

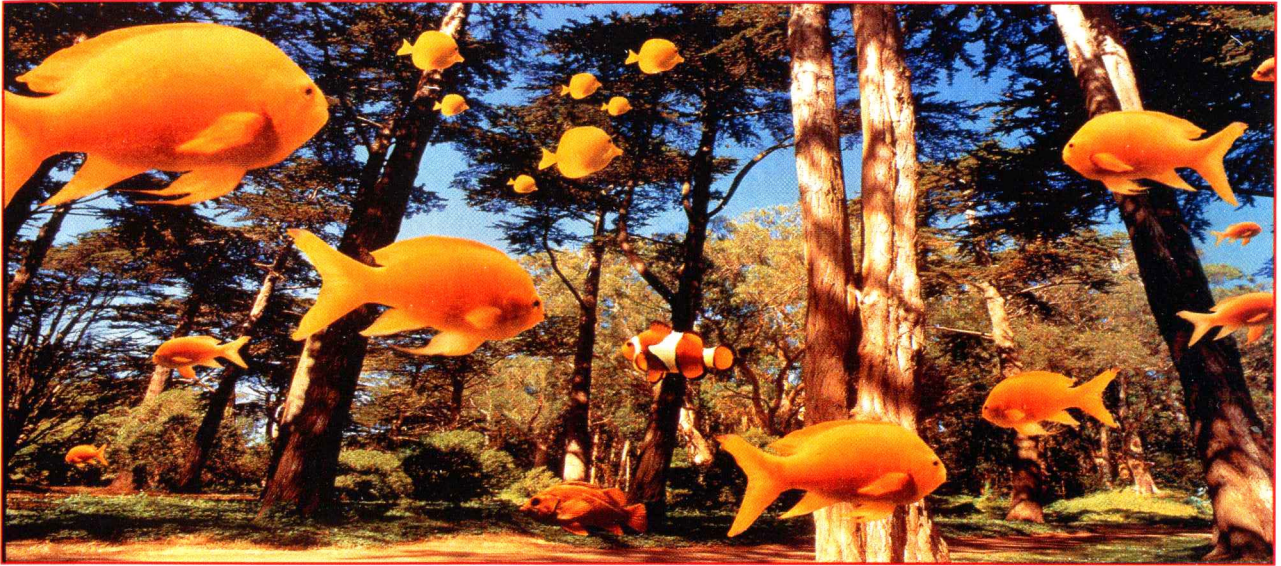


OPERATIONS MANAGEMENT

R. DAN REID ■ NADA R. SANDERS

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Operations Management



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Dedicated to all of our students

past, present, and future.
May the insights and
lessons learned from past
students enable all of us
to better travel through
the world of operations
management.

ABOUT THE AUTHORS

R. Dan Reid is Associate Professor of Operations Management at the Whittemore School of Business and Economics at the University of New Hampshire. He holds a Ph.D. in Operations Management from The Ohio State University, an M.B.A. from Angelo State University, and a B.A. in Business Management from the University of Maryland. During the past twenty years he has taught at The Ohio State University, Ohio University, Bowling Green State University, Otterbein College, and the University of New Hampshire.

Dr. Reid's research publications have appeared in numerous journals such as the *Production and Inventory Management Journal*, *Mid-American Journal of Business*, *Cornell Hotel and Restaurant Administration Quarterly*, *Hospitality Research and Education Journal*, *Target*, and the *OM Review*. His research interests include manufacturing planning and control systems, quality in services, purchasing, and supply chain management. He has worked for, or consulted with, organizations in the telecommunications, consumer electronics, defense, hospitality, and capital equipment industries. Dr. Reid has served as Program Chair and President of the Northeast Region of the Decision Sciences Institute (NEDSI) and as Associate Program Chair and Proceedings Editor of the First International DSI Conference, and held numerous positions within DSI. He has been the Program Chair and Chair of the Operations Management Division of the Academy of Management. Dr. Reid has also served as President of the Granite State Chapter of the American Production and Inventory Control Society. He has been a board member of the Operations Management Association and the Manchester Manufacturing Management Center. Dr. Reid is a Past Editor of the *OM Review*.

Dr. Reid has designed and taught courses for undergraduates, graduates, and executives on topics such as resource management, manufacturing management, introduction to operations management, purchasing management, and manufacturing planning and control systems.

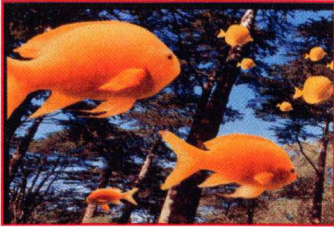


Nada R. Sanders is Professor of Operations Management at the Raj Soin College of Business at Wright State University. She holds a Ph.D. in Operations Management from The Ohio State University, an M.B.A. from The Ohio State University, and a B.S. degree in Mechanical Engineering from

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Dr. Sanders has extensive research experience and has published in numerous journals such as *Decision Sciences*, *Journal of Operations Management*, *Sloan Management Review*, *Omega*, *Interfaces*, *Journal of Behavioral Decision Making*, *Journal of Applied Business Research*, *Production & Inventory Management Journal*. She has authored chapters in books and encyclopedias such as the *Forecasting Principles Handbook* (Kluwer Academic Publishers), *Encyclopedia of Production and Manufacturing Management* (Kluwer Academic Publishers) and the *Encyclopedia of Electrical and Electronics Engineering* (John Wiley & Sons). Dr. Sanders has served as Vice President of Decision Sciences Institute (DSI), President of the Midwest Decision Sciences Institute, and has held numerous other positions within the Institute. In addition to DSI, Dr. Sanders is active in the Production Operations Management Society (POMS), APICS, INFORMS, Council of Logistics Management (CLM), and the International Institute of Forecasters (IIF). She has served on review boards and/or as a reviewer for numerous journals including *Decision Sciences*, *International Journal of Production Research*, *OM Review*, *Omega*, and others. In addition, Dr. Sanders has worked and/or consulted for companies in the telecommunications, pharmaceutical, steel, automotive, warehousing, retail, and publishing industries, and is frequently called upon to serve as an expert witness.

PREFACE



Something different is going on in the world of operations management. Rapid economic changes such as global competition, e-business, the Internet, and advances in technology have placed operations management in the limelight of business. Today companies are competing in a very different environment than they were only a few years ago, and operations management is the function through which companies can succeed in this competitive economic landscape.

Instead of being confined to one department, operations management concepts are far reaching, affecting every aspect of the organization. Whether if one's area of expertise is accounting, finance, human resources, information technology, management, marketing, or purchasing, students need to understand the critical impact operations management has on any business.

We each have over 20 years of teaching experience and understand the challenges inherent in teaching and taking the introductory OM course. The vast majority of students taking this course are not majoring in operations management. Rather, classes are typically composed of students from various business disciplines or students who are undecided about their major and have little knowledge of operations management. The challenge is not only to teach the foundation of the field, but also to help students understand the impact operations has on the business as a whole, and the close relationship of operations management with other business functions. We were motivated to write this book to help students understand operations management and to make it easier for faculty to teach the introductory operations management course. We have three major goals for this book:

GOALS OF THE BOOK ■

1. Provide a Solid Foundation in Operations Management

Our book is standard in terms of the concepts and techniques that are covered, but also covers emerging topics such as supply chain management, enterprise resource planning, and electronic data interchange. We give equal time to strategic and tactical decisions and provide coverage of both service and manufacturing organizations. We look closely at some of the unique challenges service organizations face in OM.

2. Demonstrate Cross Functional Relevance

While several excellent textbooks provide appropriate foundation coverage, we believe that few provide sufficient motivation for students. We are aware that a major teaching challenge in OM is that students aren't motivated to study OM because they don't

understand its relevance to their majors. We think the course textbook can greatly support the professor in this area; therefore, a chief goal of this book is to integrate coverage of why and how OM is integral to all organizations. Interfunctional coordination and decision making have become the norm in today's business environment. Throughout every chapter we discuss information flow between business functions and the role of each function in the organization.

3. Provide an Accessible and Engaging Learning Package

A good textbook is not just a repository of everything about the subject. In addition to providing relevance for business students, the third main goal of our textbook is to help students learn the material in an engaging and accessible way. Our textbook supports professors by providing the right amount of depth and useful pedagogy—with the ultimate goal of reducing lines during office hours.

FEATURES OF THE BOOK

We have developed our pedagogical features to implement and reinforce the goals discussed above and address the many challenges in this course.

Streamlined Presentation

We have streamlined the treatment and coverage of OM topics. Through our teaching experience we have found that many OM texts present material in a manner difficult to understand by students completely unfamiliar with the topic. Over the years we had been inundated with students who needed clarification on text material which was confusing and unclear. To meet students' needs we focused on presenting the basics of OM concepts with extensive use of practical and relevant business examples. We eliminated from the printed book coverage of topics less frequently covered at the introductory level, such as Linear Programming, the Transportation Method, and Simulation Analysis. However, the complete chapters of these topics are available on the CD provided in each textbook.

Links to Practice

Many OM texts have many boxes and sidebars, which make it difficult for students to understand what they need to know. Furthermore, the many examples frequently interrupt the flow of the text and make a chapter difficult to read and assimilate. We recognize the importance of including “real world” examples, but believe they should be integrated into the stream of the text instead of interrupting the text. Therefore, we

Consider how Lands' End uses technology in its business. Lands' End went on-line in 1995. The company sold only \$160 worth of gear the first month. Today, Lands' End sells over \$10 million per month on-line. The company has a live chat room that allows customers to ask questions about merchandise. It also offers a “shopping with a friend” service that allows a customer, his or her friend or friends, and a customer service representative to be linked together. However, Lands' End's “virtual model” highlights how far technology has advanced. A few strokes on the keyboard and the shopper is able to produce an on-screen model with his or her body measurements. Even though this virtual model is not perfect, over 1 million shoppers have built their own models at the Lands' End site.

LINKS TO PRACTICE
Lands' End, Inc.
www.landsend.com



have developed “embedded boxes” called *Links To Practice* which provide brief examples of specific companies in every chapter. Embedded by both content and design into the general text discussion, each provides a concise and relevant example without interrupting the flow of the text. The examples chosen range from large multinational organizations to small local businesses.

“OM Across the Organization” and “Cross Functional” Icons

Unique to this book is an end-of-chapter summary titled “OM Across the Organization” that highlights the relationship between OM and key business functions such as accounting, finance, human resources, information technology, management, marketing, and purchasing. This section is designed to help students understand the close relationship of operations management with other business functions and appreciate the critical impact OM has on other business



functions. In addition, a cross-functional icon is used throughout the text to highlight sections in the text where the relationships between OM and other key business functions are discussed.

Relevant Business Examples

Current textbooks typically do not use business examples students can relate to. The typical examples provided are those of large corporations such as General Motors, IBM, or Xerox. Primarily using these types of examples creates the impression for the students that this is a field that is either beyond their reach or irrelevant to their needs. We have found that students understand the concepts better when these concepts are also presented in a context that is smaller in scale, including more on small and medium-sized business examples. Our text also uses selected big business examples where appropriate.

Chapter Opening Vignettes and “OM Is Everywhere”

To help students intuitively understand the topic, each chapter begins with a description of a personal problem that can be solved using the concepts discussed in the chapter. Our objective is to attract the attention of the student by starting with a personal example they can relate to. We demonstrate that OM is not just about operating a plant or a business, but that it is relevant in everything that we do. An end-of-chapter section called “OM Is Everywhere” relates back to the chapter-opening vignette and describes how the chapter topic impacts the student’s personal life. It addresses the issue of why this is important even outside the business organization and helps summarize the concepts in the chapter.



OM ACROSS THE ORGANIZATION

Supply chain management changes the way companies do business. Consider how supply chain management affects different functional areas in the organization.

Accounting shares some of the benefits and responsibilities of supply chain management. As inventory levels decrease, customer service increases. Manufacturing is using its capacity more effectively. Accounting is exposed to the risks of information sharing and of developing partnerships. With information sharing comes the need for increased confidentiality.

Marketing benefits by improved customer service levels achieved by POS data collection. A shared database gives marketing current demand trends and eliminates demand filtering between levels of the supply chain. POS data also facilitates quick customer response time.

Information systems are critical for supply chain management. Information systems provide the

means for collecting relevant demand data, developing a common database, and providing a means for transmitting order information. Information systems enable information sharing through POS data and EDI.

Purchasing has an elevated role in supply chain management within organizations. Purchasing facilitates and manages a strong supplier base through partnering.

Operations uses timely demand information to effectively plan production schedules and use its capacity. Operations responds to customer demand data, improving customer service.

Who is responsible for supply chain management within an organization? In a manufacturing company this is usually the materials manager, who is familiar with external suppliers, internal functions, and external distributors. The person who does supply chain management must see the big picture so that local priorities do not overshadow global priorities.



Buying a product used to mean getting dressed, leaving home, and shopping at stores or malls until you found what you wanted. Today, most of us can go online 24 hours a day, 7 days a week and buy just about anything over the Internet. You can shop while sitting at your computer and never leave home. You can order food from a supermarket or a restaurant online, or buy clothing and household goods. You can buy books, videos, CDs—the Internet has revolutionized the way we do business.

In this chapter we look at supply chains: the connected links of external suppliers, internal processes, and external distributors. We also learn how advances in information technology help companies coordinate their supply chains.

We will begin with the effect of supply chain management on organizations.

Integrated Technology Perspective

E-commerce and the Internet are transforming the business environment, and we integrate these concepts in every chapter. We discuss a range of topics from enterprise resource planning (ERP) and electronic data interchange (EDI) to quality issues of buying goods on-line.

Pedagogy

Before Studying This Chapter Before the start of each chapter students are provided with a short statement of what they need to either know or review from previous material, referring students to specific topic and page information. This enables the student to review previous material necessary to understand the topic being covered.

Before studying this chapter you should know or, if necessary, review

1. The implications of competitive priorities Chapter 2, pages 28–32.
2. Product design considerations Chapter 3, pages 48–52.
3. Process selection considerations Chapter 3, pages 52–58.

Before You Go On Sections strategically placed within every chapter summarize key material the student should know before continuing. Often the material in chapters can be overwhelming. We felt that breaking up the chapter with a brief summary of key material is highly beneficial in aiding learning and comprehension. Finally, key terms and concepts are highlighted in boldface when they are first explained in the text and are listed at the end of the chapter with page references.

Before You Go On

Make sure you understand the structure of the supply chain, the bullwhip effect, and some of the challenges to supply chain management in today's marketplace: (1) A supply chain consists of external suppliers, internal functions of the company, and external distributors. (2) The bullwhip effect causes erratic replenishment orders placed on different levels in the supply chain that have no apparent link to final product demand. (3) Customers demand more value from their suppliers. Added value to the customer can take the form of higher quality, quicker response, or lower prices. Consumer expectations, globalization, information technology, and environmental needs can affect the future of supply chain management.

Solved Problems Numerous solved problems are provided complete with step by step explanations to ensure students understand the process and why the problem is solved in a particular way. Where appropriate we provide a series of steps for problem solving and offer *Problem Solving Tips*.

SOLVED PROBLEMS

■ Solved Problem 1

Jack Smith, owner of Jack's Auto Sales, is deciding whether his company should process its own auto loan applications or outsource the process to Loans Etc. If Jack processes the auto loan applications internally, he faces an annual fixed cost of \$2500 for membership fees, allowing him access to the TopNotch credit company, and a variable cost of \$25 each time he processes a loan application. Loans Etc. will process the loans for \$35 per application but Jack must lease equipment from Loans Etc. at a fixed annual cost of

\$1000. Jack estimates processing 125 loan applications per year. What do you think Jack should do?

Solution

First, set the total costs of each alternative equal to each other, or $\$1000 + (\$35 * Q) = \$2500 + (\$25 * Q)$. Solving for Q, we have $10Q = \$1500$, or $Q = 150$ loan applications. Since the costs are equal at 150 loan applications and Jack expects to need 125 applications processed, he is better off outsourcing the loan applications to Loans Etc.

Cases Each chapter ends with a case that reinforces the issues and topics discussed in the chapter. The cases can provide the basis for group discussion or can be assigned as individual exercises for the student. Many cases conclude with a list of questions for students to answer.

In addition, each chapter offers a unique interactive learning exercise titled *Internet Challenge* where students are provided with a short case and given specific Internet assignments.

Interactive Learning Using the Text, the Interactive CD, and the Web Site

We have created a number of interactive learning activities for students which will help them learn the material in a dynamic and interesting way. At the end of each chapter, there is a list of activities which are available on the CD and the web site. Students can work on these activities on their own, and instructors have the flexibility to assign material for individual or group study. The activities include:

- **Interactive Simulations**
- **NBR Videos**
- **Interactive Spreadsheets**
- **Company Tours**
- **Internet Challenge**
- **Virtual Company Consulting Case**
- **Additional Web Resources**



INTERACTIVE LEARNING

Enhance and test your knowledge of Chapter 4 using the interactive CD.

1. Video *Cisco Systems, Inc.*
2. Spreadsheet *The Bullwhip Effect*
3. Company Tour
Finkel & Sons, Inc.
Reynolds Metal Company
4. Additional Web Resources
nummi, www.nummi.com
IBM, http://hours54.clearlake.ibm.com



Visit our dynamic Web site, www.wiley.com/college/reid, for more cases, Web links, and additional information.

5. INTERNET CHALLENGE *Global Shopping*

Since the Internet provides access to products around the world, your challenge involves some global shopping. This year you have been given a budget of \$10,000 to furnish and decorate your off-campus apartment. You have chosen a global theme. Your job is to find items from as many different parts of the world as you can to use in your apartment. You can spend up to \$10,000 but you cannot exceed your budget. Do not forget that shipping must be included

not need to worry about major appliances (computer, television, stereo, oven, refrigerator, dishwasher, etc.) but you do need everything else. Since you plan to host a major party in your new apartment, everything you buy must be delivered within six weeks.

- (b) Provide a list of all of the items you would buy, the cost of each item, and the total money spent. Organize your list by the room the item is intended for. Be sure

ORGANIZATION OF THE BOOK

We have arranged the topics in the book in progressive order from strategic to tactical. Early in the book we cover operations topics that require a strategic perspective and a cultural change within the organization, such as supply chain management, total quality management, and just-in-time systems. Progressively we move to more tactical issues, such as work management, inventory management, and scheduling concerns. We recognize that most faculty will select the chapters relevant to their needs. To make it easier for students and faculty each chapter can stand alone. Any specific knowledge needed for a chapter is summarized immediately prior to the chapter, with specific topic and page references for the student to review.

INSTRUCTIONAL SUPPORT PACKAGE

Our supporting material has been designed to make learning OM easier for students and teaching OM easier for faculty.

Instructor Resources

1. The Instructor's Resource CD A comprehensive resource guide designed to assist professors in preparing lectures and assignments. The resource guide provides:

- **Instructor's Manual:** Includes a suggested course outline, teaching tips and strategies, war stories, answers to all end-of-chapter material, brief description of the additional resources in the Interactive Learning box, additional in-class exercises, and tips on integrating the Theory of Constraints.

- **Solutions Manual:** A complete set of detailed solutions is provided for all problems.
- **Video Guide:** A guide to help instructors use the NBR videos includes a brief description of each video clip, additional discussion questions, and suggested answers to all the discussion questions.
- **Test Bank:** A comprehensive Test Bank comprised of approximately 1700 questions that consists of multiple choice, true-false, essay questions, and open-ended problems for each chapter. The Test Bank is also available in a computerized version that allows instructors to customize their exams.
- **PowerPoint Slides:** PowerPoint Slides are available for use in class. Full-color slides highlight key figures from the text as well as many additional lecture outlines, concepts, and diagrams. Together, these provide a versatile opportunity to add high-quality visual support to lectures.



2. Nightly Business Report Video The comprehensive Video package offers video selections from the highly respected business news program, *Nightly Business Report (NBR)*. These video clips tie directly to the theme of operations management and bring to life many of the examples used in the text.

3. eGrade: eGrade is a web-based student quizzing program that enhances academic productivity by providing immediate scoring and feedback. For each chapter of the text, students can test their knowledge with these interactive quizzes that give hints for solving the problem. eGrade quizzes contain a variety of problem types, and specialize in quantitative problems. The quiz questions are randomized so that students can take the quiz multiple times.

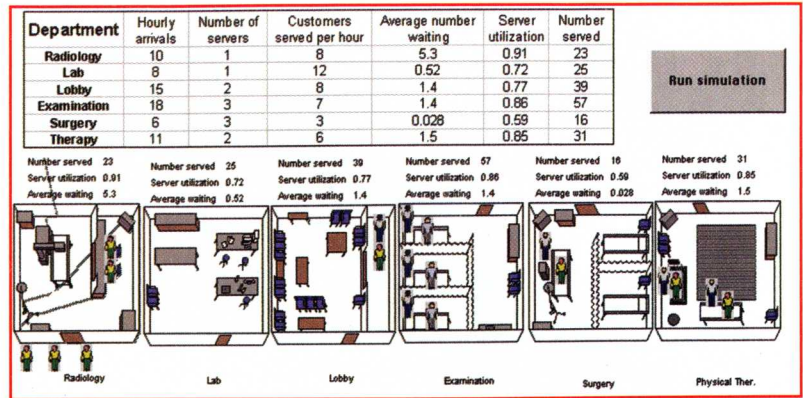
4. Student Resource CD-ROM: Included in each copy of the book, this CD-ROM includes various resources including selected video cases, simulations, and Excel spreadsheets, for personal student use and study.

5. Wiley Business Extra and Xanedu: The Business Extra Program, a partnership between Wiley and the Dow Jones Company, offers an exciting new way to extend your textbook beyond the walls of the classroom. The Business Extra Program includes a special password to Wiley's *Business Extra* web site, through which your students get instant access to a wealth of current articles, as well as a special offer for the *Wall Street Journal* and *wsj.com*. The *Business Extra Password Card* can be packaged with the text. Another way to extend the boundaries of the classroom is by combining Xanedu with the textbook. The Xanedu web site includes millions of articles from thousands of publications. Wiley's partnership with Xanedu allows us to offer a portion of these vast resources to students at a minimal cost. Students receive a password to access a special portion of the Reid & Sanders web site that contains links to articles related to a variety of operations management topics.

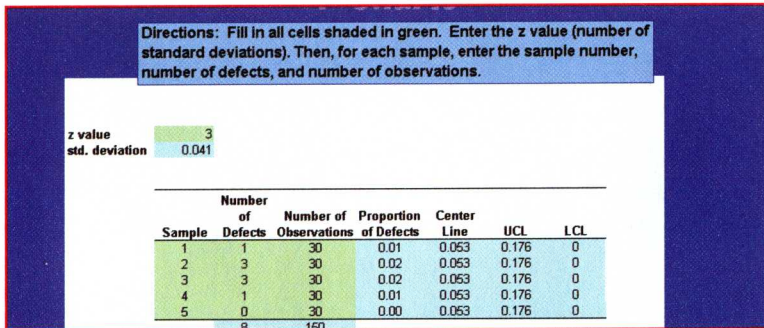
Student Resources

Student Resource CD Included in each copy of the book, the CD contains the following resources:

- **NBR Videos:** Students will have the ability to view selected Nightly Business Report videos before or after class. They can view the videos and link to video overviews and questions on the text web site. The questions prompt students to think critically about the issues described in the video.
- **Simulations:** Simulations have been created using Extend LT to illustrate the functioning of intermittent (job shop) and continuous (flow shop) operations that students typically have difficulty visualizing. Students can not only see the flow (line versus jumbled), speed of production, and product variety; they can also change numerous variables in the operation (e.g. number of products produced, layout arrangement) and directly view the consequences. Using Extend LT, students can create their own simulations.



- **Excel Spreadsheets:** Templates are provided so that students can model and solve problems presented in the textbook. Step-by-step directions are provided. Directions prompt students as they work through each spreadsheet. Expected outcomes and questions are also given.



Operations Management Web site

An extensive web site has been developed in support of *Operations Management*. The site is available at <http://www.wiley.com/college/reid>, and offers a range of information for both the instructor and the student. The web site includes the following resources:

1. Instructor Web Site

- **Company Tours:** Web links to the tours of various companies. Each tour includes a brief description of the company and discussion questions for students to consider after viewing the tour.
- **Current Articles:** Current articles are provided to aid instructor in linking lectures to business practice.

- **Updates and Corrections:** Any corrections and updates to the text will be communicated to the instructor via this web site.
- **Additional Cases:** Additional cases for use in class.
- **Additional Problems:** Additional solved problems for use in class.
- **Excel Data Sets:** End-of-chapter problem data inserted into Excel spreadsheets to avoid errors from copying.

2. Student Web Site

- **Virtual Company Consulting Case:** A web-based company features an Intranet site for a simulated company. Students are “hired” as interns and are

Valley Memorial Hospital


[Home](#) [About the Hospital](#) [Departments](#) [Staff and Faculty](#)

Helicopter Service

About the Helicopter Service

The **Valley Memorial Helicopter Service** started in 1984 to meet the emergency transport demands of the entire region, including a large number of Native Americans served by the **Indian Health Service**.

VMHS has three helicopters. Each can take two stretcher patients plus an in-flight nurse and a copilot. The helicopters are Bell 222 UTs with a cruising speed of 230 miles an hour and a range of 500 miles. There is a two-patient capability with room for flight nurses or the attending physician to work. In addition, there is space for family members to travel with the patient. There are highly qualified, full-time hanger-based pilots, who, along with the flight nurses, are prepared for quick response, 24 hours a day. The nurses accompany patient's bedside to bedside, from referring to receiving facility. The VMH-based medical team supervises all transports. Each aircraft is hanger based, has a full-time maintenance crew, and is equipped with the latest emergency statewide radio/phone service.



asked to complete assignments that require them to use information from the online cases and Intranet site to develop recommended solutions. These exercises get the students into active, hands-on learning to complement the concepts discussed in the chapter.

- **Company Tours:** Web links to the plant tours of various companies along with a brief description of the tour and discussion questions for students to consider after viewing the tour.
- **Current Articles:** Articles discussing current events are provided by topic. Students can perform a search allowing them to research an OM topic of interest.
- **Web Links:** Direct links to related web sites are provided.
- **Updates:** Allows us to directly communicate changes in either the text or the field directly to the students.

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During the development of *Operations Management* we benefited greatly from the comments, suggestions, and evaluations from many of our colleagues who teach the OM course throughout North America. We would like to acknowledge the contributions made by the following individuals:

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