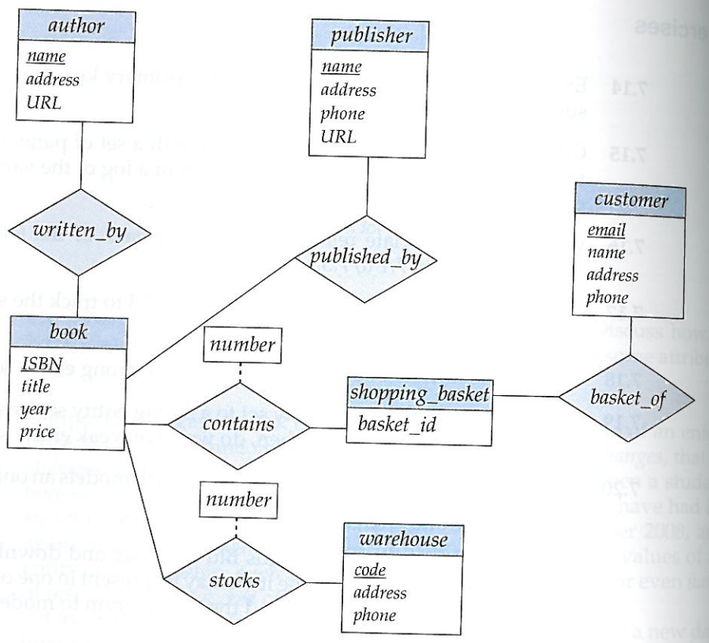

Figure 7.29 E-R diagram for Exercise 7.20.

Each package must be identifiable and trackable, so the database must be able to store the location of the package and its history of locations. Locations include trucks, planes, airports, and warehouses.

Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

7.23 Design a database for an airline. The database must keep track of customers and their reservations, flights and their status, seat assignments on individual flights, and the schedule and routing of future flights.

Your design should include an E-R diagram, a set of relational schemas, and a list of constraints, including primary-key and foreign-key constraints.

7.24 In Section 7.7.3, we represented a ternary relationship (repeated in Figure 7.27a) using binary relationships, as shown in Figure 7.27b. Consider the alternative shown in Figure 7.27c. Discuss the relative merits of these two alternative representations of a ternary relationship by binary relationships.

7.25 Consider the relation schemas shown in Section 7.6, which were generated from the E-R diagram in Figure 7.15. For each schema, specify what foreign-key constraints, if any, should be created.

7.26 Design a generalization–specialization hierarchy for a motor vehicle sales company. The company sells motorcycles, passenger cars, vans, and buses. Justify your placement of attributes at each level of the hierarchy. Explain why they should not be placed at a higher or lower level.

7.27 Explain the distinction between condition-defined and user-defined constraints. Which of these constraints can the system check automatically? Explain your answer.

7.28 Explain the distinction between disjoint and overlapping constraints.

7.29 Explain the distinction between total and partial constraints.

Tools

Many database systems provide tools for database design that support E-R diagrams. These tools help a designer create E-R diagrams, and they can automatically create corresponding tables in a database. See bibliographic notes of Chapter 1 for references to database-system vendors' Web sites.

There are also several database-independent data modeling tools that support E-R diagrams and UML class diagrams. The drawing tool Dia, which is available as freeware, supports E-R diagrams and UML class diagrams. Commercial tools include IBM Rational Rose (www.ibm.com/software/rational), Microsoft Visio (see www.microsoft.com/office/visio), CA's ERwin (www.ca.com/us/data-modeling.aspx), Poseidon for UML (www.gentleware.com), and SmartDraw (www.smartdraw.com).

Bibliographical Notes

The E-R data model was introduced by Chen [1976]. A logical design methodology for relational databases using the extended E-R model is presented by Teorey et al. [1986]. The Integration Definition for Information Modeling (IDEF1X) standard NIST [1993] released by the United States National Institute of Standards and Technology (NIST) defined standards for E-R diagrams. However, a variety of E-R notations are in use today.

Thalheim [2000] provides a detailed textbook coverage of research in E-R modeling. Basic textbook discussions are offered by Batini et al. [1992] and Elmasri and Navathe [2006]. Davis et al. [1983] provides a collection of papers on the E-R model.

As of 2009, the current UML version was 2.2, with UML version 2.3 near final adoption. See www.uml.org for more information on UML standards and tools.