzing RFID Data to Develop Business Intelligence**

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Notes to REA-25 participants:

1. The teaching notes for the case are available from the first author.
 2. Student access to the case is viewable as follows:
 1. Conversation in text form:
<http://www2.gsu.edu/~wwais/pro/BloomScape/site/BloomScapeText.htm>
 2. Conversation in audio form:
<http://www2.gsu.edu/~wwais/pro/BloomScape/site/BloomScapeAudio.htm>
- For access, use name = acct431 and password = Pr2378.

Modeling a Business Process and Querying the Resulting Database:

Analyzing RFID Data to Develop Business Intelligence

Abstract: In this case, students analyze RFID and related fulfillment data to develop business intelligence for a grower of bedding plants that sells to big-box retailers. Detecting and correcting data recording errors and developing insights to help the grower requires integrating knowledge constructed from multiple activities. The activities include preparing a business process diagram to understand the business process; identifying business objectives to guide data analysis for assuring data quality and analyzing business performance; constructing an REA diagram to specify a database design; implementing the database and querying it to respond to the business questions; documenting procedures for clerical staff; and interpreting and communicating query results to the grower for managing the business. The case is appropriate for students with moderate database querying proficiency, e.g., at the level developed by Borthick and Jones' (2005) case on investigating a possible budget overrun for a PC maker's warranty service call center. The case is suitable for courses in AIS and database systems for advanced undergraduate students and in AIS, database, and managerial courses for master's students. The data are supplied in the form of Microsoft Access[®] databases.

Key Words: Business process modeling; Cost analysis; Data quality; Database querying; Error detection; Performance analysis; Query strategy; Queries

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LEARNING OBJECTIVES

Querying to Assure Data Quality and Analyze Business Performance

The success of data warehouses in providing information about business operations to support decisions has increased expectations that decision makers will retrieve information from databases and analyze it whenever a compelling problem or a promising opportunity arises (Cooper et al. 2000; Wixom and Watson 2001; Speier and Morris 2003). Accountants, especially, are expected to query transaction data generated about business operations for investigating business situations to develop insights for improving the business (Borthick 1992; McKinnon and Bruns 1992; Klamm and Weidenmier 2005). This shift to users retrieving and analyzing data themselves sets up new demands for accountants to develop process modeling, analysis, and querying skills (McCollum 2002; Fennel 2003; Jackson 2004). This case supports the high-level objective of *learning to model business situations to design databases and query them to solve business problems*. The specific objectives of this case are to detect and correct data recording errors to assure data quality and analyze business performance to identify potential improvements in operations.

The case features correcting and analyzing data collected from radio frequency identification (RFID) tags as a way to track objects in a supply chain (Bose and Pal 2005). The specific context for the case is a plant grower's need to improve operations by making sense of RFID data representing the movement of flats of plants and the carts transporting them (Sullivan 2004). The context is enabled through a conversation about the situation in text or audio form, databases with tables containing data from RFID sensing of flat and cart movement and fulfillment-related data

including orders and inventory, and a reporting template. Students analyze transaction-level data to detect and correct RFID recording errors and develop insights for managing the business.

Learning Objectives

The high-level learning objective is to *learn to model business situations to design databases and query them to solve business problems*. In the context of this case, students detect and correct data recording errors to assure data quality and analyze business performance to identify potential improvements in operations. The case achieves these objectives through the activities of:

1. Preparing a business process diagram (BPD) (BPMI 2004; White 2004) as a means of understanding the business process,
2. Developing objectives for assuring data quality and analyzing business performance for subsequently directing database querying,
3. Constructing a database model in the form of a Resources-Events-Agents (REA) diagram (McCarthy 1982; Dunn and McCarthy 1997) and implement it in a relational database with the supplied data,
4. Querying the database to satisfy the objectives developed above for assuring data quality and analyzing business performance,
5. Documenting querying procedures for clerical staff to allow the querying to be used routinely in the company, and
6. Communicating the results in a report.
7. Optional: Evaluating other students' work.

These objectives operationalize the process of identifying analysis needs and continuing the project through to communicating results. The case illustrates how accountants can make sense of a new situation to provide information for improving operations consistent with expectations that accountants provide information for management (McKinnon and Bruns 1992; Borthick 1996; Speier and Morris 2003).

Learning Theory: Situation Model Building

In the theory of situation model building (Zwaan and Radvansky 1998; Barsalou 1999), the best preparation for action is having constructed one's own mental situation models in analogous prior situations. This case constitutes a prior situation for future situations requiring skills in modeling business processes, designing and implementing databases, and querying databases to solve business problems. To construct their own situation models, learners make inferences and elaborations as they encounter new information in the situation. In this theory, learners demonstrate comprehension of a problem by constructing a coherent situation model representing it (Johnson-Laird 1983; van Dijk and Kintsch 1983; Gernsbacher 1997; Graesser et al. 1997; Zwaan and Radvansky 1998). The process of constructing situation models requires one to make inferences and elaborations as new information about the situation emerges. More learning occurs when situations are hard rather than easy to understand because easy-to-understand situations do not prompt elaborations or inferences (Myers et al. 1987). Thus, modeling easy-to-understand situations provides less opportunity for learning than more challenging situations (Gernsbacher 1997; Zwaan and Radvansky 1998).

The case was designed for its comprehension to be hard enough to prompt learners to make the substantial inferences and elaborations required to make sense of a business situation. Preparing the business process and REA diagrams ensures that students make their understanding of the situation explicit, which enables its completeness and correctness to be assessed, which permits them to refine their process skills. Constructing the queries requires learners to think through (1) sources and purposes of the data files, (2) how the data were recorded and potential sources of data errors, (3) the objectives for using the data, and (4) how the data could be analyzed to inform business operations. Understanding these matters requires insights that come one at a time as learners integrate knowledge from the conversation, the data tables, and other materials into their existing situation models (Gernsbacher 1997; Zwaan and Radvansky 1998).

Although experienced business people make these kinds of inferences almost automatically, inexperienced business people, e.g., learners in classroom settings, tend to miss important relationships. The inferences and elaborations are subtle, but they represent the kinds of situation model updating required to make sense of a business situation and develop insights about it.

Prerequisite Skills

To work the case, students need to have (1) REA modeling skills at the level of Dunn et al. (2005) or Romney and Steinbart (2006) and (2) analysis skills and database querying proficiency at the level of Borthick and Jones' (2005) case investigating a possible budget overrun for a PC maker's warranty service call center.

Case Design Rationale

Although it contains a substantial number of rows, the database for the case was designed with just enough tables and attributes to represent the situation but without overwhelming detail. Like Borthick and Jones' (2005) warranty call center case, the tables in this case have too much data for hand manipulation of records.

The case is presented in three parts. In part 1, learners (1) prepare a business process diagram (BPD), (2) identify business objectives to guide data analysis for assuring data quality and analyzing business performance, (3) construct an REA diagram to specify a database design and implement the database, (4) query the database to respond to the business questions, (5) document procedures for clerical staff, and (6) communicate query results to the grower for managing the business. In part 2, learners respond to a small set of multiple-choice questions as practice for answering the questions in part 3. Learning objectives for the questions in parts 2 and 3 appear in Table 1.

TABLE 1
BloomScape Questions by Learning Objective

Learning Objective	Question Number ^a
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Design and represent business processes	
Develop process implications	7, 10 , 4
Make inferences about process behavior	15 , 24
Infer reasons for system design	6
Improve the system or processes	25 , 28
Evaluate business strategy	8
Design and implement databases	
Develop data structures	16 , 20
Match or convert data types	9, 11
Construct keys	12
Match cardinalities to business processes	16 , 24
Configure joins	17 , 21, 22, 23, S5
Query databases to provide insights about performance	
Develop business performance analysis objectives	S1, 5, 30
Compose query strategy	2
Formulate queries	15 , 21, 22, 23, S3, S5, S6
Construct expressions	18, 27, S4
Interpret query results	11 , 17, 23, 25, 29, 30, 4, S3, S5
Document queries for others to use	26
Evaluate internal control and design controls	
Develop data quality monitoring objectives	1, 3, 13, 14, 19, 29
Detect and correct data errors	7 , 10, 17, S2, 29, S6

^a Question numbers in **bold** pertain to more than one learning objective. Question numbers beginning with “S” refer to sample questions.

Reaction to the Case

Two key themes emerged from student feedback: the appeal of RFID technology and the realism of the case. The use of RFID technology is an effective way to develop student interest in analyzing data. After reading the background articles on RFID and thinking about the potential uses of RFID, students were engaged in working the case. A few students were so engaged they attempted to research investment opportunities related to RFID technology. The engagement engendered by the use of RFID technology is a key feature of the case because student engagement is related to the amount of effort they exert, which is associated with learning.

Students were also caught up in the realism of the case. The case setting is vivid and familiar in the sense that students can imagine how BloomScape operates. Students also learn to recognize that technology does not solve all problems. For example, RFID readers may not detect all the tags, and BloomScape workers can forget to change the attributes identifying an order or its direction. Querying can, however, be used to help detect and correct errors as well as analyze business performance. The case helps students realize that knowing how to construct queries is not just an academic exercise but that query expertise has real-world implications.

IMPLEMENTATION GUIDANCE

Course Use

The case is suitable for courses in (1) AIS and database systems for advanced undergraduate students and (2) AIS, database, and managerial courses for master's students. Ideally, students should have some familiarity with RFID, e.g., as explained in Romney and Steinbart (2006). Students need proficiency in (1) REA modeling at the level of Dunn et al. (2005) or Romney and Steinbart (2006) and (2) database querying at the level developed by Borthick and Jones' (2005) case on investigating a possible budget overrun for a PC maker's warranty service call center.

The case can be used as an individual or as a team assignment. If students complete the multiple-choice questions in part 3 individually as an in-class assessment of proficiency level, these questions can serve as a control on freeloading by team members on the querying tasks in part 1.

Business Process Modeling Choice

Although the business process diagram can be created in several graphical formats, e.g., flowcharting or data flow diagramming, an approach that works well for this case is the Business Process Modeling Notation (BPMN) (BPMI 2004) developed by the Business Process Modeling Initiative's (BPMI) Notation Working Group (which has merged with the Object Management

Group). In February 2006, BPMN 1.0 was adopted as an Object Management Group (OMG) standard. BPMN was designed specifically for business process modeling for use by business users, business analysts, technical developers, and business managers. The documentation in White's (White 2004) introduction, available at no cost from the BPMP web site, is sufficient guidance for preparing the process diagram for this case.

Software Choice

Although they are supplied in the form of Microsoft Access[®] databases, the data could be exported to any relational database system that supports querying with Structured Query Language (SQL) or Query-By-Example (QBE). The teaching notes feature queries developed for Microsoft Access[®] QBE. Given the growing use of database querying in business and in prerequisite courses, some students may already prefer one of these two interfaces. Instructors can permit use of either one or require students to use a specified one. Differing preferences across team members prompt them to negotiate their choice of tool interface.

Case Staging

Students can work the case as single or multiple assignments. The single-assignment approach has the advantage of enabling students to experience the case as an integrative whole, in which the completeness of their lists of objectives for assuring data quality and analyzing business performance affects querying outcomes. The multiple-assignment approach allows instructors to help students that might need coaching on how to approach tasks in situations for which the mental model construction requires inferences and elaborations. Thus, a multiple-assignment approach has the advantage of ensuring that student lapses early in the case do not jeopardize subsequent performance. For example, if students get feedback on their lists of objectives for assuring data quality and analyzing business performance, they will develop a more complete set of results. The feedback could be in the form of discussion in class or on a

discussion board. Because students typically make sense of different aspects at different times, they can respond to each others' questions.

For a multiple-assignment approach, phase one might encompass the objectives of (1) prepare a business process diagram and (2) develop objectives for assuring data quality and analyzing business performance. Phase two might include the objectives of (3) construct a database model and implement it in a database. Phase three would then include objectives (4) query the database to satisfy the objectives for assuring data quality and analyzing business performance, (5) document querying procedures, and (6) communicate the results in a report.

Time Requirements

The time that students spend on the case is highly variable, depending on (1) their skills in REA modeling and database querying and (2) their propensity to procrastinate. Students with the suggested levels of skill in REA modeling and database querying typically spend 15 to 20 hours on the case. Students without the prerequisite skills that want to do good work may spend 40 or more hours on the case, where the hours above about 20 are spent on developing the needed skills. Students without the prerequisite skills that are satisfied with ordinary work may spend 10 to 20 hours on the project.

Independent of their modeling and querying skills, students that defer working on the case until the last week before it is due tend to report more hours than those that pace their work more uniformly. Procrastinators forgo opportunities to get answers to their questions in the weeks that they can ask questions about the case in class sessions and on an electronic discussion board. Doing all the work at the end also eliminates time for reflection, which can trigger epiphanies about how to proceed with the case. The combination of not being able to get answers to questions on short notice and not reflecting on case aspects results in procrastinators missing out on insights that would enable them to minimize the hours they spend on the case. Of course, instructors can ensure that students do not defer all the work to the end of the assignment period

by requiring submissions of sub-parts at intervals for grading as explained in the previous section. Sparing procrastinators from the consequences of deferring the work, however, eliminates an opportunity for students to learn to manage their time effectively.

Peer Evaluation of the Case (Optional)

Having students evaluate other students' work facilitates students recognizing that there may be multiple ways to approach different tasks. A report form for peer evaluation of the case is included with the case materials. If students publish their work on web sites, e.g., on institutionally-provided web spaces or in a learning management system, the instructor could create a page linking to all students' work, which facilitates giving students access to everyone's work. For each team, the instructor can designate the team whose work it is to evaluate. Students can complete this kind of evaluation in about 30 minutes. The linking page can also include links to completed evaluation reports. Class time permitting, student teams could summarize their evaluations briefly (5-10 minutes) for the class. We prefer this approach to having teams present their work because it focuses students' attention on evaluating others' work, which ensures that students see other ways to accomplish the same tasks, including the best approaches developed by any team.

Case Nuances and Coaching Learners

Students may not, at first, be able to distinguish between objectives for assuring data quality and for analyzing business performance. Working through an example of each kind of objective is usually enough coaching to help students distinguish between them.

Because learners typically start at different places with respect to their skills for analyzing a business situation to develop querying objectives, for structuring databases, and for developing queries and making sense of their results, instructors should be ready to provide targeted coaching for varied skill levels. Instructors can choose how and when in the life of the project they offer

different kinds of guidance to learners. Rather than simply telling learners how to do something, however, helping them construct their own mental models of the situations or tasks will enhance their ability to construct models for subsequent situations on their own. One way to guide construction of mental models is to prompt learners to make connecting inferences by asking them questions that step them through the model. The questions in Table 2 illustrate the kinds of questions that instructors could pose to students to prompt them to construct their own mental models of the situation and the needed analysis.

TABLE 2
Questions for Prompting Learners to Construct Mental Models

Developing objectives

1. Why is it important to develop objectives first?
2. How do you decide what the objectives are?
3. How can you make sense of the conversation to tease out potential objectives?
4. How do you distinguish between objectives for assuring data quality and objectives for analyzing business performance?
5. Why is it important to assure data quality *before* analyzing business performance?

Constructing the BPD and the REA diagram

1. How do you figure out what the needed events are? Where are the clues? How do you recognize them?
2. How do you distinguish between objectives for assuring data quality and objectives for analyzing business performance? Why does it matter?
3. Although the take order event occurred before the conversation started, are resources needed for it and for items ordered?
4. Is a compost resource needed or will the plant type (inventory) resource do?

Designing tables and querying the data

1. How do you make all the tables appear in the same database so you can work with them?
2. Can query results be used as tables?
3. Where are the SKUs in the RFID data? How do you extract the SKU from the GTIN? Does data type matter? If so, what do you do about it?
4. What are the hardest tables to create? How can you create them with queries rather than manual data entry?
5. Does it matter that queries do not have explicit primary keys? Why? What substitutes for them?

Preparing documentation

1. Who is the audience for the documentation?
 2. How knowledgeable is this audience about database querying?
 3. How do you explain what to look for in query results even though the next set of RFID data may have different data errors?
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THE CASE

The Business Situation

The scene: Managers at BloomScape, a company that grows and supplies bedding plants such as pansies and begonias to big-box retailers, mulling over the implications of using RFID¹ to track the carts with flats of plants they deliver to customers and how to take advantage of the avalanche of data² that tag reading could generate. Other growers are already using RFID to track carts.

Hitomi (greenhouse manager): “Do we have to redo our SKUs to use RFID?”

Kelly (IS manager): “Instead of ‘redo,’ it's more like ‘embed,’ as in the current SKUs being embedded in a larger ID number. Each cart and each flat of plants will have a tag with the ID number.”

Chandra (sales manager): “Does that mean we could track products to the flat? With that information, I might be able to convince big-box staff that we really did deliver what they ordered in the delivery window.”

“Lane” (shipping manager): “What makes you so sure you'll get 100% reading for carts?”

Kelly: “I'm going on what another grower achieved with antennas built into the floor at loading docks. As carts pass the readers, the antennas broadcast signals to nearby PCs, which record the data.”

Hitomi: “What records do the PCs keep?”

Kelly: “If it works right, they record all the RFID tags--on carts and on flats--that pass close enough to be read.”

Lane: “How do you distinguish between a full cart headed out and an empty cart coming back?”

Kelly: “A worker at the loading dock would do it at a PC, which means changing the settings for each shipment to associate it with an order by orderID and indicating whether the shipment is outbound to the customer or empty carts are returning to us.”

Hitomi: “What about tags on the flats of plants? How well will they read?”

Kelly: “It's not clear yet. I don't think anybody's expecting 100% reading at that level at first. The most common errors are omissions. If the reader sees a working tag, it usually reads it correctly. We may have to experiment with the best position for the tags on flats. We already know that the tags on the bottom of carts should be embedded in a plastic sleeve.”

Lane: “Why?”

Kelly: “Metal surfaces tend to scatter the signals, and the plastic sleeve gets the tag ever so slightly off the surface of the metal.”

¹ Levinson, M. 2003. The RFID imperative. *CIO*: 78-91. Available at <http://www.cio.com/archive/120103/retail.html>

² Whiting, R. 2004. Data avalanche. *InformationWeek* 30-36. Available at <http://www.informationweek.com/story/showArticle.jhtml?articleID=17700027>

Lane: "Okay, you convinced me that RFID will help us keep up with carts. What else is possible?"

Chandra: "Could we determine how long carts stay at customer stores and with which products? Knowing the quantity and frequency of cart traffic to and from stores would let us do a cost and profitability analysis by customer."

Lane: "What about carts hanging around empty at stores?"

Hitomi: "Well, maybe organizing some of this data would let us keep closer tabs on carts so we could retrieve them before they disappeared into cart heaven at \$500 apiece."

Lane: "Back to the financial breakdown part. Do you mean we don't already know the cost and profitability per customer?"

Kelly: "That's right! If it makes you feel any better, not many companies, large or small, know that."

Chandra: "Why not, given all the data that companies collect?"

Kelly: "Before ERPs were invented, the data fields you'd need for these calculations were scattered across different systems, making it hard to isolate just the relevant data."

Chandra: "And after ERPs came?"

Kelly: "Even though ERPs integrate across applications, getting the data out is still non-trivial because somebody that knows what they're doing with the underlying database has to write reports based on queries to retrieve it."

Chandra: "If ERPs are so integrated, why do you have to get the data out to analyze it?"

Kelly: "Because ERPs, for the most part, haven't been modified to accept RFID data. Even Kimberly-Clark is still analyzing RFID data in a separate database. And, even though it might be theoretically possible to get to the data, no one has much experience with this kind of calculation. We'd be breaking new ground."

Hitomi: "Like putting a shovel in brick-hard clay?"

Kelly: "Yep! Let's see how far we can get thinking through what the calculations might be. Part of the computation would include factoring in plant loss. Now, we just compost the returns. With RFID, we'd count returned flats before composting what's left of the plants. Beats me why we can't keep plants looking good long enough for our customers to sell them."

Lane: "Maybe they hide them!"

Chandra: "Or we don't water them consistently. Um...[obviously thinking]...wonder if it varies by store."

Kelly: "Is this enough to get you thinking about the possibilities? We can configure the PCs to record carts and flats outbound and inbound, stripped of duplicate signals. I have no idea when our accounting software will be upgraded to accept RFID data--could be a long time given the data-formatting issues and software incompatibilities. There are fancy report writing programs we could get to analyze the data, but they're expensive, and it's not clear to me which one we'd really need."

Chandra: “Wouldn't the cheapest one do?”

Kelly: “I don't know because I don't know just what kind of analyses will be useful and what the data volumes will be. We've just talked about some analysis needs, but talking is not the same as analyzing.”

Chandra: “Is there an alternative to get us started?”

Kelly: “Maybe. If someone imported data into a database and analyzed it with queries, we might get some insight into useful analyses and data volume.”

Chandra: “Do we have anybody that can do that?”

Kelly: “I can get the data extracted. I don't have anyone for the querying at the moment, but my neighbor teaches accounting information systems at the university. I'll see if she has students that might be interested.”

Chandra: “I know it will take a while, maybe a long while, but I can't wait until we can enjoy RFID benefits. If Wal-Mart reduced its out-of-stocks with RFID, we ought to see some gains too!”

Hitomi: “Be patient. This is going to be like growing plants--ssllloowww.”

Later, after Hitomi, Chandra, and Lane realized they needed to know more about tag reading.

Lane: “I know just enough about this stuff to be dangerous! I'm looking at a tag whose paper bar code says ‘0156483010474.’ If I mentally drop the ‘4’ in the 1's position, the last four digits are ‘1047,’ which corresponds to our SKU of ‘1047,’ which is Majestic Giant red/black blotch 6-pack.”

Kelly: “You got it! The number on the bar code is the Global Trade Item Number (GTIN), which is what the tag tells the reader, and the PC writes in its file. The item number is actually ‘01047.’. The numbers in front of the item number are country and company codes, and the last digit, the ‘4’ you stripped off, is the check digit.”

Chandra: “Does every flat of Majestic Giant red/black blotch 6-pack have the same GTIN?”

Kelly: “Yes.”

Chandra: “Then how does the tag reader keep up with the fact that one cart might have several flats with the same GTIN? We usually put like plants together on a shelf, e.g., seven 6-pack flats fill a shelf.”

Kelly: “When a tag passes within range, the reader and tag do a little dance called the Q protocol. The reader issues a query to the tag, which responds with a randomly generated number. The reader acknowledges the number, after which the tag sends its ID. When the reader gets the ID, it tells the tag to be ‘quiet,’ which makes it easier for the reader to hear all the tags and be sure it read all of them. Because each tag generates its own random number, the reader can keep up with each tag it read. Although the cycle might be repeated several times, carts and flats are supposed to be recorded once.”

Hitomi: “How many tags can a reader handle at once?”

Kelly: “Theoretically, the number is 1,000 tags per second in the best conditions although we don't need to run ours at that speed. Something in the 100-500 range is more likely.”

Hitomi: “In other words, the reader ought to be able to keep up with a dock worker pushing carts out the door to a delivery truck.”

Required

Part 1: Data Cleansing and Analysis

1. Model the business process by preparing a one-page business process diagram (BPD)³ for aspects of the process revealed in the situation.
2. Develop objectives for assuring data quality and analyzing business performance to respond to the managers' needs as represented by the conversation. Assuring data quality pertains to detecting and correcting data errors as early as possible in the business process. Analyzing business performance pertains to measuring how well the business process is working and how profitable it is.
3. Construct a database model for the data in the form of an REA diagram that integrates the data from the existing system (systemExtract.mdb, data attributes in Figure 1) and the data from RFID (RFID.mdb, data attributes in Figure 2). Implement the model in a relational database in Access[®].
4. Create and debug queries for satisfying the objectives identified in 2 above for (1) assuring data quality and (2) analyzing business performance.
5. Document the following aspects of working with the data and your queries for clerks so that they can assume responsibility for them:
 - a. Importing data into the database
 - b. Detecting and correcting data errors
6. Communicate your outcomes in the report format in Figure 3.
7. Optional: Evaluate another team's BloomScape work by completing the report format in Figure 4. The instructor will identify the team whose work you are to evaluate.

³ For BPD conventions, see White, S. A. 2004. *Introduction to BPMN*. Aurora, CO: BPMI. Available at http://www.bpmi.org/downloads/Introduction_to_BPMN89.pdf.

FIGURE 1
Data Attributes: SystemExtract.mdb

Table/Attribute^a	Explanation
flat : Plastic tray for grouping plants in plastic liners	
flatID	Unique identifier for a kind of flat
type	Kind of liners that go in a flat
unitsPerFlat	Number of liners in a flat
flatsPerShelf	Number of flats that fill a cart shelf
order : Orders for plants received from retailers	
orderID	Unique identifier for an order
buyerID	Unique identifier for a buyer
buyerOrderID	A buyer's purchase order identifier
storeID	A buyer's identifier for its store
orderDate	Date the order was received
requestDate	Date the buyer requests delivery of the order
orderTotal	Dollar price of the order to a buyer
orderItem : Item ordered	
orderID	Unique identifier for an order
lineID	Unique identifier for a line in an order
SKU	Stock keeping unit, unique identifier for an item
quantity	Quantity of flats ordered
priceList : Price list from which buyers order	
SKU	Stock keeping unit, unique identifier for an item
plant	Genus of plant
description	Description of plant
flatID	Unique identifier for a kind of flat
flatPrice	Price to buyer for a flat of plants
flatCost	Cost for producing a flat of plants

^a Table names and primary keys in bold

FIGURE 2
Data Attributes: RFID.mdb

Table/Attribute^a	Explanation
RFID : Transactions recorded through RFID readers	
ID	Unique identifier for a record
date	Date of transaction
orderID	Unique identifier for an order
direction	Direction of movement of cart: 'del' for delivery outbound, 'ret' for return of cart
cartID	Unique identifier for a cart, sensed by RFID
GTIN	Global Trade Item Number, the unique identifier for an item, sensed by RFID
quantity	Quantity of a GTIN on a cart

^a Table names and primary keys in bold

FIGURE 3
BloomScape Report

1	Business process diagram (BPD)	
2	Objectives for assuring data quality and analyzing business performance	
	Objectives for assuring data quality	
	[here, numbered list of objectives]	
	Objectives for analyzing business performance	
	[here, numbered list of objectives]	
3	REA diagram	
4	Assuring data quality	
	Objectives for assuring data quality (Use objectives from above.)	Explanation of the query strategy in terms of manipulating database attributes
		Results from executing queries and implications of the results (Show names of queries and specific numerical results.)
1		
2		
3	[add/delete rows as needed]	
5	Analyzing business performance	
	Objectives for assuring data quality (Use objectives from above.)	Explanation of the query strategy in terms of manipulating database attributes
		Results from executing queries and implications of the results (Show names of queries and specific numerical results.)
1		
2		
3	[add/delete rows as needed]	
6	Documentation for clerks	
	[Documentation for clerks here]	
	Time log (hours spent on this assignment, by person)	
	Name	Total hours
	[add/delete rows as needed]	

FIGURE 4
BloomScape Evaluation Report

Evaluation of the work of team x		Completed by team y
Exemplary aspects	Incomplete, misguided, or nonfunctional aspects	
BPD		
[Exemplary aspects of BPD here]]	[Incomplete, misguided, or nonfunctional aspects of BPD here. Include an explanation of how to remedy these aspects.]	
Objectives for assuring data quality		
Objectives for analyzing business performance		
REA diagram		
Queries and results for assuring data quality		
Queries and results for analyzing business performance		
Documentation for clerks		

Part 2: Practice Objective Questions

The following questions are for student practice in answering objective questions.

Alternatively, these questions could be combined with the objective questions for assessment purposes.

1. With respect to profitability analysis, an allocation of cart use should be:
 - a. Excluded because the cost is not controllable
 - b. Excluded to avoid analysis for small values
 - c. Included to match revenues and expenses
 - d. Included because the cost is controllable

2. Suppose querying detects errors or inconsistencies in the RFID table. The best approach for handling them is to:
 - a. Correct, in a copy of the RFID table, errors and inconsistencies for which there is sufficient information to reconstruct the values and document errors and inconsistencies for which values cannot be reconstructed
 - b. Document all errors and inconsistencies and correct, in a copy of the RFID table, those for which there is a reasonable basis for what the values should have been.

- c. Correct, in the RFID table, errors and inconsistencies for which there is sufficient information to reconstruct the values and document errors and inconsistencies for which values cannot be reconstructed
 - d. Document all errors and inconsistencies and correct, in a copy of the RFID table, those for which there is sufficient information to reconstruct the values
3. The best statement about the variation in returned plants is that they varied:
 - a. Randomly across stores
 - b. Randomly across buyerIDs
 - c. Systematically across buyerIDs
 - d. Systematically across plant SKUs
 4. Suppose a cartDeployed query contains orderID, cartID, and dateDeployed. Suppose a cartReturned query contains orderID, cartID, and dateReturned. To calculate the whole days carts are in use where a portion of a day is treated as a whole day, the best expression is:
 - a. $\text{Round}(\text{CInt}([\text{cartReturned.dateReturned}] - [\text{cartDeployed.dateDeployed}])))$
 - b. $\text{Round}(\text{CInt}([\text{cartReturned.dateReturned}] - [\text{cartDeployed.dateDeployed}] + 0.5))$
 - c. $\text{Round}([\text{cartReturned.dateReturned}] - [\text{cartDeployed.dateDeployed}])$
 - d. $\text{Round}([\text{cartReturned.dateReturned}] - [\text{cartDeployed.dateDeployed}] + 0.5)$
 5. Suppose the cartDeployed query and the cartReturned query defined in the previous question were linked on cartID with a default join. Suppose the query, named cartDaysUsed, includes a new attribute cartDays for calculating the number of days carts are in use. Creating another query averageCartDays with orderID (with Group By) and cartDays (with Avg) gives a result that:
 - a. Understates average cart use
 - b. Calculates average cart use correctly
 - c. Overstates average cart use
 - d. Is not assessable for correctness
 6. Suppose some errors were detected in direction values in the RFID table. The best approach for correcting the errors would be to:
 - a. Through querying the RFID table, create a query result without the errors, rerun the cartDeployed and cartReturned queries on the corrected data, and rerun the error detection query to verify error correction
 - b. Edit the RFID table to create a table without the errors, rerun the cartDeployed and cartReturned queries on the corrected data, and rerun the error detection query to verify error correction
 - c. Query the RFID table to create a query result without the errors, rerun the cartDeployed and cartReturned queries on the corrected data, and inspect the cartDeployed and cartReturned queries to verify error correction
 - d. Edit the RFID table to create a table without the errors, rerun the cartDeployed and cartReturned queries on the corrected data, and inspect the cartDeployed and cartReturned queries to verify error correction

Part 3: Objective Questions

To maximize instructor flexibility, the objective questions appear in the teaching notes. Instructors could use all the questions for assessment of learning at the completion of the case or select questions for students to work on at different stages of the case to guide them in making sense of the business situation, mapping data relationships to the business situation, identifying query objectives, and formulating queries.

IV. TEACHING NOTES

The Teaching Notes for this case include:

1. The text of:
 - a. Nuances of modeling the business situation, including a table of REA elements by database table name
 - b. Part 1
 - i. A business process diagram
 - ii. An REA diagram
 - iii. A completed report
 - iv. Point allocations with and without peer evaluation
 - c. Part 2 Solutions for practice objective questions with response-level feedback
 - d. Part 3 Objective questions and solutions with response-level feedback
2. Links for the following files:
 - a. Access mdb files containing the data for student querying: RFID.mdb and systemExtract.mdb
 - b. Access mdb file containing the data and QBE queries for instructor use that supports the part 1 analysis of querying: BloomScapeQueries.mdb

- c. Word file containing the part 2 practice questions, part 3 objective questions, solutions, and response-level feedback: BloomScapeQuestions.doc
- d. HTML files of the case text to enable instructors to stage the case on a web site: BloomScapeText.htm, audio files for the conversation (BloomScapeAudio.htm, BloomScapeConversation.mp3, and BloomScapeConversation.swf), BloomScapeDataStructure.htm, BloomScapeTemplate.htm. Web sites used for this purpose should be password-protected, and the passwords should be given only to students enrolled in courses using the case.

V. SUMMARY

The case, based on the context of RFID for tracking flats of plants and carts transporting them, affords an opportunity for learners to experience solving a problem from beginning to end, i.e., from deciding what the problem is by modeling the business process and developing querying objectives to querying a database they designed and implemented and interpreting query results. The case is workable by learners with moderate query skills and includes multiple-choice questions for assessing learners' proficiency by sub-objective. The case responds to the need for learning experiences that help students develop skills for analyzing transaction data to solve business problems and exploit business opportunities.

REFERENCES

- Barsalou, L. W. 1999. Language comprehension: Archival memory or preparation for situated action? *Discourse Processes* 28 (1): 61-80.
- Borthick, A. F. 1992. Helping users get the information they want, when they want it, in the form they want it: Integrating the choice and use of information. *Journal of Information Systems* 6 (2): v-ix.
- . 1996. Helping accountants learn to get the information managers want: The role of the accounting information systems course. *Journal of Information Systems* 10 (2): 75-85.
- Borthick, A. F., and D. R. Jones. 2005. Analyzing a potential warranty call center budget overrun: Using database queries to solve business problems. *Journal of Information Systems* 19 (1): 97-111.
- Bose, I., and R. Pal. 2005. Auto-ID: Managing anything, anywhere, anytime in the supply chain. *Communications of the ACM* 48 (8): 100-106.
- BPMI, Business Process Management Initiative. 2004. *Business Process Modeling Notation (BPMN) Version 1.0*. Aurora, CO: BPMI. Available at <http://www.bpmi.org/downloads/BPMN-V1.0.pdf>.
- Cooper, B. L., H. J. Watson, B. H. Wixom, and D. L. Goodhue. 2000. Data warehousing supports corporate strategy at First American Corporation. *MIS Quarterly* 24 (4): 547-567.

- Dunn, C. L., J. O. Cherrington, and A. S. Hollander. 2005. *Enterprise Information Systems: A Pattern Based Approach*: McGraw-Hill/Irwin.
- Dunn, C. L., and W. E. McCarthy. 1997. The REA accounting model: Intellectual heritage and prospects for progress. *Journal of Information Systems* 11 (1): 31-51.
- Fennel, N. I. 2003. Make your data pay. *Internal Auditor* (June): 55-59.
- Gernsbacher, M. A. 1997. Two decades of structure building. *Discourse Processes* 23: 265-304.
- Graesser, A. C., K. K. Millis, and R. A. Zwaan. 1997. Discourse comprehension. *Annual Review of Psychology* 48: 163-189.
- Jackson, R. A. 2004. Get the most out of audit tools. *Internal Auditor* (August): 36-47.
- Johnson-Laird, P. N. 1983. *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness, Cognitive science series ; 6*. Cambridge, MA: Harvard University Press.
- Klamm, B. K., and M. L. Weidenmier. 2005. ERP lockup: Planning successful data jailbreaks. *Strategic Finance* 87 (1): 49-53.
- McCarthy, W. E. 1982. The REA accounting model: A generalized framework for accounting systems in a shared data environment. *The Accounting Review* 57 (3): 554-577.
- McCollum, T. 2002. Data analysis with SQL. *Internal Auditor* (August): 25-27.
- McKinnon, S. M., and Jr. Bruns, W. J. 1992. *The Information Mosaic*. Boston, MA: Harvard Business School.
- Myers, J. L., M. Shinjo, and S. A. Duffy. 1987. Degrees of causal relatedness and memory. *Journal of Memory and Language* 26: 453-465.
- Romney, M. B., and P. J. Steinbart. 2006. *Accounting Information Systems*. Tenth Edition ed. Upper Saddle River, NJ: PrenticeHall.
- Speier, C., and M. G. Morris. 2003. The influence of query interface design on decision-making performance. *MIS Quarterly* 27 (3): 397-423.
- Sullivan, L. 2004. Reaching down the supply chain. *InformationWeek* 49-52.
- van Dijk, T. A., and W. Kintsch. 1983. *Strategies of Discourse Comprehension*. New York: Academic Press.
- White, S. A. 2004. *Introduction to BPMN*. Aurora, CO: BPMI. Available at http://www.bpmi.org/downloads/Introduction_to_BPMN89.pdf.
- Wixom, B. H., and H. J. Watson. 2001. An empirical investigation of the success factors for data warehousing. *MIS Quarterly* 25 (1): 17-41.
- Zwaan, R. A., and G. A. Radvansky. 1998. Situation models in language comprehension and memory. *Psychological Bulletin* 123 (2): 162-185.