



Notes

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Introduction To Document Engineering

1. Israel Eph'al and Joseph Naveh, ARAMAIC OSTRACA OF THE FOURTH CENTURY B.C. (Magnes, 1996). An ostrakon is a fragment of pottery. Halfat's tax receipt is Ostrakon #13 in Eph'al & Naveh's book. Such ancient tax receipts are commonly found in Egypt and elsewhere.
2. This validation might have taken place in the "bricks and mortar" bookstore, too, but it is essential in the online store because more stringent regulations apply whenever the merchant doesn't see the actual card. But an even more important point here is that what looks like a single information exchange from either bookstore's perspective is in fact several transactions between the merchant, the merchant's bank, the authorization network, and the bank that issued the customer's credit card.
3. Robert Glushko, Jay Tenenbaum, and Bart Meltzer, "An XML framework for agent-based e-commerce," COMMUNICATIONS OF THE ACM, 42 (1999): pp. 106-115. This paper introduced the idea that XML documents could serve as interfaces to business services that could be combined to form virtual companies. It significantly predates the "web services" announcements.
4. The website at <http://www.the-drop-ship-guide.com> is a useful guide, written from the perspective that you want to set up an Internet store that uses drop shipment (last visited 13 January 2004).
5. The Federal Enterprise Architecture Program Management Office (FEAPMO) publishes all of its documents at <http://www.feapmo.gov> (last visited 13 January 2004).
6. Nick Wingfield, "In latest strategy shift Amazon is offering a home to retailers," WALL STREET JOURNAL, 24 September 2003. See also Amazon Web Services at <http://www.amazon.com/-/gp/browse.html/104-5602037-8299135?node=3435361> (last visited 19 January 2004).
7. NASA, MARS CLIMATE ORBITER MISHAP INVESTIGATION BOARD PHASE I REPORT (10 November 1999): 16. "The MCO Investigation Board has determined that the root cause for the loss of the MCO spacecraft was the failure to use metric units...Specifically, thruster performance data in English units instead of metric units was used in the software application code." Available from ftp://ftp.hq.nasa.gov/pub/pao/reports/1999/MCO_report.pdf (last visited 3 September 2004).
8. The most comprehensive listing of relevant standards is the XML Cover Pages list of "XML Applications and Initiatives" at <http://xml.coverpages.org/xmlApplications.html> (last visited 19 January 2004).
9. The home page for the UBL initiative is at http://www.oasisopen.org/committees/te_home.php?wg_abbrev=ubl (last visited 19 January 2004).

10. A wide range of application development approaches are called model based or model driven, but the latter term is strongly associated with specific technologies and methods proposed by in the Object Management Group's MDA initiative (<http://www.omg.org/mda/>), so we prefer to use the former term in a more generic sense.
11. We are certainly aware that the Object Management Group's MDA considers UML models the normative representations, playing the same role as XML schemas do for us. For a UML-centric approach, see David Carlson, *MODELING XML APPLICATIONS WITH UML* (Addison-Wesley, 2001) or Anneke Kleppe, Jos Warmer, and Wim Bast, *MDA EXPLAINED* (Addison-Wesley, 2003).
12. We use web form generically here to include HTML forms, which have long been the primary user interface for fill-in-the-form services, as well as those based on the W3C XFORMS recommendation or implemented using Adobe Reader, Microsoft InfoPath, or similar software for rich client applications.
13. See the publication Australian Department of Foreign Affairs and Trade, *PAPERLESS TRADING: BENEFITS TO APEC* (2001), at http://www.dfat.gov.au/publications/paperless/paperless_trading.pdf (last visited 28 December 2004). This lists the most common paper documents required for international trade as: Insurance Certificate, Certificate of Origin, Letter of Credit, Bill of Lading, Waybill, Manifest, Declarations, Sanitary and Phytosanitary Certificates, Payment Order, Remittance Advice, Debit Advice, Customs Clearance, Purchase Order, Invoice, Forwarding Instruction, Stowage Plan/Bay Plan, and Arrival Notice Advice.
14. Heather Kröger, "Web services conceptual architecture," IBM, at <http://www-4.ibm.com/software/solutions/webservices/pdf/WSCA.pdf> (last visited 23 September 2004).
15. Bart Meltzer, "XML and the network economy," keynote address at CommerceNet Japan XML Conference, Tokyo, June 1998.
16. Although you might conclude from its limited availability, slow response latency, or other similar quality of service measures that a service was being provided by a person rather than by a computer.
17. There are numerous directories of web services. See, for example, the Microsoft UDDI service registry at <http://uddi.microsoft.com/> (last visited 3 September 2004) or <http://www.xmethods.com/> (last visited 3 September 2004).
18. To IBM, this is business on demand; to HP, it is adaptive; to Microsoft, it is agile. Real-time or event-driven are related terms that aren't as clearly tied to particular companies.
19. The SOAP and WSDL Web Services specifications are maintained by the W3C at <http://www.w3.org/TR/soap/> and <http://www.w3.org/TR/wsdl>. The UDDI specification is at <http://www.uddi.org>. Other Web Services specifications are maintained by the Web Services Interoperability Organization at <http://www.ws-i.org/> and by OASIS at <http://www.oasis-open.org/com>

mittees/tc_cat.php?cat=ws (all last visited 3 September 2004). O'Reilly publishes a wide range of books on web services, which are listed at <http://webservices.oreilly.com/> (last visited 3 September 2004).

20. Alorie Gilbert "Wal-Mart project boon for software makers," C/NET News.com, 14 August 2003. at http://news.com.com/2100-1017_3-5064075.html (last visited 10 June 2004).

21. Data analysis is related to object analysis. Object analysis techniques focus on the methods that will operate on or manipulate the information embodied in the object.

22. Utrecht University, Master's Programme in Business Informatics, <http://businessinformatics.nl/-index.php?id=1&subid=0>

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XML Foundations

1. XHTML is a modularization of HTML to make it fully XML compliant, so this criticism of HTML doesn't apply to anyone who uses XHTML. But relatively few web pages use XHTML, and most of the Web's HTML isn't even valid with respect to any HTML specification.

2. At UC Berkeley the XML and Document Engineering courses have used Eric Ray, *LEARNING XML* (O'Reilly, 2003), Elliott Harold and W.Scott Means, *XML IN A NUTSHELL* (O'Reilly, 2002), and Priscilla Walmsley, *DEFINITIVE XML SCHEMA* (Prentice Hall PTR, 2002).

3. Michael Cusamano and David Yoffie, *COMPETING ON INTERNET TIME: LESSONS FROM NETSCAPE AND ITS BATTLE WITH MICROSOFT* (Free Press, 1999). Microsoft won this first browser war, but a second browser war may now be developing, with the anti-Microsoft forces winning some small battles as a result of the security vulnerabilities in Internet Explorer. See Robert McMillan, "Mozilla Gains on IE," *PC WORLD*, 9 July 2004, at <http://www.pcworld.com/news/article/0,aid,116848,00.asp> (last visited 3 September 2004). Unlike the first browser war, in the second one neither side is creating proprietary tags, and indeed, some of the competition rests on which side can claim better compliance with W3C specifications.

4. Even worse was the emergence of a genre of web publishing software that completely inverted the original premise of HTML. Instead of using standard HTML to mark up document structure for display in a simple and predictable way, people could now use powerful graphical layout software to design visually rich and complex web pages. However, this seductively appealing outcome required that "under the hood" the application would create a proprietary HTML dialect that only it could render, often by using <table> tags for most of the content and otherwise abusing the HTML tag repertoire. Users of such software are captives of the vendors, since tools expecting HTML to work the way it was originally intended can't easily maintain HTML created that way.

5. Hakon Lie and Bert Bos, *CASCADING STYLE SHEETS: DESIGNING FOR THE WEB* (Addison-Wesley, 1997).
6. We think that using application in this sense is confusing because of the more conventional meaning of “a bundle of functionality embodied in software.” So we will always use XML language or vocabulary for the former and XML software for the latter.
7. This can be done in strict conformance to standards without sacrificing any of the precise design control that often tempts graphical designers to use proprietary techniques. See the CSS Zen Garden at <http://www.csszengarden.com/> (last visited 3 September 2004).
8. For a colloquial list of many dozens of different types of documents, see *THE ORIGINAL ROGET'S THESAURUS OF ENGLISH WORDS AND PHRASES* (Dell Publishing, 1962), especially Section 520, “Publication,” and Section 589, “Book.”
9. It would be more accurate to credit XML's parent technology of SGML (Standard Generalized Markup Language) for the idea of formally defined document types. But XML was optimized to be an SGML for the Web, abandoning the most difficult features of SGML that restricted its widespread adoption.
10. Up to now in this chapter we've used documents like newspapers, novels, purchase orders, and invoices to motivate the idea that the expected information content of some class of documents can be described in formal models. But it is equally important to model the business processes that create and consume documents, and we can also use XML to represent the models. It may sound a bit awkward at first to talk about document types for specifying business processes, but from an XML encoding standpoint it simply means that there is a set of tags useful for describing them.
11. Many articles and books about XML say that it is “self-describing,” usually to contrast the idea of marked-up content with record-based syntaxes that contain position-sensitive and fixed-length data fields or use delimiters like commas or semicolons to separate variable-length fields. For either of the latter, the meaning of each data element must be defined somewhere else in a catalog or dictionary. But while we agree that an XML element can have a name that suggests the meaning of its content, this doesn't make it self-describing. To be self-describing an XML element would have to simultaneously convey its specific content and all the rules that govern its relationships to other content without any additional information. If elements could do that we wouldn't need schemas or any other documentation.
12. See Section 8.3.
13. As we said in Section 2.5, it is conventional for most web browsers to render an XML document with indentation that corresponds to the hierarchical structure created by its tags. Browsers generally don't do anything at all with DTDs, because they aren't encoded in XML.
14. XSD provides many different (some would say too many) options for organizing the element and type definitions within a schema. The nesting structure determines the scope and reusability of the defi-

nitions. The approach illustrated in Figure 2-3b is called the Russian Doll style because it is strictly nested, with each definition containing those that it uses, making them local and unavailable for reuse outside of that structure. See Eve Maler, “Schema Design Rules for UBL...and Maybe for You,” IDEALLIANCE XML 2002 CONFERENCE, at http://www.idealliance.org/papers/xml02/dx_xml02/papers/05-01-02/05-01-02.html for discussion of the Russian Doll schema design style and three others called the Venetian Blind, Salami Slice, and Garden of Eden (last visited 10 October 2004).

15. See <http://xml.ascc.net/resource/schematron/schematron.html>, or Eddie Robertson, “An Introduction to Schematron,” XML.COM, 12 November 2003, at <http://www.xml.com/pub/a/2003/11/12/schematron.html> (both last visited 3 September 2004).

16. See the RELAX NG website at <http://www.relaxng.org/> (last visited 3 September 2004).

17. A very practical guide to EDI-XML integration is Michael Rawlins, USING XML WITH LEGACY BUSINESS APPLICATIONS (Addison-Wesley, 2003).

18. See “XSL Transformations (XSLT),” W3C Recommendation, 16 November 1999, at <http://www.w3.org/TR/xslt> (last visited 26 September 2004).

19. See W3C, “The Extensible Stylesheet Language Family (XSL),” at <http://www.w3.org/Style/XSL/> (last visited 26 September 2004).

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Models, Patterns, and Reuse

1. Object Management Group, “Introduction to OMG's Unified Modeling Language (UML),” at http://www.omg.org/gettingstarted/what_is_uml.htm (last visited 18 September 2004).

2. “Information processing systems—Concepts and terminology for the conceptual schema and the information base,” ISO/TR 9007 (1987).

3. Data analysts may be more familiar with the term Domain Model for what we call a document component model. The terms are almost interchangeable but we wanted to emphasize the document-centric view.

4. Denise Schmandt-Besserat, HOW WRITING CAME ABOUT, (University of Texas Press, 1996). The discovery of non-iconographic counting tokens overturned the conventional view that Cuneiform writing evolved as an abstraction and simplification of pictorial representations.

5. The Model Matrix is itself a conceptual artifact because we haven't yet created a physical knowledge repository organized in this way. But we are inspired to do so by the online MIT Process Handbook, which resembles it in some respects. See Thomas Malone, Kevin Crowston, and George Herman (Editors), ORGANIZING BUSINESS KNOWLEDGE: THE MIT PROCESS HANDBOOK (MIT Press, 2003). An

online version is at <http://ccs.mit.edu/ph/>. This is an ambitious effort to organize knowledge about business models and business processes. It doesn't take the document / information exchange perspective of the Model Matrix or describe processes at that level of granularity, but it has a huge repertoire of patterns at less granular levels.

6. This is distinct from the use of meta to mean change or alteration (as in metamorphism).
7. The standardization of metadata for information exchange is led by the ISO TC154 Subcommittee 32. See <http://metadata-stds.org/>, (last visited 18 April 2005).
8. A downloadable version of the ebXML CCTS is available at [http://www.oasis-open.org/committees/download.php/4259/CEFACT CCTS Version 2 of 11 August.pdf](http://www.oasis-open.org/committees/download.php/4259/CEFACT_CCTS_Version_2_of_11_August.pdf) (last visited 18 April 2005).
9. UN Economic Commission for Europe, UN/CEFACT Modeling Methodology, version 3.1 (CEFACT/TMWG/N090R3.1, 2001).
10. UN/CEFACT ebXML Business Process Specification Schema. Version 1.10. 18 October 2003. By using the BPSS as the conceptual model for business processes we are not really creating a business process model as an XML schema. Since all of our process descriptions follow the same metamodel schema, it would be more correct to say we are creating a Business Process Model Instance. But this sounds a bit unnatural and makes it harder to treat document models and process models as two related views of the same thing, so we will often not tack on “instance” when we talk about business process models.
11. The idea of patterns as standard solutions in software design goes back several decades but is most often associated with the landmark book DESIGN PATTERNS by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides (Addison-Wesley, 1995). See also Jonathan Adams, Srinivas Koushik, Guru Vasudeva, and George Galambos. PATTERNS FOR E-BUSINESS: A STRATEGY FOR REUSE (IBM Press, 2001) and Gregor Hoppe and Bobby Wolfe. ENTERPRISE INTEGRATION PATTERNS: DESIGNING, BUILDING, AND DEPLOYING MESSAGING SYSTEMS (Addison-Wesley, 2004).
12. U.S. Census Bureau. NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM. See <http://www.census.gov/epcd/www/naics.html> (last visited 18 April 2005).
13. United Nations Standard Processes and Services Code. See <http://www.unspsc.org/> (last visited 18 April 2005).

4 Describing What Businesses Do and How They Do It

1. Some of the classic works here are Alfred D. Chandler, *THE VISIBLE HAND: THE MANAGERIAL REVOLUTION IN AMERICAN BUSINESS* (Cambridge University Press, 1977), William McKelvey, *ORGANIZATIONAL SYSTEMATICS: TAXONOMY, EVOLUTION, CLASSIFICATION* (University of California Press, 1982), Oliver Williamson, *MARKETS AND HIERARCHIES: ANALYSIS AND ANTITRUST IMPLICATIONS* (Free Press, 1975), and Oliver Williamson, *THE ECONOMIC INSTITUTIONS OF CAPITALISM* (Free Press, 1985). Carl Shapiro and Hal Varian's, *INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY* (Harvard Business School Press), 1999 isn't quite old enough to be a classic but it is on its way.
2. Object-oriented programming techniques usually use UML class diagrams in highly physical ways to describe models that have a one-to-one correspondence to implementing code, but in Document Engineering we use them more conceptually (see Section 3.2).
3. Demo of BluePeople seen in May 2004 at IBM Watson Research Center.
4. Robert Haugen and William E. McCarthy, "REA, a semantic model for Internet supply chain collaboration," at <http://jeffsutherland.org/oopsla2000/mccarthy/mccarthy.htm>. (last visited 20 October 2004).
5. This use of a word more commonly associated with biology to describe an Internet-based network of a firm's relationships with other entities originated in Jay Tenenbaum, Tripatinder Chowdry, and Kevin Hughes, "Eco System: An Internet Commerce Architecture," *COMPUTER*, 30 (5), May 1997, 48-55. Scores of articles on ecosystem topics can be found at Internet newsmagazine LINE56's E-business Ecosystem section at http://www.LINE56.com/articles/ebiz_ecosys_index.asp. (last visited 18 October 2004).
6. Federal Enterprise Architecture Program Office, "24 presidential priority e-gov initiatives," at http://www.feapmo.gov/resources/24_PPE-Gov_Init_Rev_1.pdf (last visited 14 February 2004).
7. "Education anytime, anywhere. How do you spell B2B and B2C?" at <http://www.trendsreport.net/2000/education/3.html> (last visited 15 February 2004).
8. This problem is increasingly attacked with linear or constraint-based mathematical programming techniques that evaluate huge numbers of feasible designs for a supply chain network against some objective function like minimizing cost, maximizing customer service levels, or minimizing cycle time. Some of these capabilities are built into the planning and scheduling components of ERP systems. See Jim Shepard and Larry Lapide, "Supply Chain Optimization: Just the Facts." *ASCET*, Volume 1, 15 April 1999. Available at http://www.ascet.com/documents.asp?d_ID=217# (last visited 20 October 2004).

9. Some generally useful services include those that provide information about potential business partners (like credit or customer satisfaction ratings), that facilitate financial or accounting processes (like tax calculation, payment, factoring), or that ensure the delivery of goods (like escrow, trade facilitation, freight forwarding, and shipment).
10. The most common auction pattern is the forward or English auction typified by eBay, in which one seller offers something to many potential buyers. When information about price is continuously exchanged, the offered price moves up as buyers bid against each other. Another auction pattern involving aggregated buyers is the uniform price or Dutch auction in which multiple identical products are available, and the price moves down until there are enough buyers willing to pay that clearing price. This kind of auction has been used in stock market floats to set an offering price that maximizes the money going to the newly public firm while ensuring that all the new shares are sold. Auction patterns can also involve aggregated sellers, most often in direct procurement where the buyer provides product specifications and the sellers bid against each other in what is called a reverse auction. The price the seller pays goes down as the sellers bid against each other. For a serious discussion of auctions, see Vijay Krishna, *AUCTION THEORY* (Academic Press, 2002), or Lawrence Ausubel, "Auction theory for the new economy," in Derek Jones (Ed.), *NEW ECONOMY HANDBOOK* (Academic Press, 2003).
11. Charles Fishman, "The Wal-Mart you don't know," *FAST COMPANY*, December 2003, at <http://www.fastcompany.com/magazine/77/walmart.html> (last visited 12 November 2004).
12. Mohanbir Sawney, "Forward thinking about reverse auctions," *CIO*, 1 June 2003, at <http://www.cio.com/archive/060103/gains.html> (last visited 12 November 2004).
13. Susan Helper, John Paul MacDuffie, and Charles Sabel, "Pragmatic collaborations: Advancing knowledge while controlling opportunism," *INDUSTRIAL AND CORPORATE CHANGE* 9 (2000): pp. 443-489.
14. Susan Helper and John Paul MacDuffie, "B2B and modes of exchange: Evolutionary and transformative effects," in Bruce Kogut (ed.), *THE GLOBAL INTERNET ECONOMY* (MIT Press, 2003), at <http://wsomfaculty.cwru.edu/helper/b2bfinal.pdf> (last visited 12 November 2004).
15. Helper and MacDuffie, *ibid.*, p. 2
16. Takahiro Fujimoto, *THE EVOLUTION OF A MANUFACTURING SYSTEM AT TOYOTA* (Oxford University Press, 1999), p. 104.
17. Fujimoto, *ibid.*, Chapter 5, "Evolution of the Black Box Parts Supplier System."
18. Intel, *Automating through RosettaNet*, January 2003, at <http://www.intel.com/techtrends/trends/rosettanet/automating.pdf> (last visited 6 January 2005).

19. "The Bylaws signed by these Charter Members create the ability for the Global Trading Web to adopt rules, standards, guidelines and best business practices that will enable and promote the seamless buying and selling of goods and services securely over the Web on a worldwide basis. The Global Trading Web Association will also allow members and their customers to benefit from the expertise, experience and capabilities of other member companies across the globe." From "23 of the World's Leading Companies Join Commerce One in Incorporating the Global Trading Web Association," Commerce One Press Release, 14 August 2000, at http://web.archive.org/-web/20000815093416/www.commerceone.com/news/us/gtw_association.html (last visited 27 December 2004).
20. IBM Web Services Council, at <http://www-306.ibm.com/software/solutions/webservices/council> (last visited 28 December 2004).
21. Demir Barlas, "GTWA becomes ONCE," LINE 56, 3 December 2002, at <http://www.LINE56.com/articles/default.asp?NewsID=3980> (last visited 27 December 2004).
22. See <http://www.sitpro.org.uk/> (last visited 2 January 2005).
23. Tradegate's foremost role is to facilitate the use of electronic commerce techniques for the exchange of information between customers and their suppliers. It does this by bringing together all the different types of organizations involved in each supply chain so that a common agreed strategy can be developed and implemented using the relevant international standards. See <http://www.tradegate.org.au/> (last visited 2 January 2005).
24. UN/CEFACT maintains a list of National Trade Facilitation Contacts at http://www.unece.org/cefact/trafix/bdy_part.htm (last visited 28 December 2004). Among the most advanced efforts to automate the submission and processing of cross-border documentation are those in Southeast Asia in Singapore (Tradenet, http://www.tradenet.gov.sg/trdnet/index_home.jsp), Hong Kong (Tradelink, <http://www.tradelink.com.hk/eng/index.html>), and Taiwan (Tradevan, <http://www.tradevan.com.tw/97English/Index.htm>) (all URLs last visited 28 December 2004).
25. EAN/UCC standardizes bar codes, EDI transactions sets, XML schemas, and other supply chain solutions. See <http://www.ean-ucc.org/> (last visited 2 January 2005).
26. EIDX is the leading organization in the definition and development of industry standard approaches to enable high-tech enterprises and their business partners to integrate across disparate e-commerce and enterprise application integration technologies. See <http://www.rosettanet.org/> (last visited 2 January 2005).
27. UN/CEFACT is a United Nations body that encourages close collaboration between governments and private business to secure interoperability for the exchange of information between the public and private sector. See <http://www.unece.org/cefact/> (last visited 2 January 2005).

28. The Supply-Chain Council's membership is primarily practitioners representing a broad cross-section of industries, including manufacturers, services, distributors, and retailers. See <http://www.supply-chain.org/public/aboutus.asp> (last visited 2 January 2005).
29. Etienne Wenger, *COMMUNITIES OF PRACTICE: LEARNING, MEANING, AND IDENTITY* (Cambridge University Press, 1998). See also *Communities of Practice: A Brief Introduction*, at <http://www.ewenger.com/theory/index.htm> (last visited 28 December 2004).
30. User Groups for XML and Related Structured Information Standards are listed at http://www.xml.org/xml/user_groups.shtml (last visited 28 December 2004). Many of the U.S. government's key XML architects and practitioners have created a community of practice that is described in Brand Niemann, "The Federal CIO Council's semantic interoperability community of practice (SICoP)," *IDEALLIANCE XML 2004 CONFERENCE*, November 2004, at <http://www.idealliance.org/proceedings/xml04/papers/224/bniemann11162004.html> (last visited 28 December 2004).
31. See Liberty Alliance Project at <http://www.projectliberty.org/> and Microsoft .Net Passport at <http://www.passport.net> (both last visited 28 December 2004).
32. For example, there are hundreds of administrative policies and procedures at the University of California, Berkeley. One of them guarantees a free reserved parking place for life to any employee who wins a Nobel Prize. See <http://campuspol.chance.berkeley.edu/directory.htm> (last visited 15 February 2004).
33. Federal Enterprise Architecture Program Management Office. *BUSINESS REFERENCE MODEL (BRM) VERSION 2.0*. at <http://www.feapmo.gov/feaBrm2.asp> (last visited 20 October 2004). Denmark has a similar e-government effort underway; see the Openness Initiative at <http://www.oio.dk/english> (last visited 20 November 2004).
34. The Supply-Chain Council's Supply-Chain Operations Reference Model is described at <http://www.supply-chain.org/public/scor.asp>. (last visited 20 October 2004).
35. RosettaNet PIP Directory at <http://www.rosettanet.org/pips> (last visited 20 October 2004).
36. Tom Krazit, "Intel conducts \$5b in transactions via RosettaNet," *INFO WORLDS*, 10 December 2002 at <http://archive.infoworld.com/articles/hn/xml/02/12/10/021210hnmintelrose.xml?s=IDGNS> (last visited 14 February 2004). See also "e-Business at Intel" at <https://supplier2.intel.com/B2Bi/> (last visited 14 February 2004).
37. The term "value chain" is usually attributed to Michael E. Porter, *COMPETITIVE ADVANTAGE: CREATING AND SUSTAINING SUPERIOR PERFORMANCE* (Free Press, 1998). Treating the flow of information in a value chain as an independent source of value is discussed in Chapter 4, "The Information Supply Chain," in Larry Downes, *THE STRATEGY MACHINE* (Harper-Collins, 2002).

38. Christopher Koch. "It all began with Drayer," CIO, 1 August 2002, at <http://www.cio.com/archive/080102/drayer.html> (last visited 20 October 2004). Both parties in a VMI relationship benefit from the increased efficiency of procurement and logistics: the retailer no longer loses sales because goods are out of stock and no longer has to maintain inventory in warehouses, and the supplier can control inventory and transportation costs while providing better service. VMI works best for consumer packaged goods, consumables, and other merchandise that is purchased regularly and in large volumes, such as clothing, cosmetics and groceries.
39. See <http://www.cpfr.org> (last visited 20 October 2004) for a rich archive of specifications and case studies. See also Dirk Seifert, COLLABORATIVE PLANNING, FORECASTING AND REPLENISHMENT: HOW TO CREATE A SUPPLY CHAIN ADVANTAGE (SAP Press, 2003).
40. "Remote elevator monitoring," at http://www.otis.com/innovationdetail/0,1416,CLI1_HID805-_RES1,00.html (last visited 20 October 2004) and Jay Miller, "Keeping Tabs," MANUFACTURER, May 2003, at http://www.themanufacturer.com/content_detail.html?header=article&contents_id=1236&t=manufacturer_us#. (last visited 20 October 2004).
41. Much of the work is in response to a mandate by the U.S. Securities and Exchange Commission that firms settle trades in just one day (called T+1, following a T+3 initiative in 1995). Settlement involves getting information from the front office of the selling entity to its back office and then to the back and front office of the buying entity. The goal is to reduce the time to "settle" securities trades to one day after the trade takes place.
42. Jonathan Parsons, "Legislation, deliberation, and documents: XML and the legislative process," IDEALLIANCE XML 2004 CONFERENCE, November 2004, at http://www.idealliance.org/proceedings/xml04/papers/179/XML_and_Legislative_Process.html (last visited 20 November 2004).
43. Eric Auchard, "U.S. Army aims to halt paperwork with IBM system," COMPUTERWORLD, 17 December 2004, at <http://www.computerworld.com/printthis/2004/0,4814,98358,00.html> (last visited 5 January 2005).
44. See US Securities and Exchange Commission, "Spotlight on Sarbanes-Oxley Rulemaking and Reports" at <http://www.sec.gov/spotlight/sarbanes-oxley.htm> (last visited 20 October 2004).
45. Nigel King, "Web services to support Sarbanes Oxley activities," IDEALLIANCE XML 2004 CONFERENCE, November 2004, at <http://www.idealliance.org/proceedings/xml04/papers/16/XML2004.html> (last visited 20 November 2004).
46. Jim Ericson, "Technology rising for SOX," LINE 56, 23 November 2004, at <http://www.LINE56.com/articles/default.asp?ArticleID=6172> (last visited 5 January 2005).
47. Mikkel Brun and Brian Nielsen, "Naming and design rules for e-government - The Danish approach," IDEALLIANCE XML 2003 CONFERENCE, December 2003, at

http://www.idealliance.org/papers/dx_xml03/papers/05-06-04/05-06-04.html (last visited 20 November 2004).

48. Not surprisingly the British Companies Act of 1844, was soon followed by the creation of a slew of accounting firms in London by people whose names were Deloitte, Price, Waterhouse, Coopers, and Peat. Two centuries later these names remain associated with the largest global accounting firms.

49. The US EDI standards are maintained by an ANSI Associated Standards Committee at <http://www.x12.org>. The international EDI standards are maintained by the United Nations Centre for Trade Facilitation and Electronic Business at <http://www.unece.org/cefact/>.

50. Kroger, "EDI Programs & Requirements," at http://edi.kroger.com/edi/programs_001.htm (last visited 14 February 2004).

51. John Edwards, "I'm not dead yet," LINE56, May 2001, at <http://www.LINE56.com/articles/default.asp?NewsID=2563> (last visited 14 February 2004).

52. Many XML vocabularies are published at web sites whose domain names are the vocabulary acronym and ".org". For example, <http://www.xcbl.org/> (last visited 20 October 2004) is the web site for the XML Common Business Library. Lists of XML vocabularies can be found in the Cover Pages at <http://xml.coverpages.org/xmlApplications.html> and at <http://xml.org>. (last visited 20 October 2004).

53. John Edwards, "Doing it with meaning," CIO, 15 August 2002, at http://www.cio.com/archive/081502/et_article.html (last visited 20 October 2004). For a more theoretical treatment see Joshua Fox, "Know what your schemas mean," IDEALLIANCE XML 2003 CONFERENCE, December 2003, at http://www.idealliance.org/papers/dx_xml03/papers/04-03-04/04-03-04.html (last visited 20 October 2004).

54. See, for example, Narinder Singh, "Unifying heterogeneous information models." COMMUNICATIONS OF THE ACM, 41 (1998): pp. 37-44, or Michael Stonebraker and Joseph Hellerstein, "Content Integration for E-Business," ACM SIGMOD 2001, pp. 552-560.

55. David Hay, DATA MODEL PATTERNS: CONVENTIONS OF THOUGHT (Dorset House, 1996) and Len Silverston, THE DATA MODEL RESOURCE BOOK (John Wiley, 2001).

56. Electronic Business XML at <http://ebxml.org/> (last visited 18 April 2005). The original Core Component Dictionary created by the ebXML working group is at <http://ebxml.org/specs/ccDICT.pdf> (last visited 20 October 2004). The Core Components work is now being carried out under the auspices of UN/CEFACT and a more recent version of the specification is at http://www.unece.org/cefact/ebxml/CCTS_V2-01_Final.pdf (last visited 20 October 2004).

57. The UBL home page is Organization for the Advancement of Structured Information Standards (OASIS) Universal Business Language at http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ubl. (last visited 20 October 2004). See Mark Crawford (Editor), OASIS Universal Business

Language (UBL) Naming and Design Rules, 15 September 2004 at <http://www.oasis-open.org/committees/download.php/9236/cd-UBL-NDR-1.0.pdf> (last visited 20 October 2004). See also Eve Maler, "Schema design rules for UBL...and maybe for you," IDEALLIANCE XML 2002 CONFERENCE, December 2002, at http://www.idealliance.org/papers/xml02/dx_xml02/papers/05-01-02/05-01-02.pdf (last visited 20 October 2004). The UBL customization methodology is described by Arofan Gregory and Eduardo Gutentag in "UBL and object-oriented XML: Making type-aware systems work.," IDEALLIANCE XML 2003 CONFERENCE, December 2003 at http://www.idealliance.org/papers/dx_xml03/papers/04-04-04/04-04-04.html. (last visited 20 October 2004).

58. See, for example, David S. Linthicum, *NEXT GENERATION APPLICATION INTEGRATION* (Addison-Wesley, 2004), or W. Scott Means, *STRATEGIC XML* (SAMS, 2002).

59. This phrase originated with the Gartner Group. See Gian Trotta, "Get a grip, with enterprise nervous systems," *ebizQ*, 23 September 2003, at http://www.ebizq.net/topics/real_time_enterprise/features/2807.html (last visited 20 October 2004).

60. David S. Linthicum, *B2B APPLICATION INTEGRATION* (Addison-Wesley, 2001).

61. Heather Kreger, "Web services conceptual architecture," IBM, at <http://www-4.ibm.com/software/solutions/webservices/pdf/WSCA.pdf>, p 6. (last visited 18 April 2005). We single out this author only because her report was one of the first clear explanations of Web Services and undoubtedly encouraged others to adopt a similarly enthusiastic perspective.

62. The idea of using XML specifications for services and the documents they exchanged had emerged a few years earlier in a 1997 proposal titled "XML in Component-Based Commerce" to the U.S. Department of Commerce Advanced Technology Program by several Silicon Valley firms. See Brad Meltzer and Robert Glushko, "XML and electronic commerce: Enabling the network economy," *ACM SIGMOD* 27 (1998), and Robert J. Glushko, Jay M. Tenenbaum, and Bart Meltzer, "An XML framework for agent-based commerce," *COMMUNICATIONS OF THE ACM*, 42 (1999): 106-114. This work also inspired a quasi-standards effort called the eCo Framework that in 1998-1999 developed a set of specifications two years before the Web Services "standards stack." See "eCo Architecture for Electronic Commerce Interoperability," at <http://www.commerce.net/docs/ecoframework.pdf> (last visited 20 October 2004). The ebXML initiative, begun in 1999, had also begun to cover some of the same ground a year before the Web Services specifications emerged. The most important work today on specifications for Web Services is being conducted under the auspices of the Web Services Interoperability Organization at <http://www.ws-i.org/> and OASIS at http://www.oasisopen.org/committees/tc_cat.php?cat=ws (both last visited 20 October 2004).

63. Jonathan Adams, Srinivas Koushik, Guru Vasudeva, and George Calambos, *PATTERNS FOR E-BUSINESS: A STRATEGY FOR REUSE* (IBM Press, 2001). See also IBM Patterns for E-Business at <http://www-106.ibm.com/developerworks/patterns/> (last visited 18 April 2005).

64. Peter Weill and Michael R. Vitale, *PLACE TO SPACE* (Harvard Business School Press, 2001).

65. David Kaye, author of *LOOSELY COUPLED: THE MISSING PIECES OF WEB SERVICES* (RDS Associates, 2003) at <http://www.rds.com/doug/weblogs/webServicesStrategies/2002/11/18.html> (last visited 20 October 2004), says “Loose coupling is like pornography. Everyone talks about it, but when challenged, few can tell you what it is.”
66. Gregor Hoppe and Bobby Wolfe, *ENTERPRISE INTEGRATION PATTERNS: DESIGNING, BUILDING, AND DEPLOYING MESSAGING SYSTEMS* (Addison-Wesley, 2004).
67. See note 5 in this chapter. See also Atul Saini, “Demystifying the enterprise service bus,” *BUSINESS INTEGRATION JOURNAL*, September 2003: 24-27, at <http://bijonline.com/Article.asp?ArticleID=764&DepartmentID=9> (last visited 22 October 2004) and Marty Tenenbaum, “CommerceNet’s vision: Millions of interoperable business services,” CommerceNet Whitepaper, at http://www.commerce.net/docs/BSN_vision.pdf (last visited 22 October 2004). It is also enlightening to study the changes in product positioning of software vendors like CommerceOne, Ariba, Web Methods, and BEA since the B2B bubble began to burst in 2001. CommerceOne developed the first XML-based marketplace platform in 1999, followed by other vendors who offered similar software that was highly functional and complex and came bundled with a suite of marketplace, supply chain, and auction services. Today the surviving companies have re-implemented and repositioned their software to have a much lighter footprint and to function as more generic service integration platforms; none offers completely packaged “marketplace” software anymore.
68. Nick Wingfield, “In latest strategy shift Amazon is offering a home to retailers,” *WALL STREET JOURNAL*, 24 September 2003. See also Amazon Web Services at <http://www.amazon.com/-gp/browse.html/104-5602037-8299135?node=3435361> (last visited 22 October 2004).
69. Talaris Corp., “Services business language (SBL): Supplier integration using SBL,” at http://www.talaris.com/technology/SBL_Whitepaper.pdf (last visited 22 October 2004).
70. Above All Software, “Above All Studio”, at <http://www.aboveallsoftware.com/products/studio.asp> (last visited 22 October 2004). Above All Software was founded by Roger Sippl, a Silicon Valley serial entrepreneur who also founded Informix, Vantive, and Visigenix. Just as Informix did nearly 30 years ago with SQL for relational databases and Visigenix did a decade ago with application servers, Above All is making composite services that latest step in an evolutionary trend to raise the level of abstraction to increase the reuse information assets and business logic.
71. Eric Knorr, “Enterprises sketch out service-oriented architectures,” *INFOWORLD.COM*, 26 November 2003, at http://reviews.infoworld.com/article/03/11/26/47FEwsretrofit_1.html?s=feature. (last visited 22 October 2004).

5

How Models and Patterns Evolve

1. Sometimes change takes place slowly and incrementally and at other times it takes place quickly, triggered by some significant business or political event or revolutionary technology breakthrough. And sometimes hindsight shows that a large change that apparently took place quickly actually took a long time, but the incremental changes that led to it were invisible.
2. John F. Kennedy, "Special Message to the Congress on Urgent National Needs" (delivered in person before a joint session of Congress, 25 May 1961), at <http://www.jfklibrary.org/j052561.htm> (last visited 23 October 2004).
3. David Williams, "The strategic implications of Wal-Mart's RFID mandate." *DIRECTIONS MAGAZINE*, 29 July 2004, at http://www.directionsmag.com/article.php?article_id=629 (last visited 23 October 2004).
4. Alfred D. Chandler, *THE VISIBLE HAND: THE MANAGERIAL REVOLUTION IN AMERICAN BUSINESS* (Cambridge University Press, 1977).
5. Oliver Williamson, *MARKETS AND HIERARCHIES: ANALYSIS AND ANTITRUST IMPLICATIONS* (Free Press, 1975), and *THE ECONOMIC INSTITUTIONS OF CAPITALISM* (Free Press 1985). Ronald Coase won the 1991 Nobel Prize in economics and is best known for a 1937 article titled "The Nature of the Firm" that introduced the concept of transaction costs to explain the size of firms. Transaction costs are incurred in searching for products and business partners, bargaining to establish price and other terms and conditions, and enforcing them. A very readable introduction to Coase's ideas is Chapter 2 of Larry Downes and Chunka Mui, *UNLEASHING THE KILLER APP* (Harvard Business School Press, 1998).
6. Carl Shapiro and Hal Varian, *INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY* (Harvard Business School Press, 1999).
7. See, for example, Naomi Lamoureaux, Daniel Raff, and Peter Temin, "Beyond markets and hierarchies: toward a new synthesis of American business history," *THE AMERICAN HISTORICAL REVIEW* 108 (2003): pp. 404-433; Richard N. Langlois, "The vanishing hand: The changing dynamics of industrial capitalism" *INDUSTRIAL AND CORPORATE CHANGE* 12 (2003): pp. 351-385; and Walter W. Powell, "Neither market nor hierarchy: Network forms of organization," *RESEARCH IN ORGANIZATIONAL BEHAVIOR* 12 (1990): pp. 295-336. For an excellent example of new types of supplier relationships, see Susan Helper, John Paul MacDuffie, and Charles Sabel "Pragmatic collaborations: Advancing knowledge while controlling opportunism," *INDUSTRIAL AND CORPORATE CHANGE* 9 (2000): pp. 443-489.

8. Amazon's book sales in 2003 were over US\$2 billion. See the 2003 Amazon.com annual report at http://media.corporate-ir.net/media_files/irol/97/97664/reports/Annual_Report2003041304.pdf (last visited 18 April 2005). Of course, Amazon.com has made substantial investments in warehouses and distribution centers, but it can optimize them for its online business model, unlike its competitors who are constrained by their existing offline channels.
9. CORBA stands for Common Object Request Broker Architecture, a specification promoted by the OMG to enable distributed object invocation. See <http://www.corba.org> (last visited 18 April 2005). It requires and benefits from tight coupling and thus is most successful when changes to interfaces can be controlled, usually within a single enterprise. A provocative but flawed proposal to apply CORBA to inter-enterprise applications was made by Jay Tenenbaum, Tripatinder Chowdry, and Kevin Hughes, "Eco System: An Internet Commerce Architecture," *COMPUTER*, 30 (5), May 1997, pp. 48-55.
10. Robert J. Glushko, "How XML enables Internet trading communities and marketplaces," *GRAPHICS COMMUNICATIONS ASSOCIATION XML 1999 CONFERENCE* (Philadelphia, 1998).
11. Peter Dodds, Duncan Watts, and Charles Sabel. "Information exchange and the robustness of organizational networks," *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES*, 100(21), pp. 12516-12521, 14 October 2003.
12. Timothy Bresnahan, Alfonso Gambardella, and AnnaLee Saxenian. "Old Economy Inputs for New Economy Outcomes: Cluster Formation in the New Silicon Valleys," *INDUSTRIAL AND CORPORATE CHANGE* 10(4), pp. 835-860, 2001.
13. Ben Worthen. "Hot Potato!" *CIO*, 15 January 2003, at <http://www.cio.com/archive/011503/potato.html> (last visited 23 October 2004).
14. Automakers sometimes have to offer costly incentives to sell some car models because of overoptimistic sales forecasts. At the same time, the buyers of popular models have to wait months to get the car they order from their local dealer, and it can even take two to three weeks for the buyer's order to get from the dealer to the production floor at the factory. See M. Verispej, "Automakers put wheels on supply chains," *INDUSTRY WEEK.COM*, 1 December 2001, at <http://www.industryweek.com/CurrentArticles/ASP/printerfriendly.asp?ArticleId=1174> (last visited 23 October 2004). The exact car the buyer wants could be sitting on another dealer's lot just a hundred miles away, but if all the dealers in a region don't share inventory information, the car might as well be on the moon. Other automation and standards efforts in the automotive industry are discussed in Laurie Sullivan, "Driving Standards," *INFORMATION WEEK*, 1 March 2004, at <http://www.informationweek.com/shared/printableArticle.jhtml?articleID=18201098> (last visited 23 October 2004).
15. Electronic Privacy Information Center, "Radio Frequency Identification (RFID) Systems," at <http://www.epic.org/privacy/rfid/> (last visited 23 October 2004).

16. Daniel Machalaba and Andy Pasztor, "Thinking inside the box: Shipping containers get 'smart,'" WALL STREET JOURNAL, 15 January 2004.
17. The growth of this emerging industry called "third-party logistics" is being driven by globalization. See for example, UPS Supply Chain Solutions, at <http://www.ups-scs.com/> (last visited 23 October 2004).
18. See Henry Chesbrough, OPEN INNOVATION (Harvard Business School Press, 2003) and Clayton Christensen, THE INNOVATOR'S DILEMMA (Harvard Business School Press, 1997).
19. See Public Library of Science at <http://www.publiclibraryofscience.org/>, and a collection of articles and editorials about open access publishing at <http://www.nature.com/nature/focus/accessdebate/> (last visited 23 October 2004).
20. Stephan Haeckel, ADAPTIVE ENTERPRISE: CREATING AND LEADING SENSE-AND-RESPOND ORGANIZATIONS (Harvard Business School Press, 1999). Randall Hancock, Peter Korsten, and George Pohle, "On demand business: The new agenda for value creation," at <http://www-1.ibm.com/services/us/index.wss/xs/imc/a1000745> (last visited 23 October 2004).
21. Make-to-order is the process category term (M2) used in the SCOR reference model; Build-to-order seems to be used more frequently but would be less consistent with the Make process at the highest level of the SCOR model.
22. David Anderson, BUILD-TO-ORDER AND MASS CUSTOMIZATION (CIM Press, 2004).
23. Bruce Silver, The Business Case for Demand Chain Management (Granada Research, 2002). Dell's success has been extensively documented in the academic and trade press. See Kenneth Kraemer, Jason Dedrick, and Sandra Yamahiro, "Refining and extending the business model with information technology: Dell Computer Corporation," THE INFORMATION SOCIETY 16 (2000): 5-21. See also Michael Dell and Joan Magretta, "The power of virtual integration: An interview with Dell Computer's Michael Dell," HARVARD BUSINESS REVIEW (March-April 1998): 73-84.
24. See, for example. Mirko Hager, "Ordering via vendor managed inventory (VMI): Fully automatic delivery chain reduces procurement costs," SAP INFO, 2 March 2003, <http://www.sap.info/index.php4?ACTION=noframe&url=http://www.sap.info/public/en/article.php4/Article-5543e3965105dfd3/en> (last visited 23 October 2004).
25. Richard Roehl and Hal Varian. "Circulating libraries and video rental stores," FIRST MONDAY, 6(5), 2001.
26. See <http://www.ipv6.org/> for the specification of the IPv6 protocol (last visited 18 April 2005). Also, Chana R. Schoenberger, "The Internet of Things," FORBES, 18 March 2002

27. Larry Downes, "The Information Supply Chain," in *THE STRATEGY MACHING* (Harper-Collins, 2002).
28. Internet Engineering Task Force, EDI-Internet Integration Home Page, at <http://www.ietf.org/html.charters/ediint-charter.html> (last visited 15 February 2004). For an example of web forms, see <https://www.sterlingwebforms.com/> (last visited 14 February 2004) and Alorie Gilbert, "Wal-Mart project boon for software makers" *C/NET News.com*, 14 August 2003, at http://news.com.com/2100-1017_3-5064075.html (last visited 10 June 2004).
29. Robert J. Glushko, "How XML enables Internet trading communities and marketplaces," *GRAPHICS COMMUNICATIONS ASSOCIATION XML 1999 CONFERENCE* (Philadelphia, 1998).
30. This is the definition proposed by the first author in Martin Lamonica, "You Call That A Standard?" *NEWS.COM*, 28 April 2004, at http://news.com.com/2008-1013_3-5200672.html (last visited 18 April 2005).
31. For the most recent "recommendation" about XML, see <http://www.w3.org/TR/2004/REC-xml-20040204/> (last visited 18 April 2005).
32. Chris Moritz, "Beyond the hype," *ACTIONLINE* (December 2001), at http://www.supplysolution.com/newsroom/Beyond_the_Hype_december01_p20.pdf (last visited 23 October 2004).
33. UCCNet is a nonprofit subsidiary of the Uniform Code Council, which brings together several business standards efforts and consortia (it began with article numbers for barcodes and now includes RosettaNet). See <http://www.uc-council.org/> and <http://www.uccnet.org/> (both last visited 18 April 2005).
34. The home page of the SDMX initiative is <http://www.sdmx.org/> (last visited 22 November 2004). See also Statistical Commission and Economic Commission for Europe, Conference of European Statisticians, Joint UNECE/Eurostat Work Session on Statistical Metadata Working Paper #11. "Common open standards for the exchange and sharing of socio-economic data and metadata: the SDMX initiative," (March 2002), at http://www.sdmx.org/Data/UNECE_Mar02.pdf (last visited 22 November 2004).

6 When Models Don't Match: The Interoperability Challenge

1. Of course, a web form application also uses document exchange because the form creates an HTML document.
2. The examples we will use in the chapter are based on a simplified version of Universal Business Language (UBL) vocabulary, but we are not attempting to create UBL compliant documents.

3. This is clearly a modeling error or oversight by GMBooks.com because it implies that prices will be interpreted as US dollars. The affiliate is trying to be precise here, but the good deed is being punished by the GMBooks.com system because of the data type mismatch.
4. For many practical examples of EDI to XML translation, we recommend Mike Rawlins, *USING XML WITH LEGACY BUSINESS APPLICATIONS* (Addison-Wesley, 2003).
5. XML is very flexible in how it encodes content models, and people disagree about best practices in using elements and attributes. Some differences are merely stylistic, while others affect document size, extensibility, and other substantive considerations. For example, programmers often rely heavily on XML attributes because of their familiarity with attribute-value pairs to record or exchange information, but this approach seems less natural to writers and others used to embedded markup.
6. As a related example, in San Francisco we learned the hard way that “No parking between 8 a.m. and 5 p.m. on weekdays” is enforced on holidays in tourist areas and not in residential ones.
7. Natural language processing and text analysis software can probably extract BuildingNumber, StreetName, and Room from the StreetAddress component in Figure 5-15a in many cases. In North America, initial numbers probably form the BuildingNumber, letters that follow make up the StreetName, leaving the ending numbers as the Room. But extracting street names that include numbers, numbers with fractions, post office box numbers, and all the other tricky cases you can imagine suggests that trying to accommodate all the mismatches is the wrong approach. The models are just too different.
8. See Dick Raman, *XML/EDI: CYBER ASSISTED BUSINESS IN PRACTICE* (TIE Holding NV, 1999).
9. The classic paper in this area is George Furnas, Thomas Landauer, Louis Gomez, and Susan Dumais, “The Vocabulary Problem in Human-System Communication,” *COMMUNICATIONS OF THE ACM* 30 (1987): pp. 964-971. The likelihood of two people choosing the same term to describe a familiar concept is less than 20 percent.
10. We’re certain it doesn’t really work this way; people who live on oil platforms probably get their mail forwarded from a regular street address or post office box. But there are oil platforms out in the Yellow Sea (see <http://www.cnooc.com.cn/english/business/youtian.html>), and surely people who work on them need to read books to pass the time. The point of this example is to show how completely incompatible conceptual models can be.

7

The Document Engineering Approach

1. UN Economic Commission for Europe, *UN/CEFACT Modeling Methodology, version 3.1* (CEFACT/TMWG/N090R3.1, 2001), Chapter 3. The UMM is a set of metamodels and a prescriptive

methodology for using them in the design of business processes and their associated documents.

2. RosettaNet at <http://www.rosettanet.org> (last visited 18 April 2005).
3. The BPSS is a metamodel described as an XML schema that can be used to define public business process models as XML document instances. See http://www.oasis-open.org/committees/te_home.php?wg_abbrev=ebxml-bp (last visited 18 April 2005).
4. Defining information components as objects rather than data allows the behavior of the component to be attached to its definition. While this has relevance to building reusable programming functions, it is less applicable to loosely coupled document modeling, so we shall focus on analysis of the static component rather than its behavior.
5. The artifacts created by these phases roughly correspond to the business requirements view (BRV) and business transaction view (BTV) in the ebXML BPSS metamodel.
6. See for example Jakob Nielsen, *USABILITY ENGINEERING* (Morgan Kaufman, 1994), or Deborah Mayhew, *THE USABILITY ENGINEERING LIFECYCLE: A PRACTITIONER'S HANDBOOK FOR USER INTERFACE DESIGN* (Morgan Kaufman, 1999).
7. The source of the correct quote is “Devotions upon Emergent Occasions, No. 17” (1624).
8. For big ideas about “naturalist” design see William Rouse, *DESIGN FOR SUCCESS* (Wiley, 1991); for specific case studies, see Dennis Wixon and Judith Ramey, *FIELD METHODS CASEBOOK FOR SOFTWARE DESIGN* (Wiley, 1997).
9. Any component with a number also has a text title, but it would be a stretch to treat each text title as a label of the type of content.
10. Normalization techniques are taught in almost every database book and course. We recommend the classic text by Chris Date, *AN INTRODUCTION TO DATABASE SYSTEMS, VOLUME 1 - 8th edition* (Addison-Wesley, 2003).
11. In a complex problem context, the number of possible associations can become unmanageably large, so in practice we need to focus on the most important associations. We might need to simplify the pattern or model somewhat; for example, the most important associations in an organizational model would be the hierarchical reporting relationships, and while some “dotted-line” responsibilities might exist, we might safely ignore them in some contexts.
12. This idea might be implicit in Barbara van Halle, *BUSINESS RULES APPLIED: BUILDING BETTER SYSTEMS USING THE BUSINESS RULES APPROACH* (Wiley, 2001), but it was first expressed this clearly by Peter Charles and Bob Daly, *RULE BASED INFRASTRUCTURE: A DESIGN AND RUN-*

TIME SYSTEM FOR ENABLING XML SCHEMA DRIVEN APPLICATIONS (UC Berkeley Master's Project Report, School of Information Management and Systems, 2004).

8

Analyzing the Context of Use

1. Allison Bloodworth and Robert Glushko, "Model-driven application design for a campus calendar network," IDEALLIANCE XML 2004 CONFERENCE, November 2004. at <http://www.idealliance.org/proceedings/xml04/papers/228/XML2004BloodworthGlushko.pdf>. See also Allison Bloodworth, Jeffrey Kahn, and Jon Conhaim, "UC Berkeley Calendar Network: A campuswide event calendar project," BERKELEY COMPUTING AND COMMUNICATIONS, 14 February 2005 at <http://istpub.berkeley.edu:4201/bcc/Spring2005/ucbcalendarnetwork.html> (both last visited 16 February 2005).
2. Todd Weiss, "Group seeks calendar, scheduling app interoperability," COMPUTERWORLD, 14 December 2004, at <http://www.computerworld.com/softwaretopics/software/groupware/story/0,10801,98274,00.html> (last visited 5 January 2005). The Calendar and Scheduling Consortium's home page is <http://www.calconnect.org/> (last visited 5 January 2005).
3. The phrase "Creeping featurism" has been around for a while but probably derives from the "Second System Effect" in Fred Brooks' classic THE MYTHICAL MAN-MONTH: ESSAYS ON SOFTWARE ENGINEERING (Addison-Wesley, 1975).
4. Design personas were proposed by Allan Cooper in THE INMATES ARE RUNNING THE ASYLUM: WHY HIGH TECH PRODUCTS ARE DRIVING US CRAZY AND HOW TO RESTORE THE SANITY (SAMS, 1999).
5. ebXML Core Components Project Team, Catalog of Context Drivers, 10 May 2001, at <http://www.ebxml.org/specs/ccDRIV.pdf> (last visited 3 September 2004).
6. Federal Information Processing Standard 55 DC-3, Codes for Named Populated Places, Primary County Divisions, and Other Locational Entities of the United States, Puerto Rico, and the Outlying Areas, 28 December 1994, at <http://www.itl.nist.gov/fipspubs/fip55-3.htm>. (last visited 16 September 2004).
7. Allan Afuah and Christopher Tucci, INTERNET BUSINESS MODELS AND STRATEGIES: TEXT AND CASES (McGraw Hill, 2000) and Paul Timmers, ELECTRONIC COMMERCE: STRATEGIES AND MODELS FOR BUSINESS-TO-BUSINESS TRADING (Wiley, 1999).
8. Yes, we can count and we know we've not included the System Capabilities context dimension because it doesn't suit our subsequent discussion. But if the Buyer used an Oracle procurement application and the Seller used an SAP ERP system these System Capabilities would certainly be important constraints on the documents they need to exchange.

9. Eduardo Gutentag and Arofan Gregory, "XML-based rules: Automating business context classification to produce semantic interoperability," *EXTREME MARKUP LANGUAGES*, 2001, at <http://www.mulbenytech.com/Extreme/Proceedings/xslfopdf/2001/Gutentag01/EML2001Gutentag01.pdf> (last visited 3 September 2004). See also Arofan Gregory and Eduardo Gutentag, "UBL and object-oriented XML: Making type-aware systems work," *IDEALLIANCE XML 2003 CONFERENCE*, at http://www.idealliance.org/papers/dx_xml03/papers/04-04-04/04-04-04.pdf (last visited 3 September 2004).
10. Tom Gilb, "Quantifying The Qualitative: how to avoid vague requirements by means of clear specification language," September 1997, at http://www.btt-research.com/quantifying_qualitative_requirements.htm (last visited 18 April 2005).
11. There are many different schemes for categorizing requirements or business rules. A very readable treatment is Tony Morgan, *BUSINESS RULES AND INFORMATION SYSTEMS* (Addison-Wesley, 2004). Most approaches distinguish constraints on content that are represented in data models from constraints on behavior represented in process models. Other schemes distinguish single-item constraints that must always be true from those that reflect the relationship between two or more items or that can change according to a process context. Finally, constraints can be classified according to the manner in which they are represented and enforced in an implemented application. Our own taxonomy for business rules attempts to synthesize these diverse approaches with a bias toward aligning types of rules with conventional ways of thinking about XML in general and XML schemas in particular. Our approach is consistent with the categories of Interoperability Challenges in Chapter 6 and with the analysis approach we describe in Chapters 9-11.
12. David Ferraiolo, John Barkley, and D. Richard Kuhn, "A role-based access control model and reference implementation within a corporate intranet," *ACM TRANSACTIONS ON INFORMATION AND SYSTEM SECURITY*, 2 (1999). A comprehensive set of resources on RBAC is at <http://csrc.nist.gov/rbac/> (last visited 3 September 2004).
13. UNECE Recommendation 1, United Nations Layout Key for Trade Documents, 1981, at http://www.unece.org/cefact/rec/rec01/rec01_1981_ecetrdB7.pdf. See also Annex to UNECE Recommendation 1, Applications of the United Nations Layout Key at http://www.unece.org/cefact/rec/rec01/rec01_%20Informative%20Annex_2001_%2001cf16.pdf (both last visited 3 September 2004). A brilliant case study of creating technology-neutral formatting specifications for rendering UBL documents to conform with the UN Layout Key is Ken Holman, "Writing formatting specifications for XML documents," *IDEALLIANCE XML 2003 CONFERENCE* at http://www.idealliance.org/papers/dx_xml03/papers/04-05-02/04-05-02.pdf (last visited 3 September 2004).

9

Analyzing Business Processes

1. Clayton Gillette and Steven Walt, "Implied terms," SALES LAW (Foundation Press, 1999). Describes how the customary practices or methods of dealing that are regularly observed within a trade or industry are treated as default provisions in sales contracts.
2. ebXML Business Process and Business Information Analysis Overview v1.0 (11 May 2001). <http://www.ebxml.org/specs/bpOVER.pdf> (last visited 18 April 2005).
3. We coined this term to convey the corporate sense of a demography.
4. Michael Treacy and Fred Wiersema, THE DISCIPLINE OF MARKET LEADERS (Harper Collins, 1995).
5. C. K. Prahalad and Gary Hamel, "The core competence of the corporation," HARVARD BUSINESS REVIEW, May-June 1990.
6. Benson Shapiro, V.Kasturi Rangan, and John Sviokla. "Staple yourself to an order," HARVARD BUSINESS REVIEW, July/August 1992.
7. UN Economic Commission for Europe, UN/CEFACT Modeling Methodology (UMM) User Guide (CEFACT/TMG/N093 22nd September 2003) at http://www.unece.org/cefact/umm/umm_userguide.pdf (last visited 18 April 2005).
8. Howard Smith and Peter Fingar, BUSINESS PROCESS MANAGEMENT: THE THIRD WAVE (Meghan-Kiffer Press, 2003). Efforts to reengineer and standardize business processes can be traced back to the early 1920s.
9. Todd Datz, "Integrating America," CIO, 1 December 2002, at <http://www.cio.com/-archive/120102/america.html> (last visited 14 February 2004).
10. Our worksheet format is inspired by ebXML Business Process Analysis Worksheets & Guidelines at <http://www.ebxml.org/specs/bpWS.pdf> (last visited 18 April 2005), which contains detailed definitions of each section and guidance for filling them out.
11. G. Fitzpatrick, P. Lanner, and P. Hjelm, "SkiCal—An extension of iCalendar," (Internet Engineering Task Force Draft, July 2001) at <http://skical.metamatrix.se/skical20010905.html> (last visited 18 October 2004).

12. Scott Ambler, *AGILE MODELING: EFFECTIVE PRACTICES FOR EXTREME PROGRAMMING AND THE UNIFIED PROCESS* (John Wiley & Sons, 2002).
13. See Helmut Wachter and Andreas Reuter: "The ConTract model," in A. Elmagarmid (ed.), *DATA-BASE TRANSACTION MODELS FOR ADVANCED APPLICATIONS* (Morgan Kaufmann, 1992): pp. 219-263.
14. Receipts are also sometimes called Acknowledgment Messages or ACKs, but we prefer Receipt because business documents can also serve as acknowledgments and might even have Acknowledgment in the name of the document type.
15. ebXML Business Process Specification Schema, 11 May 2001, at <http://www.ebxml.org/specs/ebBPSS.pdf> (last visited 15 January 2005).
16. United Nations Convention on Contracts for the International Sale of Goods (Vienna 1980).
17. We thank David Burdett for this insightful addition to our definition.
18. Jamie Clark (ed.), "ebXML e-commerce patterns v1.0" (May 2001) at <http://www.ebXML.org/specs/bpPATT.pdf> (last visited 18 April 2005).
19. Paula and Paul Swatman, "Electronic data interchange: Organisational opportunity, not technical problem," in Bala Srinivasan and John Zeleznikow (eds.), *DATABASES IN THE 1990s*, 2 (World Scientific Press, 1991): pp. 354-374

10

Designing Business Processes with Patterns

1. If the drop shipping retailer wants to hide the fact that a third party distributor is part of their virtual enterprise by controlling every communication with the buyer, this indirection is essential and not viewed as inefficient.
2. "Recipes" for drop shipment are described in "The drop ship guide" at <http://www.the-drop-ship-guide.com/> and "Start wholesale drop shipping" at <http://www.wholesalemarketer.com/> (both last visited 12 January 2005).
3. Geoffrey Moore. "Darwin and the Demon: Innovation within Established Enterprises." *HARVARD BUSINESS REVIEW*, July-August 2004, 86-92.
4. Italian Pizza has 114,000 hits using Google and Hawaiian Pizza gets 16,000. But Indonesian Pizza has only 60 on 12 January 2005. For both a fascinating and practical look at recipe patterns principles and experimentation, see Elizabeth Rozin, *THE FLAVOR PRINCIPLE COOKBOOK* (Hawthorn Books, 1973), republished under the title *ETHNIC CUISINE* (Penguin Books, 1992).

5. The International Benchmarking Clearinghouse managed by the American Productivity and Quality Center (APQC) categorizes 271 common business processes as part of an extensive repository of best practices and metrics (see <http://www.apqc.org>). The European Foundation for Quality Management (EFQM) maintains a similar repository (see <http://www.efqm.org/>). The MIT Process Handbook Repository currently has over 5000 other business process entries at <http://process.mit.edu/Info/Contents.asp> (all last visited 12 January 2005).
6. Thomas Malone, Kevin Crowston, and George Herman (Eds.), *ORGANIZING BUSINESS KNOWLEDGE: THE MIT PROCESS HANDBOOK* (MIT Press, 2003).
7. The least-detailed cluster view of RosettaNet is at <http://www.rosettanet.org/pips>; the most-detailed PIP view is at <http://www.rosettanet.org/pipdirectory> (both last visited on 13 January 2005).
8. Taxation and Customs Union, "The Single Administrative Document (SAD)," 20 December 2004, at http://europa.eu.int/comm/taxation_customs/customs/procedural_aspects/general/sad/index_en.htm (last visited 31 January 2005).
9. Two representative research papers, both of which use as an example a composite travel service like the one we have described, are Jiang Wang, "Web Service Componentization," *COMMUNICATIONS OF THE ACM*, October 2003, 46(10), pp. 35-40 and Quan Sheng, Boualem Benatallah, Marlon Dumas, and Eileen Mak, "SELF-SERV: A Platform for Rapid Composition of Web Services in a Peer-to-Peer Environment," *PROCEEDINGS OF THE 28TH VLDB CONFERENCE*, 2002.
10. In the period from 1878 to 1880 Edison and his associates worked on thousands of potential materials to use for an electric light filament. He finally narrowed his testing to the carbonized filaments of 6,000 different plants, a range that included baywood, boxwood, hickory, cedar, flax, and bamboo. He eventually discovered that a carbonized cotton thread filament began to radiate a soft orange glow. See <http://www.ideafinder.com/history/inventions/story074.htm> (last visited 13 January 2005).
11. UDDI Version 3 Features List, see http://www.uddi.org/pubs/uddi_v3_features.htm#_Toc10457173 (last visited 13 January 2005).
12. See http://en.wikipedia.org/wiki/Cargo_cult (last visited 13 January 2005).
13. For more information about the "Copy Exactly" factory strategy see Intel's Worldwide Manufacturing Operations Virtual Press Kit at http://www.intel.com/pressroom/kits/manufacturing/-copy_exactly_bkgrnd.htm (last visited 1 November 2004).
14. The university analog to a Forecast would be a student's intent to take courses in future semesters; Inventory Reports would give more precision to the usual "in or out" course registration process; Commitment to Supply requests would ask instructors to commit to teach courses and prevent them from canceling courses.

15. "Channel Assembly: A Lexicon", at <http://www.varbusiness.com/sections/98pages/-198chsupp2.jhtml>. (last visited 13 January 2005). See also Norm Bogen, "Channel Assembly Gains Favor," ELECTRONIC NEWS, 21 April 1997.
16. For information about UPS Supply Chain Solutions see <http://www.ups-scs.com/logistics/index.html> (last visited 15 January 2005). See also Aberdeen Group, "Service Parts Management: Unlocking Value and Profits in the Service Chain," September 2003 at <http://www.ups-scs.com/logistics/servicepartsreport.pdf> (last visited 15 January 2005).
17. Bob Tedeschi, "Returns are Early, But New Categories of 'Stores' On Amazon.com Show Promise," NEW YORK TIMES, 22 December 2003. See also Edd Dumbill, "Making Web Services Work at Amazon," XML.COM, 9 December 2003 at <http://www.xml.com/pub/a/2003/12/09/xml2003amazon.html> (last visited 31 October 2004).
18. "Order Management Choreographies," Version 1.0., 15 May 2003 at <http://www.xcbl.org/xcbl40/documentation/view/OrderManagementChoreographies.rtf> (last visited 27 January 2005).
19. RosettaNet Request Purchase Order (PIP 3A4) Specification 8 January 2004 at <http://www.rosettanet.org/PIP3A4> (last visited 15 January 2005).
20. Kenneth Kraemer, Jason Dedrick, and Sandra Yamashiro, "Refining and Extending the Business Model with Information Technology: Dell Computer Corporation," THE INFORMATION SOCIETY, 16 (2000): pp.5-21.
21. See "Fast Moving Consumer Goods: When to Change a GTIN," at <http://www.ean-int.org/gtin-rules/Help/When%20to%20change%20GTIN%20basics.htm> (last visited 16 January 2005). GTINs can have up to 14 digits and are managed by the European Article Numbering Association (EAN). EAN was created in 1977 to set European standards and controls for the identifiers used on bar codes. The organization has gone global by extending membership to similar organizations on other continents and today has member organizations from more than 100 countries, including the U.S. Uniform Code Council, which also manages the RosettaNet Consortium. In January 2005, EAN announced a name change to GS1, presumably to get European out of its name. See <http://www.ean-int.org> and <http://www.uc-council.org/> (both last visited 15 January 2005).
22. Peter Jones, "Unique consignment numbering: the foundation for a universal tracing and tracking system or an additional obstacle to world trade?," FORWARDERLAW.COM, 3 October 2002, at <http://www.forwarderlaw.com/Feature/ucr.htm> (last visited 15 January 2005). See also "The World Customs Organization (WCO) and EAN International (EAN) agree continued cooperation on the Unique Consignment Reference (UCR)," press release by the World Customs Organization, 25 June 2004, at http://www.wcoomd.org/ie/En/Press/Joint%20Statement%20WCO%20EAN_36.htm (last visited 15 January 2005).

23. See, for example, RosettaNet Implementation Guide: PIPs 3A4, 3A7, 3A8, 3A9 for Order Management in Japan Business Model Alignment Process, 16 April 2004, at <http://www.rosettanet.org/usersguides> (last visited 16 January 2005).

11

Analyzing Documents

1. Thomas Malone, "How do people organize their desktops? Implications for the design of office systems," *ACM TRANSACTIONS ON OFFICE INFORMATION SYSTEMS* 1 (1983): pp. 99-112.
2. Steve Whittaker and Julia Hirshberg, "The character, value, and management of personal paper archives." *ACM TRANSACTIONS ON COMPUTER-HUMAN INTERACTION* 8 (2001): pp. 150-170.
3. The presentational emphasis of HTML and the accompanying lack of explicit semantics within web pages have motivated the idea of a semantic web. See Tim Berners-Lee, James Hendler, and Ora Lassila, "The semantic web will bring structure to the meaningful content of web pages," *SCIENTIFIC AMERICAN*, May 2001.
4. One factor in the heterogeneity of narrative documents is copyright law, which treats as infringements new instances that are too similar in content and structure to an existing work.
5. The common patterns are in their purchase orders, not in the books themselves. We know that both Moby Dick and the Bible discuss whales (see the story of Jonah in Matthew 12:40) but there isn't much benefit in proposing a common content component type to capture this fact unless we're designing for a very specialized business model.
6. Governments are especially skilled at this technique with documents that describe deficits, employment, or other economic activity. They also use the related practice of classifying documents as Secret when more accurate categorizations might be Embarrassing, Wasteful, or Likely to Jeopardize Reelection. Some product firms don't create any documents named Bugs or Known Defects, not because their projects have none of them but because they publish these lists as Change Requests, Customer Satisfaction Considerations, or similarly name-obscured documents.

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Analyzing Document Components

1. A particularly readable and entertaining book on design is Robin Williams, *THE NON-DESIGNERS DESIGN BOOK: DESIGN AND TYPOGRAPHIC PRINCIPLES FOR THE VISUAL NOVICE* (Peachpit Press, 1994). And we'd be derelict if we failed to remind readers of Edward Tufte's classic books *THE VISUAL DISPLAY OF QUANTITATIVE INFORMATION* (Graphics Press, 2001) and *ENVISIONING INFORMATION* (Graphics Press, 1990).

2. According to Webster a sidebar is “a short news story accompanying and presenting sidelights of a major story.” So a sidebar is a type of narrative content, but it appears that this semantic distinction has been corrupted by giving it a name that reflects its typical presentation at the side of the more central content.
3. MIL-STD-1472D: Human engineering design criteria for military systems, equipment and facilities, Military standard human engineering design criteria for military systems, equipment and facilities, 14 March 1989, at <http://jcs.mil/htdocs/teinfo/directives/soft/ms1472d.html> (last visited 23 November 2004).
4. We believe that this is a task best done by people, but this “table extraction” problem is being attacked using a variety of computational techniques; some infer the data model from queries into HTML forms, others analyze HTML tags or the patterns of text and data values, and others employ machine learning techniques to classify tables and web pages. See, for example, Matthew Hurst, *THE INTERPRETATION OF TABLES IN TEXT* (PhD dissertation, University of Edinburgh, 2000); Alberto H. F. Laender, Berthier A. Ribeiro-Neto, Altigran S. da Silva, and Juliana S. Teixeira, “Surveys: A brief survey of web extraction tools,” *ACM SIGMOD RECORD*, 31 (June 2002); Yingchen Yang and Wo-Shun Luk, “Web mining: A framework for web table mining,” *PROCEEDINGS OF THE FOURTH INTERNATIONAL WORKSHOP ON WEB INFORMATION AND DATA MANAGEMENT* (November 2002).
5. Yalin Wang and Jianying Hu. “A machine learning approach for table detection on the Web,” *PROCEEDINGS OF THE 11TH INTERNATIONAL CONFERENCE ON THE WORLD WIDE WEB* (2002): pp. 242-250. Wang and Hu describe a machine learning approach to classify web tables as either genuine or non-genuine. In their sample of more than 14,000 sites with <Table> tags, only about 10 percent were genuine tables. Content characteristics discriminate better than layout ones.
6. The seminal work in this area is Eleanor Rosch and Carolyn Mervis “Family resemblances: Studies in the internal structure of categories,” *COGNITIVE PSYCHOLOGY*, 7 (1975): pp. 573-605. See also Edward Smith and Douglas Medin, *CATEGORIES AND CONCEPTS* (Harvard University Press, 1981).
7. United Nations Directories for Electronic Data Interchange for Administration, Commerce and Transport, 7081 Item Characteristic Code at <http://www.unece.org/trade/umtdid/d01a/-tred/tred7081.htm> (last visited 10 March 2005).
8. An initialism is an abbreviation composed from the initial letters of a series of words (like NCAA or BBC). An acronym is a special type of initialism in which the resulting abbreviation is pronounceable (like NATO or ISO). An apocopation is an abbreviation formed by truncating a longer word (such as bicycle to bike or University of California to Cal).
9. See the W3C home page for the semantic web activity (<http://www.w3.org/2001/sw>) and especially the resource description framework (RDF) and the Web ontology language (OWL) (last visited 24 November 2004).
10. This example comes from J. Brian Farish, “What’s in a name,” 2002, at http://www.vertaasis.com/articles/whats_in_a_name.htm (last visited 20 October 2004).

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Assembling Document Components

1. Everywhere except at the extreme narrative endpoint; Melville probably didn't strive for these goals when writing *Moby Dick*.
2. Much of this subsequent skill and judgment has been successfully captured in rule-based computer programs that generate illustrations automatically from a knowledge base or semantic content provided by the author. See Doree Seligman and Steven Feiner, "Specifying composite illustrations with communicative goals," *PROCEEDINGS OF THE ACM SYMPOSIUM ON USER INTERFACE SOFTWARE AND TECHNOLOGY* (Williamsburg, VA, November 13-15, 1989):pp. 1-9, and Winfried Graf, "The constraint-based layout framework laylab and its applications," *ACM WORKSHOP ON EFFECTIVE ABSTRACTIONS IN MULTIMEDIA: LAYOUT, PRESENTATION AND INTERACTION* (ACM Multimedia '95), at <http://www.cs.uic.edu/~ifc/mmwsproc/graf/mm95.html> (last visited 3 November 2004).
3. Eve Maler and Jeanne El Andaloussi, *DEVELOPING SGML DTDs: FROM TEXT TO MODEL TO MARKUP* (Prentice-Hall, 1995). Our comments in this section and its title may imply that Maler and El Andaloussi's book is outdated. But their book contains a wealth of knowledge about project planning, team building, project politics, and other topics that transcend the implementation technology for document models, and we highly recommend it for those reasons.
4. The landmark paper is Edgar F. Codd, "A relational model of data for large shared data banks," *COMMUNICATIONS OF THE ACM*, 13 (1970): pp. 377-387.
5. The classic and authoritative data modeling textbook is C. J. Date's *AN INTRODUCTION TO DATABASE SYSTEMS, VOLUME 1*, first published in 1980 and now in its eighth edition (Addison-Wesley, 2003).
6. The Electronics Industry Data Exchange Group (EIDX) develops implementation guidelines for EDI and XML-based vocabulary standards, in addition to publishing recommendations for usage of these transactions and messages (supporting documents). See <http://eidx.comptia.org/guidelines.aspx> (last visited 23 November 2004).
7. The Society for Worldwide Interbank Financial Telecommunication (SWIFT) offers the financial services industry a common platform of advanced technology and access to shared solutions. See http://www.swift.com/index.cfm?item_id=41946 (last visited 23 November 2004).
8. ASC X12 is the U.S. standards body for the cross-industry development, maintenance, and publication of electronic data exchange standards. See <http://www.x12.org/x12org/subcommittees/dev/index.cfm> (last visited 23 November 2004).

9. United Nations Directories for Electronic Data Interchange for Administration, Commerce and Transport, at <http://www.unece.org/trade/untdid/welcome.htm> (last visited 23 November 2004).
10. OASIS Universal Business Language defines a common XML library of business documents (purchase orders, invoices, etc.). See http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ubl (last visited 23 November 2004).
11. As of early 2004, courtesy of Robin Cover, at <http://xml.coverpages.org/namesAndAddresses.html>:
 - BS 7666 Spatial data-sets for geographic referencing
 - CEN/TC133/WG3 Postal services, Addresses and Automatic Identification of Items
 - ECCMA International Address Element Code
 - GCA/IDEAlliance Address Data Interchange Specification (ADIS)
 - HR-XML Consortium Cross-Process Objects Schemas
 - Linking and Exploring Authority Files (LEAF)
 - OASIS CIQ TC Name and Address Standard (xNAL)
 - SAMPLE: Single Administrative Message for Postal Enterprises
 - UK GovTalk Address and Personal Details Fragment
 - Universal Postal Union (UPU)
 - UN/PROLST
 - US FGDC Address Data Content Standard
 - US Postal Service
 - ASTM E2182: Names in Healthcare Records
 - vCard: Electronic Business Card
12. The UN/CEFACT ebXML Core Components Technical Specification 2.01 is available from http://www.untnmg.org/artifacts/CCTS_v2.01_2003-11-15.pdf (last visited 18 April 2005).
13. ISO/IEC 11179-1:1999 Information technology — Specification and standardization of data elements — Part 1: Framework for the specification and standardization of data elements is available from [http://www.iso.org/iso/en/itf/PubliclyAvailableStandards/c035343_ISO_IEC_11179-1_2004\(E\).zip](http://www.iso.org/iso/en/itf/PubliclyAvailableStandards/c035343_ISO_IEC_11179-1_2004(E).zip) (last visited 18 April 2005).

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Assembling Document Models

1. What follows is very simplistic treatment of a complex subject. We will not get into any of the debate about data-oriented or document-oriented databases or the representation of XML in databases. See Ronald Bourret, “XML and databases” (July 2004), at <http://www.rpbourret.com/xml/XMLAndDatabases.htm> (last visited 6 November 2004).
2. Eve Maler and Jeanne El Andaloussi, DEVELOPING SGML DTDs: FROM TEXT TO MODEL TO MARKUP (Prentice-Hall, 1995), pp. 145-146.

3. Arofan Gregory and Eduardo Gutentag. "XSD type derivation and the UBL context mechanism," IDEALLIANCE XML 2002 CONFERENCE, at http://www.idealliance.org/papers/xml02/-dx_xml02/papers/05-05-06/05-05-06.pdf (last visited 8 November 2004).
4. Patrick Garvey, Marc Gratacos, Sonia Klemperer-Johnson, and John Leon. "Course project final report," at <http://dream.sims.berkeley.edu/doc-eng/projects/COURSE/course-final-report.html> (last visited 4 November 2004).
5. This example is inspired by a case study of document automation in an engine assembly plant. John Terris, "Re-use, re-purpose, re-package:A General Engine Products, Inc., case study," IDEALLIANCE XML 2001 CONFERENCE, at <http://www.idealliance.org/papers/xml2001/papers/html/04-01-04.html> (last visited 3 November 2004).
6. Figure 14-10 uses UML notations for describing dependencies between components. Components are described by a rectangle with two smaller rectangles overlaid on its left side. Dependencies are denoted by dashed lines with open arrowheads pointing from dependent to independent components. In this case the independent components are packages (or libraries) denoted as a large rectangle with a smaller rectangle attached to the top left corner.
7. ELM stands for "enables lucid models," and their notation is described in Eve Maler and Jeanne El Andaloussi, DEVELOPING SGML DTDs: FROM TEXT TO MODEL TO MARKUP (Prentice-Hall, 1995), pp. 34-35.

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Implementing Models in Applications

1. Eve Maler and Jeanne El Andaloussi, DEVELOPING SGML DTDs: FROM TEXT TO MODEL TO MARKUP (Prentice-Hall, 1995).
2. Eric van der Vlist, XML Schema (O'Reilly, 2002); James Bean, XML FOR DATA ARCHITECTS (Morgan Kaufmann, 2003); Berthold Daum, MODELING BUSINESS OBJECTS WITH XML SCHEMA (Morgan Kaufmann, 2003).
3. Priscilla Walmsley, DEFINITIVE XML SCHEMA (Prentice Hall, 2002).
4. David Orchard, "Extending and versioning XML languages with XML schema," IDEALLIANCE XML 2004 CONFERENCE, at <http://www.idealliance.org/proceedings/xml04/papers/248/Extending-VersioningXML.pdf> (last visited 10 February 2005); Dare Obasanjo, "Designing XML formats: Versioning vs. extensibility," IDEALLIANCE XML 2004 CONFERENCE, at <http://www.idealliance.org/proceedings/xml04/papers/46/VersioningXML.pdf> (last visited 10 February 2005).
5. Universal Business Language Naming and Design Rules, 5 November 2004, at <http://www.oasis-open.org/committees/download.php/9943/cd-UBL-NDR-1.0Rev1b.pdf> (last visited 10 March 2005).

6. The current version of the Berkeley Events Calendar schema can be found at: <http://groups.sims.berkeley.edu/EventCalendar/> (last visited 18 April 2005).
7. Some of these are: EDIFIX from GEFEG (see <http://www.gefeg.com/en/index.htm>), UBLish from SoftML (see <http://www.softml.net/jedi/ubl/sw/UBLish/UBLish-1.0/index.html>) and Enterprise Architect from SparxSystems (<http://www.sparxsystems.com.au/ea.htm>) (all last visited 18 April 2005).
8. David Carlson, *MODELING XML APPLICATIONS WITH UML* (Addison-Wesley, 2001). Carlson's portal for XML modeling issues where hyperModel can be downloaded is at <http://www.xmlmodeling.com/> (last visited 10 March 2005).
9. See Ronald Bourret, "Mapping W3C schemas to object schemas to relational schemas," March 2001, at <http://www.rpbourret.com/xml/SchemaMap.htm> (last visited 20 February 2005).
10. The Schematron can be useful in conjunction with many grammar-based structure-validation languages: DTDs, XML Schemas, RELAX, TREX, etc. Schematron is part of an ISO standard (DSDL: Document Schema Description Languages) designed to allow multiple XML validation languages to work together. For more details see <http://www.schematron.com/> (last visited 10 March 2005).
11. Matthew Gertner, Eduardo Gutentag, and Arofan Gregory, "Guidelines for the customization of UBL v1.0 schemas," 22 April 2004, at <http://docs.oasis-open.org/ubl/cd-UBL-1.0/doc/cm/wd-ubl-cm-sc-cmguidelines-1.0.html> (last visited 20 February 2005).
12. BPEL was originally developed by Microsoft and IBM but is now being worked on as an OASIS technical committee; the most current specification can be found at the home page at http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpel. BPSS was developed in the ebXML initiative (<http://www.ebxml.org/>) but it is also now an OASIS TC (http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ebxml-bp). BPDm is a relatively new effort of the Object Management Group (<http://www.omg.org/#BPC>). RosettaNet Implementation Framework: Core Specification. Version 2.00.01, 6 March 2002, <http://www.rosettanet.org> (all last visited 18 April 2005).
13. This idea might be implicit in Barbara van Halle, *BUSINESS RULES APPLIED: BUILDING BETTER SYSTEMS USING THE BUSINESS RULES APPROACH* (Wiley, 2001), but it was first expressed this clearly by Peter Charles and Bob Daly, *RULE BASED INFRASTRUCTURE: A DESIGN AND RUN-TIME SYSTEM FOR ENABLING XML SCHEMA DRIVEN APPLICATIONS* (UC Berkeley Master's Project Report, School of Information Management and Systems, 2004).
14. Joaquin Miller and Jishnu Mukerji (Eds.), *MDA Guide Version 1.0.1*, 12 June 2003, at <http://www.omg.org/docs/omg/03-06-01.pdf> (last visited 4 February 2005).
15. See "The architecture of choice for a changing world: OMG model driven architecture," at <http://www.omg.org/mda/> (last visited 20 February 2005).

16. See Ronald Bourret, "XML data binding resources," 12 December 2004, at <http://www.rpbouret.com/xml/XMLDataBinding.htm> (last visited 7 February 2005); Dennis Sosnoski, "XML and Java technologies: Data binding, Part 1: Code generation approaches—JAXB and more," 1 January 2003, at <http://www-128.ibm.com/developerworks/xml/library/x-databdopt/> (last visited 16 February 2005).
17. Somewhat ironically for us, the user's high-level understanding about how an application works that shapes his or her interactions with it is often called a "system model," but this model is a qualitative one that can't be executed or interpreted to run the application. See Donald Norman, *THE DESIGN OF EVERYDAY THINGS* (Basic Books, 1988).
18. The W3C XForms Recommendation and other useful resources can be found at the W3C XForms Activity Page at [ww.w3.org/MarkUp/Forms/](http://www.w3.org/MarkUp/Forms/). We also recommend a book by one of the editors of the Recommendation: Micah Dubinko, *XFORMS ESSENTIALS* (O'Reilly, 2003).
19. The home page for the Mozilla XUL project is <http://www.mozilla.org/projects/xul/> (last visited 20 February 2005). See also Vaughn Bullard, Kevin Smith, and Michael Daconta, *ESSENTIAL XUL PROGRAMMING* (Wiley, 2001).
20. "Longhorn" Markup Language (code-named "XAML") Overview. See <http://longhorn.msdn.microsoft.com/lhsdk/core/overviews/about%20xaml.aspx> (last visited 20 February 2005).
21. "Macromedia Flex: The presentation tier solution for delivering enterprise rich internet applications," October 2004, at http://www.macromedia.com/software/flex/whitepapers/pdf/flex15_tech_wp.pdf (last visited 10 February 2005).
22. Patrick Garvey and Bill French, "Generating user interfaces from composite schemas," IDEALLIANCE XML 2003 CONFERENCE, http://www.idealliance.org/papers/dx_xml03/papers/03-03-04/03-03-04.pdf (last visited 20 February 2005).
23. Dennis de Baar, James Foley, and Kevin Mullet. "Coupling application design and user interface design," *PROCEEDINGS OF ACM CHI* (1992): pp. 259-266.
24. Gustavo Rossi, Daniel Schwabe, and Fernando Lyardet. "User interface patterns for hypermedia applications," *INTERNATIONAL CONFERENCE ON ADVANCED VISUAL INTERFACES (AVI 2000)*; Matijn van Welie and Hallvard Troetteberg. "Interaction patterns in user interfaces," *7th CONFERENCE ON THE PATTERN LANGUAGES OF PROGRAMS (PLoP 2000)*; Stefano Cerl, Piero Fraternali, Aldo Bongio, Marco Brambilla, Sara Comai, and Maristella Matera. *DESIGNING DATA-INTENSIVE WEB-APPLICATIONS* (Morgan Kaufman, 2003).
25. Volker Turau. "A Framework for automatic generation of web-based data entry applications based on XML," *PROCEEDINGS OF THE 2002 ACM SYMPOSIUM ON APPLIED COMPUTING*.

26. Angel Puerta, Michael Michelletti, and Alan Mak. "The UI pilot: a model based tool to guide early interface design," INTERNATIONAL CONFERENCE ON INTELLIGENT USER INTERFACES (IUI'05).
27. Enrico Bertini and Giuseppe Santucci. "Modeling Internet based applications for designing multi-device adaptive interfaces," INTERNATIONAL CONFERENCE ON ADVANCED VISUAL INTERFACES (AVI 2004). Murielle Florins and Jean Vanderdonckt. "Graceful degradation of user interfaces as a design method for multiplatform systems," INTERNATIONAL CONFERENCE ON INTELLIGENT USER INTERFACES (IUI'04).
28. Melody Ivory and Marti Hearst. "The state of the art in automating usability evaluation of user interfaces," ACM COMPUTING SURVEYS, 33(4), December 2001, pp. 470-516.
29. Angel Puerta. "A Model Based Interface Development Environment." IEEE SOFTWARE, July/August 1997.
30. Simon Lok, Steven Feiner, and Gary Ngai. "Evaluation of visual balance for automated layout," INTERNATIONAL CONFERENCE ON INTELLIGENT USER INTERFACES (IUI'04).
31. Carlo Bellettini, Alessandro Marchetto, and Andrea Trentini. "WebUML: Reverse engineering of web applications," PROCEEDINGS OF THE 2004 ACM SYMPOSIUM ON APPLIED COMPUTING.
32. Lisa de Larios-Heiman, "Above All Studio and the Syllabus Project: Generating Data Entry Forms for a Model Based Application." Center for Document Engineering Technical Report, January 2005 (CDE-TR-2005-1).
33. Darrell Raymond and Frank Tompa, "Hypertext and the new Oxford English Dictionary," COMMUNICATIONS OF THE ACM, 31 (July 1988): pp. 871-879.
34. Open eBook Publication Structure Specification, at <http://www.openebook.org/oebps/oebps1.2/-index.htm>. See Paul Cesarini, "eBooks: A battle for standards," THE WRITING INSTRUCTOR, 2002 at <http://www.writinginstructor.com/essays/-cesarini/index.html> (both last visited 7 February 2005).
35. Interactive Electronic Training Manual (IETM) Guide (Defense Systems Management College Press, 1999), at http://nsdsa.phdnavy.mil/tmmp/ietm/ietm_DSMC%20acquisition%20doc.pdf (last visited 20 February 2005).
36. John Terris, "Re-use, re-purpose, re-package:A General Engine Products, Inc., case study," IDEAL-LIANCE XML 2001 CONFERENCE, at <http://www.idealliance.org/papers/xml2001/papers/html/04-01-04.html> (last visited 9 February 2005).
37. Center for Document Engineering, University of California, Berkeley, Center in a Box 1.0.1 Early Access User's Guide, 2003, at <http://cde.berkeley.edu/initiatives/centerinabox/> (last visited 10 February 2004). Center in a Box is a research project to explore model based publishing. It is not a full web portal because it lacks built-in functionality to support user logins or customization by role. It also lacks facili-

ties for WYSIWYG editing, content versioning, or access control that might be found in a complete content management solution.

38. For further discussion of software architecture and technology, see Michael Fitzgerald, *BUILDING B2B APPLICATIONS WITH XML* (Wiley, 2001); David Linthicum, *NEXT GENERATION APPLICATION INTEGRATION* (Addison-Wesley, 2004); Gregor Hohpe and Bobby Wolfe, *ENTERPRISE INTEGRATION PATTERNS* (Addison-Wesley, 2004).

39. David Chappell, *ENTERPRISE SERVICE BUS* (O'Reilly, 2004).

40. W3C, "Semantic web activity statement," www.w3.org/2001/sw/Activity (last visited 2 March 2005). See also Tim Berners-Lee, James Hendler, and Ora Lassila, "The semantic web," *SCIENTIFIC AMERICAN*, May 2001, <http://www.scientificamerican.com/article.cfm?articleID=00048144-10D2-1C70-84A9809EC588EF21&catID=2> (last visited 3 March 2005).

41. These two examples are adapted from W3C, "OWL web ontology language use cases and requirements." 10 February 2004, at <http://www.w3.org/TR/webont-req/> (last visited 2 March 2005).

42. W3C, "Resource description framework (RDF): Concepts and abstract syntax," 10 February 2004, at <http://www.w3.org/TR/rdf-concepts/> (last visited 2 March 2005).

43. See "(XML) topic maps" at <http://xml.coverpages.org/topicMaps.html> (last visited 3 March 2005).

44. W3C, Web-Ontology (WebOnt) Working Group, at <http://www.w3.org/2001/sw/WebOnt/> (last visited 3 March 2005).

45. The British Library defines "creator" as a superset of the Library of Congress definition of "author." See Catherine Marshall and Frank Shipman, "Which Semantic Web?," *ACM CONFERENCE ON HYPERTEXT AND HYPERMEDIA*, 2003.

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1. See "Alexander Bain," in *The History of Computing Project*, at http://www.thocp.net/biographies/bain_alexander.htm, and "Alexander Bain" in *Adventures in Cybersound*, at http://www.acmi.net.au/AIC/BAIN_BIO.html (both last visited 27 December 2004).

2. For a useful checklist for resource requirements in web services-targeted projects, see Doug Kaye, *LOOSELY COUPLED: THE MISSING PIECES OF WEB SERVICES* (RDS Associates Inc, 2003) App A.

3. Carnegie Mellon University Software Engineering Institute, *THE CAPABILITY MATURITY MODEL: GUIDELINES FOR IMPROVING THE SOFTWARE PROCESS* (Addison-Wesley, 1995). The

Software Engineering Institute no longer maintains the CMM model. See <http://www.sei.cmu.edu/cmm/> (last visited 28 December 2004).

4. The SEI's Software Measurement and Analysis site at <http://www.sei.cmu.edu/sema/> contains publications, presentations, and other useful resources; the 2004 summary data about assessments is <http://www.sei.cmu.edu/sema/pdf/CMMI/2004aug.pdf> (last visited 3 January 2005). Some critics suggest that the CMM is easily scammed by software outsourcing firms who claim higher ratings than they deserve to get business. We won't get caught up in that debate because we don't envision using the CMM for that purpose. See Christopher Koch, "Bursting the CMM hype," CIO, 1 March 2004, at <http://www.cio.com/archive/030104/cmm.html> (last visited 28 December 2004).

5. The Sarbanes-Oxley Act of 2002 requires certain corporate officers of public firms in the United States to certify that they are responsible for establishing, maintaining, and regularly evaluating the effectiveness of internal controls, as well as any disclosures, information in reports and any significant changes or other factors that could affect internal controls. A useful resource about the act is <http://www.sarbanes-oxley.com/section.php> (last visited 30 December 2004).

6. See, for example, the sophisticated processes and technology of the Federal Enterprise Architecture's Center for Component Reuse at <https://www.core.gov/> (last visited 28 December 2004).

7. In some situations where staffing levels are fixed, an alternative justification to cost savings is the benefit of being able to handle more business with the same staff. But if the enterprise is a nonprofit or governmental entity, this may not be a desirable or feasible goal.

8. Our treatment of return on investment and business cases in this paragraph and the remainder of section 16.3 is simplified and mostly qualitative. For a more rigorous treatment of ROI involving net present value calculations, see Gunjan Samtani and Dimple Sadhwani, "Web Services Return on Investment," WEB SERVICES ARCHITECT, 4 August 2002, at <http://www.webservicesarchitect.com/content/articles/samtani07print.asp> (last visited 2 January 2005). The classic and comprehensive introduction is Stephen Ross, Randolph Westerfield, and Jeffrey Jaffe, CORPORATE FINANCE, (McGraw-Hill, 2005).

9. Larry Downes, THE STRATEGY MACHINE (Harper Collins, 2002).

10. See Todd Batz, "Portfolio management: How to do it right," CIO, 1 May 2003, at <http://www.cio.com/archive/050103/portfolio.html> (last visited 2 January 2005).

11. Some of these come from Commerce One, How the Business Internet Can Save Your Company Millions. (2002).

12. Fred Metzgen, KILLING THE PAPER DRAGON (Butterworth-Heinemann, 1990), p.111.

13. CommerceOne, *ibid.*, p. 5.

14. John Edwards, "I'm not dead yet," LINE56, May 2001, at <http://www.LINE56.com/articles/default.asp?NewsID=2563> (last visited 31 December 2004).
15. Commerce One, *ibid.* p. 2. See also Demir Barlas, "E-Procurement: Steady Value," LINE 56, 4 January 2005 at <http://www.LINE56.com/articles/default.asp?ArticleID=6246> (last visited 11 January 2005).
16. Kenneth Sall, "How the US Government is Using XML: One Year Later," IDEALLIANCE XML 2004 CONFERENCE, November 2004, at <http://www.idealliance.org/proceedings/xml04/papers/150/How-US-Govt-Using-XML-1YL.html> (last visited 2 January 2005). This paper and CORE.GOV (note 26) are excellent entry points to numerous case studies and e-government initiatives.
17. Mikkel Hippe Brun, "The Danish approach to standardisation of public sector XML-interfaces and localisation of international standards," OASIS ADOPTION FORUM PROCEEDINGS, 6 October 2004, at http://www.oasis-open.org/events/adoption_forum/slides/brun.ppt (last visited 31 December 2004).
18. Australian Department of Foreign Affairs and Trade, PAPERLESS TRADING: BENEFITS TO APEC (2001), at http://www.dfat.gov.au/publications/paperless/paperless_trading.pdf (last visited 28 December 2004).
19. Polarlake, "Standards-based integration in financial services," April 2004, at http://www.polarlake.com/en/assets/whitepapers/financial_services.pdf (last visited 2 January 2005).
20. Kazumasa Takeuchi, "Supply chain management (SCM) and traceability," ELECTRONIC COMMERCE PROMOTION COUNCIL OF JAPAN (ECOM) REGIONAL WORKSHOP, 4 September 2004, at <http://www.adbi.org/files/2004.09.01.cpp.supply.chain.management.pdf> (last visited 6 January 2005).
21. Hong Kong University's Center for E-Commerce Infrastructure Development. Notifiable Infectious Disease Information Messaging System (NIDIMS) Project, June 2004, at http://www.cccid.hku.hk/newsletter/VOL3Jun2004.php?#Notifiable_Infectious (last visited 6 January 2005).
22. Metzgen, *ibid.*, p.17.
23. Metzgen, *ibid.*
24. CommerceOne, *ibid.*, p. 9.
25. Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson (Eds), TO ERR IS HUMAN: BUILDING A SAFER HEALTH SYSTEM (National Academy Press, 2000).
26. Rhonda Rundle, "WellPoint to pay \$30 million for doctors' computers," WALL STREET JOURNAL, 15 January 2004.

27. Most modern container terminals have developed systems for electronic tracking of shipments. For an example the 1-Stop service operating in Australia provides a common platform for industry to report and receive information to and from stevedoring companies. See <http://www.1-stop.biz/aboutus.php> (last visited 2 January 2005).
28. Jon Hilsenrath, "Beyond surging productivity: The service sector delivers," WALL STREET JOURNAL, 7 November 2003.
29. Australian Department of Foreign Affairs and Trade, *ibid.*, p.19.
30. For an explanation of how OpenTable works, see <http://www.opentable.com/info/restindex.asp> (last visited 2 January 2005).
31. Lynda Brooks, "ROI reality: How publishers are Realizing true return on their XML investment," IDEALLIANCE XML 2003 CONFERENCE, at http://www.idealliance.org/papers/dx_xml03/papers/03-02-03/03-02-03.pdf (last visited 2 January 2005). For more discussion of the business issues in electronic publishing and content management, see JoAnn Hackos, CONTENT MANAGEMETN FOR DYNAMIC WEB DELIVERY (Wiley, 2002), and Peter Brown, INFORMATION ARCHITECTURE WITH XML (Wiley, 2003). And while its name might make it seem dated, a very crisp discussion of the business case for XML publishing is Pamela Gennusa, "Using SGML: The pain/gain ratio," at <http://xml.coverpages.org/genmusaPain.html> (last visited 7 January 2005).
32. Among the classic works in software engineering about controlling costs through earlier defect removal are Barry Boehm and Philip Papaccio, "Understanding and controlling software costs," IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, 14 (October 1988): pp.1462-1477, and Tom Gilb, PRINCIPLES OF SOFTWARE ENGINEERING MANAGEMENT (Addison-Wesley, 1988). A more recent paper that discusses the benefits of model-based software development with UML and XML is Martin Soukop, "Model driven architecture: feasibility or fallacy," IDEALLIANCE XML 2004 CONFERENCE, November 2004, at http://www.idealliance.org/proceedings/xml04/papers/200/MDA_Feasibility.pdf (last visited 7 January 2005).
33. The last three groups also have a strategic partnership with the World Trade Organization to promote a free and fair global trading system. An introduction to ISO standards and its standards-making processes can be found at <http://www.iso.org/iso/en/aboutiso/introduction/index.html> (last visited 7 January 2005).
34. Sean McGrath and Fergal Murray, "Principles of e-government architecture," (Propylon White Paper, 7 July 2003). Available after registration at <http://www.propylon.com/> (last visited 7 January 2005).
35. For a careful and comprehensive discussion of intellectual property and standards with an extensive annotated bibliography, see "Patents and Open Standards" at <http://xml.coverpages.org/patents.html>, last modified 7 December 2004 (last visited 7 January 2005).

36. Ross Altman, "The standards maturity model and plug-and-play integration," *BUSINESS INTEGRATION JOURNAL*, November 2004, at <http://www.bijonline.com/PDF/Altman%20Nov.pdf> (last visited 7 January 2005).
37. Henry Chesbrough and David Teece, "Organizing for innovation: When is virtual virtuous?" *HARVARD BUSINESS REVIEW*, August 2002.
38. Julian Bajkowski, "Customs cargo system delayed again," *COMPUTERWORLD*, 20 October 2003, at <http://www.computerworld.com.au/pp.php?id=957631137&fp=16&fpid=0>; Chris Jenkins, "Customs busted in \$100m overrun," *THE AUSTRALIAN*, 11 November 2003, at <http://www.cbfa.com.au/bulletin/volumeView.asp?VolumeId=29&ArticleId=233>; Julian Bajkowski, "Transport heavies choke on Customs system upgrade, ready or not," *COMPUTERWORLD*, 13 August 2004, at <http://www.computerworld.com.au/index.php/id;1318167007;relcomp;1> (all last visited 9 January 2005).
39. From the Australian Customs web site, at <http://www.customs.gov.au/site/page.cfm?u=4916> (last visited 9 January 2005).
40. The connection between the telecommunications network and nearly all homes and businesses is referred to as the local loop, or the last mile. This last mile is capital intensive, and has historically been constructed with copper phone lines. See <http://www.manymedia.com/futures/bells.html> (last visited 17 March 2005).
41. Da Vinci's sketch for his helicopter can be found at http://www.artist-biography.info/gallery/leonardo_da_vinci/27/. (last visited 7 January 2005).
42. Peter Murray, *THE SAGA OF THE SYDNEY OPERA HOUSE: THE DRAMATIC STORY OF THE DESIGN AND CONSTRUCTION OF THE ICON OF MODERN AUSTRALIA* (Routledge, 2003).

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Epilogue

1. In a previous draft of this chapter, we also included some examples of the first two cases based on 20th century changes to the names of academic departments and university fields of study, but some reviewers objected to them so you'll have to come up with your own negative examples or take our claim on faith.
2. IBM Global Services, "Service-oriented architecture and web services," at http://www-1.ibm.com/services/us/index.wss/it_services/its/a1002583 (last visited 2 March 2005). See also Ed Scannell, "IBM Delivers SOA Enablers," *INFOWORLD*, 21 April 2004, at http://www.infoworld.com/article/04/04/21/HNIBMsoas_1.html (last visited 2 March 2005). The quotations in this section come from the Scannell article.

3. With the exception of the brave students who've taken the Document Engineering course at the University of California, Berkeley taught by the first author since 2002. It is listed as Information Systems 243 in the current course catalog at <http://www.sims.berkeley.edu/academics/courses/is243/> (last visited 2 March 2005).