Planning, Design, and Construction of Health Care Facilities

Addressing Joint Commission and JCI Standards and Other Considerations—from Planning to Commissioning

Foreword by Charles H. Griffin, AIA, FACHA, EDAC

third edition

THE AMERICAN INSTITUTE OF ARCHITECTS
Academy of Architecture for Health

Planning, Design, and Construction of Health Care Facilities, Third Edition

About This Book

A health care facility's new or improved design establishes the basis for safe and effective care within that structure. Designing and executing a construction or renovation project requires resources, education, communication, and collaboration throughout the process. When patient and worker safety are at risk, the stakes for a successful project are even higher.

This third edition of *Planning, Design, and Construction of Health Care Facilities*—developed in conjunction with the American Institute of Architects Academy of Architecture for Health (AIA-AAH)—presents a comprehensive guide for health care organizations around the world looking to build new facilities or update current structures. This revised edition offers the following:

- New and expanded information on the topics of process improvement, risk assessment, health care commissioning, designing for safety and reliability, alternate facility delivery models, and much more
- Case studies that highlight the application of key strategies

Health care organization leaders, their facilities managers, and the architects, designers, and construction firms they work with will all benefit from *Planning, Design, and Construction of Health Care Facilities,* Third Edition. In fact, the AIA-AAH recommends this book as preparation for becoming a certificate holder in the American College of Healthcare Architects (ACHA). A board-certified health care architect with ACHA credentials is the only specialized certification recognized by the AIA.

About Joint Commission Resources

The mission of Joint Commission Resources (JCR) is to continuously improve the safety and quality of health care in the United States and in the international community through the provision of education, publications, consultation, and evaluation services.

About American Institute of Architects Academy of Architecture for Health

The mission of the American Institute of Architects Academy of Architecture for Health (AIA-AAH) is to improve both the quality of health care design and the design of healthy communities by developing, documenting, and disseminating knowledge; educating design practitioners and other related constituencies; advancing the practice of architecture; and affiliating and advocating with others that share these priorities.

Joint Commission Resources

ISBN: 978-1-59940-888-0
Product code: PDC15

Joint Commission Resources (JCR), an affiliate of The Joint Commission, is the official publisher and educator of The Joint Commission.

1515 West 22nd Street, Suite 1300W, Oak Brook, IL 60523-2082 U.S.A.
www.jcrinc.com

ISBN: 978-1-59940-888-0
90000
9 781599 408880

Planning, Design, and Construction of Health Care Facilities

Addressing Joint Commission and JCI Standards and Other Considerations—from Planning to Commissioning

Foreword by Charles H. Griffin, AIA, FACHA, EDAC

The Joint Commission

Joint Commission Resources

Joint Commission International

third edition

THE AMERICAN INSTITUTE OF ARCHITECTS
Academy of Architecture for Health

Content Development Manager: Lisa K. Abel
Senior Project Manager: Allison Reese
Associate Director, Publications: Helen M. Fry, MA
Associate Director, Production and Meeting Support: Johanna Harris
Executive Director: Catherine Chopp Hinckley, MA, PhD
Joint Commission/JCR Reviewers: Yvonne Burdick, Jeff Conway, John Fishbeck, Anne Guglielmo, Claudia Jorgenson, Jim Kendig, George Mills, Kathy Reno

Joint Commission Resources Mission

The mission of Joint Commission Resources (JCR) is to continuously improve the safety and quality of health care in the United States and in the international community through the provision of education, publications, consultation, and evaluation services.

Joint Commission Resources educational programs and publications support, but are separate from, the accreditation activities of The Joint Commission. Attendees at Joint Commission Resources educational programs and purchasers of Joint Commission Resources publications receive no special consideration or treatment in, or confidential information about, the accreditation process.

The inclusion of an organization name, product, or service in a Joint Commission Resources publication should not be construed as an endorsement of such organization, product, or service, nor is failure to include an organization name, product, or service to be construed as disapproval.

This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. Every attempt has been made to ensure accuracy at the time of publication; however, please note that laws, regulations, and standards are subject to change. Please also note that some of the examples in this publication are specific to the laws and regulations of the locality of the facility. The information and examples in this publication are provided with the understanding that the publisher is not engaged in providing medical, legal, or other professional advice. If any such assistance is desired, the services of a competent professional person should be sought.

Joint Commission Resources, Inc. (JCR), a not-for-profit affiliate of The Joint Commission, has been designated by The Joint Commission to publish publications and multimedia products. JCR reproduces and distributes these materials under license from The Joint Commission.

Printed in the USA 5 4 3 2 1

ISBN: 978-1-59940-889-7
Library of Congress Control Number: 2015931107

table of contents

table of contents

foreword

Human health and well-being are intrinsically linked to the built environment. This linkage is where the principles guiding the American Institute of Architects Academy of Architecture for Health (AIA-AAH) and The Joint Commission come together. Each organization aims to improve the lives and the outcomes of patients and the public:

- The Academy believes in improving the quality of health care through design.
- The Joint Commission strives to improve health care by promoting safe and effective standards of care.

We believe that this book unifies our missions by guiding health care institutions through one of the most critical and costly activities—that of design and construction of a new or renovated facility. Each design decision for health care facilities impacts the care and well-being of users for many years to come.

Building for Health

Building design can help us live better and longer lives rather than contribute to current lifestyles that may not promote a healthy and motivational activity, thereby indirectly lessening our opportunities to be more active and healthy by design. Such an approach takes on even greater significance for health care facilities such as hospitals and clinics. For example, a safely lit central garden space centrally located in a hospital could encourage ambulatory patients, visitors, and hospital staff to take short walks in a calming space rather than navigate through internal corridors or sit in a windowless lounge or break room.

Impact of Health Care Trends

Living longer and healthier through better building design is a laudable approach, but it may not always be an affordable one. In recent years, the health care market in the United States has been wrestling with cost containment due to annual health care costs that, until recently, have far exceeded the consumer price index. This has resulted in health care costs escalating to more than 17% of the gross national product, per the World Bank, double that of any other developed country. At this rate, the cost of health care in the United States is not sustainable. In addition, the market is redefining itself following passage of the Patient Protection and Affordable Care Act (ACA) legislation of March 2010. The ACA, while increasing the number of insured patients, is also reducing the level of reimbursements provided to hospitals and providers; this further exacerbates the pressure to reduce the costs of providing care. These developments have expressed themselves in several trends in health care that have had strong impacts on design and construction, such as those described here.

Lower-Cost Environments

Providing care has shifted its emphasis to the least complex and lowest-cost environment—from the acute care hospital to the ambulatory clinic, and from the clinic to the home. This has resulted in a significant increase in the design and construction of ambulatory and intermediate-care facilities, which has shifted funds away from hospital construction.

Lean Methodologies

Health care institutions are using Lean methods to reduce waste and improve the quality of the patient and staff experience, thereby improving quality and helping to reduce costs (Lean methodology is a set of principles and practices for continuous process improvement by elimination of waste). Institutions such as Seattle Children's Hospital and Virginia Mason Medical Center borrowed from Lean manufacturing strategies to incorporate continuous process improvement and patient-centered care for their newly designed facilities. It is critical for architects to be engaged in process improvement at an early stage of design to avoid rework that could result in incorporating old inefficient processes into the new design.

Collaborative Teams and Spaces

Integrated clinical team delivery allows each activity to be performed at the lowest cost possible while still providing appropriate patient care. This frees each professional to perform at his or her highest skill level. Such collaborations have a direct impact on staff spaces in terms of both their openness and their relation to patient spaces.

Mobile Technologies

The use of mobile devices that serve as health tracking, diagnosis, and medical tools is still in its infancy. However, these devices may significantly shift health care provision to a range of locations beyond the hospital or clinic. Such shifts would change building utilization patterns in ways that are difficult to anticipate. These trends generate uncertainty as to how and where health care will be delivered in the future. The uncertainty leads to greater emphasis on the flexibility and adaptability of new and renovated facilities.

Impact of Design and Construction Trends

At the same time, there are similar trends evolving in the design and construction fields. These are described here and will be elaborated upon in the book.

Evidence-Based Design (EBD)

Evidence-based design (EBD) is a decision-making approach that provides research-backed information for decisions made during the design process. This may lead to shorter hospital stays due to improvements such as daylight in patient rooms. It may result in a reduction of medication errors as well, thanks to features such as appropriately sized and better lit medication rooms located away from distractions. (See DESIGN FOCUS: Designing for Safety and Reliability.)

Building Information Modeling (BIM)

Building information modeling (BIM) has replaced traditional drafting of plans and details. Using computer technology, BIM entails building a true-to-life three-dimensional model of the planned building, allowing more coordination of all disciplines prior to the construction phase. More elements may be accurately fabricated in a shop and brought to the field for quick assembly. Both design and construction teams use this method, resulting in a more collaborative effort, a safer construction environment, and the prospect of less costly changes during construction. (See Chapter 2.)

Integrated Project Deliver (IPD)

Integrated project delivery (IPD) and similar procurement methods are new means of collaboration between the design and construction teams. IPD is a joint contract between the owner, the architect, and the contractor that has them all share in the risks and the rewards (in different proportions) of the profits or savings. Similarly, there has been an increase in the use of traditional design-built and public-private partnership contracts. Either of these methods can serve to shorten the design and construction period and provide potential cost savings.

There is greater integration in the design/construction process than we have seen in recent decades. Such integration calls for radical changes in the way design and construction are procured and in the composition of their teams and contracting methods. (See PLANNING FOCUS: Alternative Facility Delivery Models.)

Education

We at the AIA are committed to educating our peers and collaborators on the impact these changes will bring to our practices. An example of a health care architect's advanced professional development is obtaining certification from the American College of Healthcare Architects (ACHA). This book is part of recommended reading in obtaining that certification. Joint Commission Resources (JCR) is making a similar educational effort with this book. We applaud them for their efforts. We are excited to participate in this endeavor, and we look forward to working together on projects that may result from it.

Special Thanks

A special thanks goes to the AAH editorial committee for its help and leadership in working with JCR in preparing this book, including the following individuals:

- R. David Frum, AIA, ACHA, Committee Chair and Board Member (2011–2014)
- Roger Call, AIA, ACHA, LEED AP, Board President (2009–2014)
- Orlando T. Maione, FAIA, FACHA, NCARB, Board Member (2011–2014)

Charles H. Griffin, AIA, FACHA, EDAC, Board President (2014), American Institute of Architects, Academy of Architecture for Health

introduction

The health care landscape has changed significantly since the last edition of *Planning, Design, and Construction of Health Care Facilities* in 2009, and the reported construction boom under way is just one aspect of the industry reflecting that. According to figures reported by major health care architecture firms in 2014, the number of signed contracts and their total dollar value are both higher than in 2012.[1]

One trend spurring this increase in health care development both in the United States and internationally is based on an evolution of consumer health care needs. The US Census Bureau has projected massive growth in the population of those aged 85 and over, while the World Health Organization (WHO) has reported that the average life expectancy globally continues to increase. A larger population living longer means that health care organizations must prepare for an influx of patients.

This is just one example of the increasing need for more and more efficient health care facilities worldwide, and those facilities are obliged to offer safe care in a safe physical environment.

Readers of This Book

This book is aimed at readers who may have differing backgrounds, but who must come together and work collaboratively on a health care facility construction or renovation project. These readers may be from health care organizations (clinical and executive leaders, construction supervisors, accreditation professionals, facilities directors, safety officers), architecture and design firms, and construction firms. Having a common understanding of the phases and issues involved in health care facility projects, as outlined in this book, will help to ensure a smoother process and a better outcome.

Purpose of This Book

This newly updated third edition of *Planning, Design, and Construction of Health Care Facilities* serves as an overview of the planning, design, and construction phases of a new or renovated health care facility, as well as the commissioning (move-in) phase—historically given less than proper attention. The primary intent is not only to define and explore each of these phases, but to also examine them, where possible, through the lens of The Joint Commission and Joint Commission International (JCI) standards, which make safety a top priority. By working with the American Institute of Architects Academy of Architecture for Health (AIA-AAH), we can ensure that this new edition meets the needs of the architects and designers in the field who are working with accredited health care organizations to upgrade or build new facilities.

Most of the concepts discussed in this publication are applicable to health care facilities throughout the world, despite the many variations within countries and among regions. That helps make this one-of-a-kind book valuable on both a domestic and an international level for architects, designers, and planners, as well as for health care leaders (including clinical leaders), administrators, and facility directors. It is a comprehensive guide for health care organizations looking to build new facilities or update their current ones.

Specifically, readers can use this book to gain a better understanding of the following:

- ***Up-front issues for planning:*** Issues to consider before building or renovating health care facilities, including information that allows readers to make an effective, efficient plan at the outset. This saves time and money by moving the construction process from concept to completion more quickly and economically.
- ***Joint Commission and JCI standards:*** The current Joint Commission and JCI standards related to the planning,

design, and construction of health care facilities. Knowing the standards and the concepts that guide the standards gives organizations a basis for sound decision making that meets accreditation requirements and supports maximum quality and patient safety.*

- ***Community needs via data analysis:*** The importance of comprehensive data collection and analysis to align the strategic plan, master plan, and architectural plan. The key benefit to this approach is a project plan that addresses the needs of the community and establishes the goals of the organization to meet those needs.
- ***Continuous process improvement:*** The critical early role of process improvement and its use as an iterative activity throughout the project—first for design, then for process alignment with the design.
- ***Collaborative design:*** How to take building design from concept to reality, which requires the ability to make adjustments within the parameters of the overall plan and budget. This also requires all parties involved—leadership, staff, architects, construction workers, and others—to have a clear understanding of the plan and implementation to avoid unnecessary distractions, delays, and regulatory barriers.
- ***Specialty-area design:*** Special considerations for the design of laboratories, pharmacies, and hybrid operating rooms. This ensures that patient and staff safety are paramount when planning functional areas where very small mistakes can make the difference between providing safe care and negatively impacting patient, visitor, and staff safety.
- ***The critical role of commissioning:*** The importance of commissioning both the systems of the building and clinical processes. Properly test driving the equipment and simulating processes through realistic scenarios (starting in the design phase) while modifications may still be made has short-term and long-term benefits for the organization.

Content and Organization of This Book

This edition provides readers with information and strategies to help them succeed in their efforts to plan, design, construct, and safely occupy new or renovated health care facilities. The scope of this book does not allow for detailed examination of every aspect of that lengthy and complex process and how to meet all local and national standards worldwide. However, it does provide guidelines and strategic linkages that organizations can use to plan and implement safe health care design in accordance with Joint Commission and JCI standards.

Chapters

The chapters in this book are organized to follow the typical process of a health care facilities construction project: planning, designing, constructing, and commissioning and the stages within those phases.

Chapter 1: The Planning Phase

This first chapter covers the specific aspects of the planning phase, the first phase of a health care facility construction project, including the importance of strategic planning on master facility planning and predesign (programming), and other important considerations within the planning phase, such as team selection, data collection, and budgeting.

Chapter 2: The Design Phase

This chapter focuses on key stages of the design phase that constitute the framework for the building process. For most projects, the stages of predesign, schematic design, design development, and construction document preparation are all fundamental to a well-designed and functional facility.

Chapter 3: The Construction Phase

This chapter discusses the stages of the construction phase that flow from the design phase and how to manage the subsequent increase in risk during construction through various types of risk assessments, interim life safety measures, and other actions.

Chapter 4: The Commissioning Phase

The final chapter addresses the commissioning/occupancy phase, including preparation for and activities needed to operate safely in the new space. An overview of both system/facility and clinical operations commissioning is provided, along with a discussion of transition and move-in activities.

* Standards referenced in this book are current as of this book's publication and are subject to change. For current Joint Commission or JCI standards, please consult the most recently published accreditation manual appropriate for your health care setting.

FOCUS Features

Before and after the chapters are special FOCUS features, some chapter length, that cover issues related to the various phases of the construction project process.

FOUNDATIONS: Standards and Regulations

This feature focuses on the role and importance of Joint Commission and JCI standards in the development of health care facilities, including how those apply to the construction project process. It also explains the Facility Guidelines Institute (FGI) *Guidelines* and other applicable regulations to the process.

PLANNING FOCUS: RPI and Change Management

Robust Process Improvement® (RPI), a process improvement method used by The Joint Commission, is introduced. The change management process that forms a part of this method is outlined with suggestions for applying it during a construction project. Note that the acronym RPI is also used extensively in Lean process improvement as Rapid Process Improvement, short studies of a limited-scope process.

PLANNING FOCUS: Alternative Facility Delivery Models

Four different alternative facility deliver models are summarized in this feature.

PLANNING FOCUS: Design Outcome Plan™

The Design Outcome Plan, created by the Safe Health Design Service℠ of JCR for use on construction and renovation projects, is explained. A sample plan is provided as well.

PLANNING FOCUS: Value Engineering

This feature describes how this approach can be used for management of costs during a health care facility construction or renovation project.

DESIGN FOCUS: Forward-Thinking Design

This feature touches on the significance of patient-focused and environmentally sustainable design, as well as design for expanding technology and design for adaptive environments.

DESIGN FOCUS: Designing for Safety and Reliability

This feature describes issues involved in designing for life safety, infection prevention and control, security, worker safety, and more. It also addresses evidence-based design and designing for facilities in developing countries.

DESIGN FOCUS: Specialty Design

Approaches to design for technically complex areas, including laboratories and pharmacies, comprise this feature. Special considerations are detailed.

CONSTRUCTION FOCUS: Construction Risks and Measures

Various types of risks present during construction of health care facilities are listed and explained. Measures to address these risks are provided as well.

COMMISSIONING FOCUS: Moving Day

This feature provides an overview of issues involved in moving into a facility, along with suggestions for making that transition easier and safer.

Key Terms

The health care, architecture, and construction fields are awash with terms and jargon. Understanding these and "talking the same language" are crucial for effective communication and collaboration. A list of key terms appears at the beginning of each chapter and feature. Key terms are in red and defined at point of use in the text.

Other Items

Throughout the chapters of this book, the following items will appear as appropriate:

- ***Overarching Issue:*** Insights into issues that occur throughout health care facility construction and renovation projects
- ***Standards Sidelight:*** Information highlighting how Joint Commission and JCI standards relate to the topic under discussion
- ***Project Gallery:*** Case studies focusing on organizations' struggles and successes during construction and renovation projects

Joint Commission and JCI Standards

The Joint Commission and JCI are not involved in the design or construction process of health care facilities. There are, for example, no standards that drive the building codes. However, there are standards associated with construction and renovation projects. These are included in both the domestic accreditation manuals and the international manuals

(see FOUNDATIONS: Standards and Regulations). While project planning, design, construction, and commissioning issues remain fundamental to a safe design, most manual chapters address facility design in a broader sense because facility design can help an organization meet accreditation standards, offer safer care, and provide a safer and more efficient building.

Manuals to Consult

Early in the planning process, the most current edition of any relevant manual should be obtained for use and reference during the project.

Domestic Program Settings

Joint Commission standards for built environments in the United States appear in manuals for the following health care settings:

- ***Ambulatory health care:*** Surgery centers, community health centers, group practices, imaging centers, telehealth providers, sleep labs, rehabilitation centers, student health centers, urgent care clinics, and other ambulatory providers
- ***Behavioral health care:*** Organizations that provide mental health services, substance-use treatment services, foster care services, programs or services for children and youth, child welfare, services for individuals with eating disorders, services for individuals with intellectual/developmental disabilities of various ages and in various organized service or program settings, case management services, corrections-based services, and opioid treatment programs
- ***Critical access hospitals:*** Hospitals in the United States that offer limited services and are located more than 35 miles from a hospital or another critical access hospital, or are certified by the state as being a necessary provider of health care services to residents in the area. A critical access hospital maintains no more than 25 beds that could be used for inpatient care. It provides acute inpatient care for a period that does not exceed, on an annual average basis, 96 hours per patient. A critical access hospital can also have a distinct part psychiatric and/or rehabilitation unit; each unit can have up to 10 beds.
- ***Hospitals (including academic medical centers):*** General, acute psychiatric, pediatric, medical/surgical specialty, long term acute care, and rehabilitation hospitals
- ***Laboratories:*** Clinical laboratories, point-of-care testing facilities, assisted reproductive technology labs, and reference labs
- ***Nursing care centers:*** Organizations that provide specialized services to patients or residents, which may include rehabilitative care, dementia-specific memory care, and long-term nursing care
- ***Office-based surgery practices:*** Surgeon-owned or -operated organizations (for example, a professional services corporation, private physician office, or small group practice) that provide invasive procedures and administer local anesthesia, minimal sedation, conscious sedation, or general anesthesia that renders three or fewer patients incapable of self-preservation (able to leave the facility independently) at any time, and are classified as a business occupancy

International Program Settings

The international standards are available for the following JCI accreditation programs:

- ***Ambulatory care:*** The standards are applicable to a variety of service models, but primarily organizations where the patient population is outpatients seeking services—general or specialty, urgent or planned. Examples of specialty services include outpatient surgical services, diagnostic testing, dental services, or palliative care. Patients stay in the facility for short periods; however, if patients need to stay overnight due to a prolonged recovery, they are expected to be released or transferred to an appropriate facility within 24 hours.
- ***Clinical laboratories:*** Facilities that perform laboratory testing on specimens obtained from humans in order to provide information for health assessment and/or for the diagnosis, prevention, or treatment of disease
- ***Hospital (including academic medical centers):*** General, acute psychiatric, pediatric, medical/surgical specialty, and rehabilitation hospitals
- ***Long term care:*** Organizations that provide specialized services to patients or residents, which may include rehabilitative care, dementia-specific memory care, and long term nursing care
- ***Primary care centers:*** Organizations that focus on community integration, health promotion and disease prevention, first-contact medical services, and linkages to other parts of the health care delivery system

Common Themes

Common themes among all of the manuals and expectations that may be pertinent to a facility construction project include

those listed below. These will be woven throughout the book, with several called out in the Standards Sidelight features.

Leadership

- Leaders base project planning on the needs of community and/or the population base.
- Project plans reflect current best practices.
- Project plans are made with input from those in the field with knowledge of the various clinical and environmental needs—for example, pharmacy, nursing, infection prevention, imaging, and so on.

Patient-Centered Care

- Facilities provide the support services necessary for specific patient populations, such as radiology, food service, and laboratory services.
- Design is centered on the well-being of the patients, both physical and psychological.
- Privacy is provided for patients in care settings.
- Built environments reflect the needs of the disabled, age-related services, cultural needs, and others as may be appropriate.
- Families are integral to patient care.
- Belongings are secure at all times.

Staff

- Staff is provided appropriate and safe work space.
- Staff training is essential and space is identified for this purpose.

The Physical Environment

- Facilities are designed and built to provide a secure and healthy environment to patients, visitors, and staff.
- Systems are in place to manage hazardous materials and waste.
- A secure environment is maintained for users, equipment, and supplies.
- A safe physical facility is maintained for users, equipment, and supplies.
- Facilities plan for and manage probable emergency situations.
- Adequate utility systems and controls are in place.
- Fire safety protocols meet prescribed local or national requirements.
- Supplies of potable water and electricity are available 24 hours a day.
- Interim life safety measures can be met.

Infection Control

- Current scientific practices, as well as local and national laws, are followed to reduce the risk of infection.
- Appropriate airflow technology is installed to mitigate contamination potential.
- Hand hygiene accommodations are made.
- Proper equipment and processes are in place for disposal of waste.
- Sterilization and/or disinfection of equipment reflect current standards.
- Infection control risk assessments are conducted and solutions applied.

Information Management

- Patient records are protected and maintained so that they are secure.
- Confidentiality is maintained.

Medication Management

- Medications are safely received, processed, stored, distributed, administered, and disposed of.

Surgical and Anesthesia Care

- The physical environment supports the customary requirements of patient monitoring and medical technologies for life support.
- Air management is appropriate for temperature, humidity, and required exchanges.

Tissues

- Appropriate and adequate technologies are adopted to protect and maintain tissues for testing, research, transplant, or other purposes.

Exit Note

Some readers of this book will be new to many of the concepts contained within, while others will find familiar topics discussed. Regardless of experience, all readers should understand that entering into a construction and renovation project in a health care facility is a huge responsibility that will affect the lives and health of millions over the years that the facility is in operation. Knowing as much as possible about such projects is part of that responsibility.

Acknowledgements

We gratefully acknowledge the individuals and organizations that contributed to this third edition.

American Institute of Architects Academy of Architects for Health

- Charles H. Griffin, AIA, FACHA, EDAC, Senior Principal, WHR Architects, Houston
- David Frum, AIA, ACHA, President, Salus Architecture, Inc., Seattle
- Roger B. Call, AIA, ACHA, LEED AP, EDAC, Herman Miller Healthcare, Zeeland, Michigan
- Orlando T. Maione, FAIA, FACHA, Owner/Principal, Maione Associates, Stony Brook, New York

Other Contributors

- Alan R. Bell, AIA LEED AP, Regional Director of Planning, Design & Construction, Facilities Resource Group, Ascension Health, Edmundson, Missouri
- Rachel Bickel, Knowledge Management Editor, CannonDesign, Chicago
- Erin Clark, RN, MS, Project Manager, Healthcare Technical Services, Inc., Emeryville, California
- Scott Cullen, Principal, Hanscomb Consulting, Alexandria, Virginia
- Travis R. English, PE, LEED AP, CEM, Chief Design Engineer, Engineering Team Manager, Kaiser Permanente, Anaheim, California
- Bernadette Farrell, Architect, Director of Health Planning and Architectural Design, Hamad Medical Corporation, Doha, Qatar
- Leny Fortaleza, RN, MBA, CPHCQ, Fellow-AIHCQ, Director of Nursing, Care Corporation, Riyadh, Saudi Arabia
- Mark Gesinger, MS, ARCH, LEED, AP, BD+C, Principal, ZGF Architects LLP, Seattle Children's Hospital, Seattle
- Janet Howard, EDAC Director of Facility Engagement for Practice Greenhealth; Director, Content and Outreach, Healthier Hospitals Initiative, Amherst, Massachusetts
- Shrimant Jaruhar, MS, BIM Manager, Department of Facility Planning and Construction, Northwestern Medicine, Chicago
- Karin Jay, Senior Director of International Business Development, Planetree, Derby, Connecticut
- Vita Lerman, Publications Manager, Ann and Robert H. Lurie Children's Hospital of Chicago, Chicago
- Harvey J. Makadon, MD, Director of Professional Education and Training, Fenway Community Health, Clinical Professor of Medicine, Harvard Medical School, Boston
- Laurie Menyo, Director of Public Relations and Marketing Communications, ECRI Institute, Plymouth Meeting, Pennsylvania
- Larry Sterle, Director, Kurt Salmon Associates, Minneapolis-St. Paul
- Erica J. Stewart, CIH, HEM, National Environmental, Health, and Safety Principal Consultant, AIHA Fellow, Kaiser Permanente, Oakland, California
- Tammy Thompson, NCARB, EDAC, CLC, President, Institute for Patient-Centered Design, Inc., Summerville, South Carolina
- Michele L. Van Hyfte, AIA, LEED AP, Manager Environmental Stewardship, Seton Healthcare Family, Austin, Texas
- Dale Woodin, CHFM, FASHE, Senior Executive Director, American Society of Healthcare Engineers, Chicago

Third Edition Reviewers

- Yvonne P. Burdick, MHA, FACHE, EDAC, Consultant, JCI
- Michael Chihoski, MS, CHFM, CHSP, SASHE, Chief Executive Officer, d1 Development, Peoria, Illinois
- Jeff Conway, MPH, Director, CMS and Hospital/CAH Programs, Accreditation and Certification Operations, The Joint Commission
- Bernadette Farrell, Director of Health Planning and Architectural Design, Hamad Medical Corporation, Doha, Qatar
- John Fishbeck, RA, Associate Project Director, Standards and Survey Methods, The Joint Commission
- Anne M. Guglielmo, CFPS, CHFM, CHSP, LEED A.P., Engineer, Department of Engineering, The Joint Commission
- Claudia J. Jorgenson, RN, MSN, Director of Standards Development and Interpretation, JCI
- James Kendig, Field Director, Surveyor Management and Development, The Joint Commission
- George Mills, MBA, FASHE, CEM, CHFM, CHSP, Director of Engineering, Department of Engineering, The Joint Commission
- Phanasan Sutjaritpanich, Chief Operating Officer of Bangkok Hospital, Vice President for Hospitality Services of Bangkok Dusit Medical Services PLC, Bangkok, Thailand

Special Acknowledgements

This third edition benefits greatly from the efforts and coordination of Karen (Kathy) Reno, PhD, MBA, RN, EDAC, Safe Health Design Managing Consultant, Joint Commission Resources. We are grateful for her contributions and critical role as subject matter expert.

We also extend our appreciation to Lea Anne Stoughton, for her dedication and patience in writing this book.

Reference

1. Healthcare Design. 2014 HCD Corporate Rankings: Healthcare A/E/C Firms Correcting Course. Silvis, J. Jul 1, 2014. Accessed Jul 3, 2015. http://www.healthcaredesignmagazine.com/article/2014-hcd-corporate-rankings-healthcare-aec-firms-correcting-course.

table of terms

Term	Chapter or FOCUS Feature	Page
latent conditions	DESIGN FOCUS: Designing for Safety and Reliability	75
life safety	DESIGN FOCUS: Designing for Safety and Reliability	76
life safety plans	Chapter 2: The Design Phase	54
master facility plan	Chapter 1: The Planning Phase	9
master facility planning	Chapter 1: The Planning Phase	9
means of egress	DESIGN FOCUS: Designing for Safety and Reliability	77
measurable elements (MEs)	FOUNDATIONS: Standards and Regulations	3
mock-ups	Chapter 2: The Design Phase	55
monolithic ceiling	DESIGN FOCUS: Designing for Safety and Reliability	81
needs analysis	Chapter 1: The Planning Phase	10
negative pressure	DESIGN FOCUS: Designing for Safety and Reliability	78
occupancy	DESIGN FOCUS: Designing for Safety and Reliability	76
owner's project requirements (OPR)	Chapter 4: The Commissioning Phase	112
P3 model	PLANNING FOCUS: Alternative Facility Delivery Models	33
patient flow	DESIGN FOCUS: Designing for Safety and Reliability	84
peer visualization	DESIGN FOCUS: Designing for Safety and Reliability	91
personal protective equipment (PPE)	CONSTRUCTION FOCUS: Construction Risks and Measures	110
phasing and demolition plans	Chapter 2: The Design Phase	61
plumbing plans	Chapter 2: The Design Phase	61
positive pressure	DESIGN FOCUS: Designing for Safety and Reliability	78
preconstruction risk assessment	Chapter 3: The Construction Phase	97
predesign	Chapter 1: The Planning Phase	10
preliminary facility plan	Chapter 1: The Planning Phase	21
preliminary specifications	Chapter 2: The Design Phase	50
process alignment	Chapter 4: The Commissioning Phase	120
process improvement	PLANNING FOCUS: RPI and Change Management	29
process redesign	Chapter 2: The Design Phase	44
project specifications manual	Chapter 2: The Design Phase	61
protective environment (PE) rooms	DESIGN FOCUS: Designing for Safety and Reliability	79
punch list	Chapter 4: The Commissioning Phase	114
reflected ceiling plans	Chapter 2: The Design Phase	54
reprocessing	DESIGN FOCUS: Designing for Safety and Reliability	80
request for proposal (RFP)	Chapter 1: The Planning Phase	13

Term	Chapter or FOCUS Feature	Page
request for qualifications (RFQ)	Chapter 1: The Planning Phase	13
revised building plan	Chapter 2: The Design Phase	50
room data sheet	Chapter 2: The Design Phase	55
room pressurization	DESIGN FOCUS: Designing for Safety and Reliability	82
schematic design	Chapter 2: The Design Phase	48
security-sensitive areas	DESIGN FOCUS: Designing for Safety and Reliability	84
sentinel event	FOUNDATIONS: Standards and Regulations	5
simulations	Chapter 4: The Commissioning Phase	115
site plan	Chapter 2: The Design Phase	49
space planning	Chapter 2: The Design Phase	53
specifications	Chapter 2: The Design Phase	50
standards	FOUNDATIONS: Standards and Regulations	3
strategic planning	Chapter 1: The Planning Phase	9
structural drawings	Chapter 2: The Design Phase	61
sustainable design	DESIGN FOCUS: Forward-Thinking Design	65
title sheet	Chapter 2: The Design Phase	61
user group teams	Chapter 1: The Planning Phase	12
value engineering (VE)	PLANNING FOCUS: Value Engineering	38
wall sections	Chapter 2: The Design Phase	54
wayfinding	DESIGN FOCUS: Designing for Safety and Reliability	85
workload analysis	Chapter 1: The Planning Phase	20

standards and regulations

FOCUS Outline

Joint Commission and Joint Commission International Standards

- Standards and the Physical Environment
  - Emergency Management
  - Facility Systems
  - Human Resources
  - Infection Control
  - Leadership
  - Medication Management
  - Patient Care
  - Patient Education and Rights
  - Patient Safety Goals
  - Sentinel Events

The Facility Guidelines Institute

- The FGI *Guidelines*

Other Relevant Standards and Regulations

- US/Domestic Standards and Regulations
- International Standards and Regulations
- Codes per the AHJ

TERMS

elements of performance (EPs)
measurable elements (MEs)
sentinel event
standards

Meeting standards and regulations, particularly in health care facilities, plays a primary role in maintaining safety in physical structures and with the systems that support them. This FOCUS feature provides a brief introduction to the types of standards and regulations that will be part of most health care facility building projects.

Joint Commission and Joint Commission International Standards

The Joint Commission accredits more than 20,000 health care organizations in the United States. Joint Commission International (JCI) provides accreditation and health care consulting services in more than 90 countries. The standards health care organizations are required to meet for accreditation are principles of patient safety and quality of care. Each standard defines performance expectations, structures, or processes that enhance quality of care in an organization. Within each Joint Commission standard are one or more elements of performance (EPs), and within each JCI standard are measurable elements (MEs). Each EP and ME is a specific action an organization must implement to achieve the goal of a standard. Overall compliance with a standard is determined by an organization's compliance with the EPs or MEs for that standard.

Standards and the Physical Environment

The Joint Commission and JCI are often asked to identify or define how their standards apply to planning, design, construction, and commissioning. In actuality, neither organization has developed its own set of such standards for health care. However, organizations accredited by The Joint Commission and JCI are expected to show processes and outcomes that rely on the built environment for effective support. This requires consideration of more standards than those traditionally addressed for the physical environment. In the United States, for example, The Joint Commission traditionally surveys health care organizations to ensure that they are meeting facility safety and health care occupancy requirements through its Environment of Care (EC), Infection Prevention and Control (IC), and Life Safety (LS) standards. JCI standards traditionally surveyed for facility systems are Facility Management and Safety (FMS); Governance, Leadership, and Direction (GLD); and Prevention and Control of Infections (PCI). Given the diversity of the areas served, however, JCI standards for construction and other health care areas must allow for local laws and regulations, which may relate to health care construction guidelines established in many developed countries.

Throughout the various chapters of the manuals issued by The Joint Commission and JCI, there are myriad standards that should influence the design of the physical environment so that safe and reliable processes can be conducted for all users of the facility. Yet, too often the standards chapters just named are the only ones reviewed during project design. It is critical that the design project team examine each of the manual chapters, as each chapter cites concepts—framed as processes and outcomes—that should be taken into account when designing or renovating health care facilities. For more information on those concepts, discussed below (listed alphabetically, not by order of importance), see DESIGN FOCUS: Designing for Safety and Reliability.

Emergency Management

When designing to deal with emergencies, the Emergency Management (EM) standards, applicable to US facilities only, encourage organizations to complete an assessment called a hazard vulnerability analysis (HVA). This activity assists organizations in understanding the potential impact of natural, technological, human, and hazardous material events. It is crucial to conduct this analysis in cooperation with community emergency responders, business owners, and other local health care organizations so that the external hazards are understood and can inform design decisions. JCI–accredited

facilities are required by FMS as well as GLD standards to assess risk both internally and externally.

Facility Systems

As mentioned earlier, in the United States, the EC and LS standards chapters encompass a good portion of the requirements that impact facility systems, while internationally, those are addressed by FMS standards. However, at the core, both The Joint Commission and JCI advocate planning for security, safety, medical equipment, utility systems, fire safety, and management of emergencies, as well as safe handling of hazardous waste.

Human Resources

Every facility accredited by The Joint Commission or JCI is required to have competent, well-trained staff. This requires adequate and appropriate spaces in which staff can be trained and receive orientation to work safely within the facility. Staff qualifications and education are covered in the standards for human resources as well as standards in other chapters that outline competencies and qualifications related to the topics of the chapters.

Infection Control

In the United States and abroad, the standards for infection control should be considered during the entire building process. In the Joint Commission manuals, these are IC standards; in the JCI manuals, these are the PCI standards. The infection control chapters present outcome directives for providing an environment that controls and prevents infection. Many design elements can serve to reduce the risk of exposure to infections for patients, visitors, and staff. These design elements are supported by evidence-based research studies from such organizations as the World Health Organization (WHO), Association for Professionals in Infection Control and Epidemiology (APIC), and the US Centers for Disease Control and Prevention (CDC). For example, one key to reducing and/or preventing infections is effective management of air and water quality. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) provides guidance on air and water quality for health care facilities (see page 6).

Leadership

The requirements found in the leadership-related chapters of the Joint Commission and JCI manuals provide broad statements about responsibility and accountability. Leadership is responsible for analyzing and developing programs that meet community needs and is accountable to the community for the results of those programs. This drives the whole strategic planning process for operations, and shapes the planning, design, construction, and commissioning of facilities.

Both Joint Commission and JCI standards require leadership to understand and use resources to buy appropriate equipment, supplies, and medications as recommended by authoritative sources such as professional organizations. The standards also require that input on space, equipment, and staffing be solicited from the appropriate director or specialist, as well as soliciting input into project decisions.

Medication Management

The safe storage, ordering, dispensing, distribution, and administration of medications in health care facilities are important processes to understand in creating an adequate design. Frequently, technology is used both in the pharmacy area and in the storage and administration locations in the patient care areas. Early in the design phase, the owner/operator of the facility needs to determine the processes for each of these important phases of medication management.

Patient Care

Patient care involves access to care, continuity of care, assessment, and care provision. Patient flow is a primary consideration related to patient care that must be addressed during design of building projects. Efficient patient flow through a health care facility reduces potentially harmful delays in patient care. Patient flow applies from the moment an individual wants access to the facility, all the way through his or her entire experience there, until transport back home. External and internal wayfinding, direct visualization, areas for assessment, and care spaces that meet the population's needs are just a few of the design elements that support good care processes and timely patient flow.

Patient Education and Rights

To appropriately care for an individual, staff must acquire a complete description of the patient's complaint and assess his or her condition accordingly. To successfully accomplish this objective, organizations need to provide a confidential space with auditory privacy where a patient can discuss his or her condition with the health care provider. This design need must be considered in relation to the patient's entire experience at the facility, from entry through discharge.

Joint Commission and JCI standards also promote family involvement in care and education as to the patient's condition, which calls for appropriate space where family can be included in the care.

Patient Safety Goals

Both domestic and international accreditation manuals highlight specific patient safety goals. In the United States, these are the National Patient Safety Goals (NPSGs); internationally they are the International Patient Safety Goals (IPSGs). These goals may change over time based on current health care issues (for example, a patient safety goal may become a standard once significant progress has been made on compliance with the goal). Many of these goals translate to design considerations. For example, a crucial patient safety goal for facility design is hand hygiene. This goal seeks to increase hand washing and use of hand gel disinfectant for hygiene purposes. That translates to design considerations that must include quantity and placement of hand-washing stations and gel dispensers. A second crucial goal is preventing patient falls. This topic is a much-researched one in the design field to determine safer design elements to include to reduce or eliminate falls.

Sentinel Events

Both US and international accreditation programs focus on prevention of sentinel events. A sentinel event is a patient safety event (not primarily related to the natural course of the patient's illness or underlying condition) that reaches a patient and results in death, permanent harm, or severe temporary harm. Joint Commission leadership standards require the design of new or modified services or processes to incorporate information about sentinel events; JCI standards require organizations to use information from their own sentinel events to revise their processes. The following are sentinel events that can be specifically impacted by safe design:

- Abductions
- Suicide attempts
- Criminal events
- Falls with harm
- Infections
- Delays in treatment
- Elopements
- Fire
- Medical equipment–related injuries
- Medication errors
- Operative and/or postoperative complications
- Restraint-related injuries
- Other events such as drowning or "found unresponsive" (failure to rescue)

The Facility Guidelines Institute

The Facility Guidelines Institute (FGI, http://www.fgiguidelines.org) is an independent not-for-profit corporation that provides multidisciplinary consensus review and revision of health care building requirements. It is the result of a long history of health care construction requirements first developed in 1947 by the federal government to apply to the Hill Burton hospital development program. In 1984 the US Department of Health and Human Services asked the American Institute of Architects Committee on Architecture for Health (AIA/CAH) to assume responsibility for overseeing the standards. The first set of standards under AIA/CAH guidance was published in 1987. In 1998 FGI emerged because of a widespread desire to have the guidelines reflect consensus among many disciplines involved in the functioning of health care facilities. FGI's early members and funding organizations were AIA/CAH, the American Society for Healthcare Engineering (ASHE), and the National Institutes of Health (NIH). A 2010 revision to the guidelines incorporated standards from ASHRAE. The name also changed from AIA standards to FGI standards.

The FGI *Guidelines*

FGI publishes its standards under the title *Guidelines for Design and Construction of Hospitals and Outpatient Facilities* (commonly known as FGI *Guidelines*). The FGI *Guidelines* contains minimum standards for hospitals, rehabilitation facilities, and ambulatory health care facilities. It addresses program, space, risk assessment, infection prevention, architectural detail, and surface and finishing needs. It also details minimum criteria for plumbing, electrical, and HVAC (heating, ventilating, and air-conditioning) systems. The Joint Commission—along with many federal agencies and authorities in most US states—uses the *Guidelines* as a code or reference standard. The *Guidelines* are updated frequently to keep up with the evolving needs of the health care industry.

The Joint Commission EC standards in particular require that facilities use design criteria based either on state-mandated

rules and regulations, or on the 2010 edition of the FGI *Guidelines*.* An exception is provided for situations when those criteria do not meet specific design needs, in which case an equivalent set of design criteria may be selected.

Other Relevant Standards and Regulations

During a building project, it is also vital to keep in mind the many and varied local, state, regional, and national standards and regulations. Following is a brief overview of such standards and regulations to note.

US/Domestic Standards and Regulations

- ***Local, state, and regional building codes:*** Many states, regions, and municipalities offer building codes and make them available on their websites. Project teams should be familiar with these codes and have ready access to them. Other entities also determine allowable dimensions, sizes, and cost allocations.
- ***International Code Council (ICC):*** The ICC is dedicated to developing model codes and standards used in the design, build, and compliance process to construct safe, sustainable, affordable, and resilient structures. Most US communities and many global markets choose the ICC codes. See http://www.iccsafe.org.
- ***Americans with Disabilities Act (ADA):*** The US–only ADA prohibits discrimination and ensures equal opportunity for persons with disabilities in employment, state and local government services, public accommodations, commercial facilities, and transportation. It also mandates the establishment of Telecommunication Devices for the Deaf/telephone relay services. Some areas the ADA specifies regarding building design and content include the width of doorways, ramps into and out of a facility, number of accessible parking spaces, and removal of barriers. The regulations were most recently revised in 2010, with mandatory compliance as of March 15, 2012. See http://www.ada.gov.
- ***Occupational Safety and Health Administration (OSHA):*** This US government agency provides standards related to the safety and health of workers. Requirements relate to several topics, including air quality, ergonomics, and safety. See http://www.osha.gov.
- ***National Fire Protection Association (NFPA):*** This nonprofit US organization provides scientifically based consensus codes and standards related to life safety. The NFPA's *Life Safety Code*† specifically addresses construction features necessary to minimize danger to life from fire, including smoke, fumes, or panic. See http://www.nfpa.org.
- ***US Environmental Protection Agency (EPA):*** This US government agency regulates and monitors the environmental impact of many industries, including the health care industry. It offers guidelines for air and water quality maintenance, hazardous and other medical waste disposal, and other issues. See http://www.epa.gov.
- ***American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):*** This US organization offers standards and guidelines related to heating, refrigerating, and air-conditioning systems. See http://www.ashrae.org.

International Standards and Regulations

Internationally, codes are often country specific; few are adopted globally. For example, in the Netherlands, a permit is required from the Netherlands Board of Health Facilities (NBHF) for the construction of new buildings and major renovations, and the NBHF develops guidelines related to such issues as correct ventilation in the operating room to prevent postoperative infections. In the Middle East, the Health Authority of Abu Dhabi developed building regulations in 2010 that are currently used as a template throughout the region. The United Kingdom publishes its building guidelines under *Health Building Notes* and *Health Technology Memorandums* for the National Health Service. These are available online.

* The 2014 FGI *Guidelines* have been released. As the current standards state, 2014 FGI *Guidelines* may be adopted by an organization as an equivalent set of design criteria. It is up to the individual state, city, or country to develop and schedule adoption of the FGI *Guidelines* for their area. Organizations should therefore check with their design professional or governmental affairs groups for the latest on the formal adoption of FGI *Guidelines* in use in a locale.

† *Life Safety Code*® is a registered trademark of the National Fire Protection Association, Quincy, MA.

Laws, regulations, and inspections by local authorities largely determine how a facility is designed, used, and maintained. JCI requires all accredited organizations to comply with these local requirements, except where standards require a higher level of compliance than local code.

Codes per the AHJ

In general, codes are written to work as a system. It is important that the project design team includes within the project manual or specifications which codes govern the project, per the authority having jurisdiction (AHJ). This provides owners and the project team with the contractual references for codes and standards that are needed to help manage these complex projects.

the planning phase

Chapter Outline

TERMS

certificate of need (CON)
detailed space plan
executive project team
master facility plan
master facility planning
needs analysis
predesign
preliminary facility plan
strategic planning
user group teams
workload analysis

The first phase of most construction and renovation projects is the planning phase. Within this phase are various types of planning that involve many activities, from incorporating goals for the future of the facility or organization to steps such as analyzing needs, assembling a team, gathering data, creating a project plan, determining a budget, and phasing in and documenting the master facility plan. All of these activities require complying with applicable standards and regulations as well as collaboration among internal and external groups and individuals.

Types of Planning

For projects in health care organizations, the planning phase typically incorporates several types of planning that often overlap: strategic planning, master facility planning, and project predesign planning.

Strategic Planning

Strategic planning is a systematic process of translating the vision of a desired future into broad goals or objectives and enacting steps to achieve them, including allocation of resources.

In the past, strategic planning was "looking through a ten-year window into the future." With the rapid changes in technology and health care, that window has narrowed to an average of three years. Given that most projects take more than three years from inception to completion, today's facility projects are fraught with uncertainties: How will such projects mesh with the evolving needs of new medical home models, the complexities of the continuum of care, and the looming challenges presented by aging acute care facilities? In addition, other areas of health care are looking through the same window, so building projects often must compete for tight resources for electronic health records, telehealth programs, and diagnostic and treatment equipment.

Because of the swift pace of change and increases in budget cuts, strategic planning now plays a heightened role in health care organizations. A strategic plan not only investigates the internal status of an existing organization, it also identifies the external environmental and competitive forces that may impact the organization in the near future.

SWOT Factors

A wide variety of strategic planning methods are available today, but the common element in each is to identify an organization's SWOT factors: its strengths, weaknesses, opportunities, and threats. In response, the organization develops a plan to improve and optimize its performance.

Planning a new facility—or renovations to existing facilities—can be a response to any of the SWOT factors. The project can capitalize on a perceived strength within the community. It can reduce a weakness caused by outdated structures or poor location of a facility. It can aid in an expansion of services or withstand a threat by a competitor. When and if a strategic imperative for construction or renovation results from the strategic planning, the construction planning phase can begin. The construction planning phase for a project consists of two types of planning: master facility planning and project predesign planning.

Master Facility Planning

Master facility planning is the planning that determines the building and/or campus needs to align with an organization's strategic plan. For health care systems, a master facility plan may be created that encompasses all of the campuses, buildings, and/or land. The goal of master facility planning is to assist an organization's leadership in making decisions that will optimize the building and/or land use for the future while still assisting the organization in making wise choices to meet current needs.

The result of master facility planning is the creation of a comprehensive master facility plan (referred to as a strategic facility plan by the International Facility Management

Association)[1] Regardless of what the plan is called, it is essentially an extensive analysis of the facility needs to support the strategic plan. Much of the data collection to support this analysis is similar to what is required for a project plan (see page 21). To determine the time line horizon for a master facility plan, it is important to consider the complexity of the plan. For example, a campus plan that incorporates multiple building projects over time and includes appropriate infrastructure, adjacencies, and circulation will take many years. Whether the completion time frame is short or long, it is always important to review and update the master facility plan regularly for continued relevance in meeting the strategic goals of the organization.

Because the master facility plan guides *all* projects for a facility or campus, it may have several phases that embrace one or more distinct or related projects, but all build toward the master facility plan. A well-developed master facility plan reveals how each project ties in to an organization's strategic plan as well as its current physical, organizational, social, political, and economic context. The master facility plan is considered by many organizations as a living document that is reviewed, revised, and updated regularly. This will be discussed in more detail later in this chapter (see page 24).

Project Predesign Planning

Project predesign planning (predesign) is the discovery type of planning that occurs prior to actual design drawings and construction, but usually after some funding is obtained. It involves planning for a *specific project:* outlining project objectives and challenges as well as conducting studies to determine space requirements, opportunities and limitations of the site, and expected cost versus the budget. Project predesign planning overlaps with design and may be referred to as programming. Note that terminology and definitions vary: Some view programming as a separate and distinctive function and predesign as more conceptual planning of a building and less defined. Project predesign planning will also be discussed later in this chapter (see page 21) and in more depth in Chapter 2.

Separate or Combined Processes

Depending on the size of the maximum build-out of the site and the scope of the project, organizations may engage in master facility and project predesign planning separately or combine them into one planning phase. For example, complex organizations may create a master facility plan to map out several projects, each of which will have its own predesign stage, so that more specificity is provided for that project. Simpler organizations with small or single-campus projects may combine many of the steps for the master facility plan with the project predesign planning. This chapter focuses on the steps to take to complete predesign for a specific project. It is important to determine early in this process if much of the needed data and analysis have been completed in a master facility plan prior to moving forward with predesign for a specific project.

Planning should be an interactive and iterative process with workshops, meetings, research, and "homework" periods for all participants. Each step in the process should eliminate certain options and, ideally, bring those involved closer to agreement on the best alternatives. The following sections describe steps in the planning phase. The scope and nature of the project will determine whether organizations engage in all of these activities or just some of them.

Step 1: Analyzing Project Needs

Analyzing project needs is a logical first step in the planning phase. Information about needs drives decisions during the planning phase and helps estimate the capital requirements of the project. One way to get this information is to perform a needs analysis. A thorough needs analysis should involve a detailed assessment of each department or service, coupled with projections for the future state of the service for volumes, relevant offerings, space requirements, and so on. For example, as part of a needs assessment for a maternity unit, an organization should examine population projections of women ages 15 to 44, including historical and projected fertility rates by geographic area. Similarly, in assessing the needs of a surgical service, an organization should examine the impact of payer-driven changes, such as from inpatient to outpatient provision of services, and estimate what the population-based surgical rate will be in the future for cases such as heart or orthopedic procedures.

Needs Analysis Topics

As part of a needs analysis, an organization collects information from either the strategic plan or an independent market study aimed at providing a detailed analysis of the project scope and direction. This type of research can help the organization obtain information on a variety of topics, including the following:

- Service area demographics and projections
- Payer mix of constituents
- Specialty service line expertise
- Community perceptions of the facility and any of its potential projects
- Appropriate location of a new facility or facilities
- Potential lost revenue due to a project or relocation of a facility
- Presence and impact of competition

Results from this research should be considered when determining whether to do a project at all, as well as when determining the location, nature, timing, and financial impact of the project if and when it goes forward.

Step 2: Assembling the Project Team

A critical step in the planning phase is selecting the project team—the group of people who influence and are involved in the planning, design, and construction phases of the project. Every project team consists of two distinct groups: representatives of the organization and the consultants, or project partners, who work on the project. To achieve a successful planning phase, organizations should be aware of the needs, goals, and perspectives of both groups. The consultants and project partners are selected at different times based on the contracting choice and bidding process.

Organization Representatives

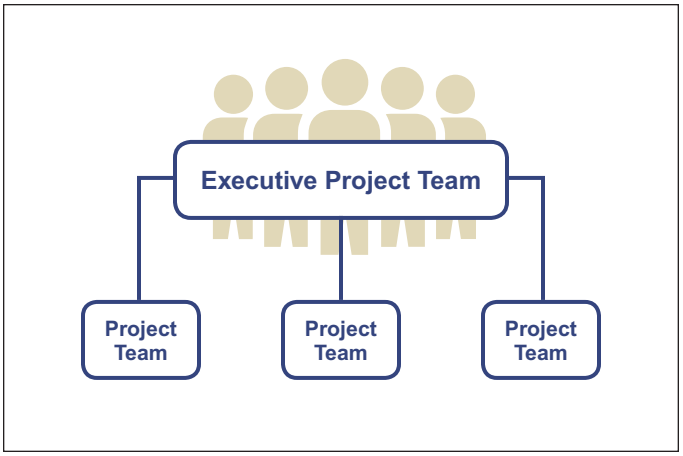
On any project team, an interdisciplinary group from various departments should represent the organization. This group should provide information to project partners (see page 12) and react to a variety of proposals made by the partners. Conversely, the project partners should work with organization representatives to tailor design and layout ideas to fit the organization's unique needs and culture.

Steps in Planning a Project

Executive Project Team

With large projects, there is usually a hierarchy of organizational involvement in teams. The leadership team with the authority for final decision making is normally called the executive project team. Following are those persons in an organization who may be included on this team:

- Representative of the executive administration, such as the CEO
- Physicians and other practitioners
- Nursing leaders, such as director of nursing
- Infection prevention and control specialist
- Facilities planning and/or engineering director
- Representative(s) of the established planning or building committee(s)
- Information technology supervisor
- Representative from the finance department
- Safety officer (the person who manages environmental risks)
- Representative(s) of the user groups



The Project Leader

Empowering a leader on the executive project team is critical to ensure that the planning phase moves forward on time and on budget. The project leader must be established as the primary contact on the team and the conduit for decisions and exchange of information. This person must therefore be a good manager of people, schedules, changes, surprises, and problems. To know when and how to bring about timely decisions, this person must have an understanding of the institution's leaders and their interests or concerns, as well as those of the project team members. A project leader must also have the respect of management and the board, and the authority and responsibility to make the planning phase work.

As project leader, this person develops the organizational structure for the project, which includes subgroups such as other project teams, including user groups.

User Group Teams

As the project moves through the design development phases, it is important to involve multiple internal stakeholders (see Chapter 2). This is often accomplished through user group teams (individuals representing those who will be using parts of the building). These stakeholders should see not only their own space but also its interdependence on other spaces and processes throughout the facility. The following are areas of the organization that should have user group teams involved in the planning, both intradepartmental and interdepartmental:

- Facilities management
- Pharmacy
- Laboratory
- Radiology
- Surgery
- Clinical engineering
- Treatment areas such as the emergency department, renal dialysis, and outpatient care areas
- Specialized clinical areas, such as oncology, magnetic resonance imaging (MRI), and computed tomography (CT)
- Support services staff, such as food service, housekeeping, and materials management
- Representative(s) of the board of directors (these may be part of the executive project team)
- Emergency management groups

The following external groups could be considered for advisory members on appropriate user group teams:

- Previous patients (particularly from focused specialties) and visitors to the campus
- Representatives from community organizations, such as senior care organizations and child and family services
- Vendors in key areas, such as information technology, imaging, and surgical specialties
- Representatives from local regulatory or governmental organizations
- Donors

Project Partners

The project partners, professional consultants who design and execute the planning, design, and construction phases, are essential to the executive project team and its subgroups.

The exact makeup of these consultants will vary according to the scope of the project, size of the organization, and nature of services needed to develop and implement a sound plan. The following list identifies a range of consultants that organizations should consider:

- Architects, including the principal, project manager, lead medical planner, and lead designer
- Engineers, including mechanical, civil, structural, electrical, and plumbing engineers
- Contractors, including the project manager, estimators, and schedulers
- Health care management consultants
- Developers or development consultants
- Financial consultants
- Cost estimators
- Equipment and technology planners
- Specialized consultants, including those specializing in kitchens, furniture, information technology, and security
- Landscape architects
- Interior designers
- Wayfinding experts (see DESIGN FOCUS: Designing for Safety and Reliability)
- Process flow experts
- Green (environmentally sustainable) construction experts (see DESIGN FOCUS: Forward-Thinking Design)
- Experts in patient handling (for example, ceiling-installed lift systems)

Integrating the Contractor

Benefits of bringing the contractor or construction manager on board during the planning phase include receiving their advice on project scheduling and their opinions on construction costs. Contractors can also provide advice on the selection of building systems and constructability issues. When a government facility or other organization requires a competitive bid process at the completion of design, an organization should consider hiring a contractor for preconstruction services to assist with these activities during the design process. Ideally, the same contractor in preconstruction will be with the project through construction, but this is not a requirement.

Criteria for Partner Selection

After determining which outside professional services are needed, criteria should be developed for selecting the best firms and individuals for each specialty. One way to do this is to send a request for qualifications (RFQ) to a number of qualified firms. The responses to the RFQ should be reviewed, and the 5 to 10 most qualified firms should be invited to submit a request for proposal (RFP). A short list of the firms submitting RFPs (3 to 4 at most) should be invited to participate in an interview process with a selection committee. Make sure deadlines for submission allow adequate time for firms to respond and prepare for RFQs, RFPs, and interviews. Also, the team does not need to issue a separate RFP for each professional consultant required for the project. The RFP should identify whether the RFP should include the architect's team only or the full design team including consultants. If the former is chosen, then the consultants may be selected by the architect with the owner's consent. Otherwise, the full design team submits and interviews jointly, under the architect's leadership.

The following criteria are useful when selecting which firms to send an RFQ, reviewing the RFQs to determine which firms to send an RFP, as well as during the interview process:

- ***Commitment:*** The firm and its principals should be able to demonstrate commitment, interest, and an understanding of the client's professional service needs.
- ***Location and availability:*** The location of the firm with respect to the site and/or client, and its availability when needed, will be important factors in selecting a firm, particularly if the firm will be involved through the construction of a project. This will make it easier to conduct master facility planning or other predesign services on a more predictable schedule. After construction begins, it is critical that the project leader from the firm be available on short notice. In some cases, local firms may not have the expertise necessary for the project. In these cases, a more geographically distant firm with appropriate expertise can team up with a local firm to manage on-site issues. Cost and availability to travel to the site are also important considerations.
- ***Skill and experience:*** It is essential that people assigned to the project have the relevant skills, experience, and professional training. The firm must distinguish between its capabilities and those of the specific staff that will be assigned. In addition, organizations choosing to pursue certain types of design—such as sustainable, evidence-based, or safety-related design—should choose consultants who are well versed in these areas. References from prior projects should be checked closely to ensure that stated skills

STANDARDS SIDELIGHT

Leadership

Master facility planning and predesign cannot proceed without input and participation from an organization's leaders. Some leaders may not directly participate in all steps of the planning phase, but the personnel they hire, the decisions they make, and the initiatives they implement do affect the ultimate completion of a project. Generally speaking, leadership must not only shape the planning for these steps and provide input into design decisions, but it must drive and actively support the entire strategic planning phase for operations.

LD and GLD

The role of leadership in project planning is addressed in the requirements of both The Joint Commission and Joint Commission International (JCI). The Joint Commission's Leadership (LD) standards and JCI's Governance, Leadership, and Direction (GLD) standards require leaders to plan carefully for the services that will be offered in facilities under development, as well as to support those services with appropriate equipment and resources. (Also see FOUNDATIONS: Standards and Regulations)

and expertise have been demonstrated in the past and are specific to hospital or other health care construction.

- *Track record:* Prospective firms should be able to demonstrate professionalism, dependability, and a proven record of delivering on time and within budget for comparable clients and types of service. Occasionally, informal research can uncover negative experiences. In such cases, consider that problems in a relationship can result from either client-created or consultant-created situations.
- *Creativity, ingenuity, and imagination:* The proposed consultant team needs to have demonstrated these attributes in solving complex problems of a similar nature and must be able to apply them within given financial constraints.
- *Firm size:* The size of the firm should match the size and scope of the work. When the scope is too large, smaller firms can be overwhelmed; large firms, on the other hand, carry higher overhead costs that are difficult for a project to absorb when the scope of services is small.
- *Culture:* There should be a positive relationship between organizational cultures and the key personnel involved in the effort. Architects and engineers should have a positive working relationship with each other and, if possible, have some history of working together. A fit between the team and organization is paramount. The team members must respect each other, understand the others' needs, and interact positively.
- *Fee:* The fee structure and rates of compensation are a significant factor in selecting consultants. However, it is not always the lowest bid that provides the best fit for the project. All the factors identified here are important to weigh and evaluate against proposed fees. Also note that fees are often negotiable, so a proposed fee need not always be seen as an absolute cost. To help with this, an organization should make sure a consistent breakdown of fees is included in all proposals for each task and consider a specialized cost consultant to see if there is an anomaly in the pricing that may be causing a significant discrepancy in the fees. In many cases the fee negotiation is set separately from the selection

process. The fee is negotiated with the top firm selected. In the few occasions when there is failure to reach an agreement, the negotiation shifts to the second selected firm.

Frequently, the best firms for consideration are those that have worked with administrative colleagues of comparable organizations. Projects need to engage professional consultants that have significant health care facility planning and architectural expertise to conduct and coordinate the planning phase. The planning and design phases of the health care facility construction process require a broad perspective and knowledge base, including an understanding of health care delivery systems and services, the effect of planning and design on these services, and the facility construction process. Professional consultants must take into account the values of the broad range of constituents involved in the process and communicate effectively with each.

Team Decision Making

In addition to a common understanding of health care facility needs, there must be a common understanding of decision making on the project team. To operate effectively, a clear chain of command should be established early on. Lack of a structured decision-making process is a major cause of delays. Such delays are likely to make consultants, such as architects and engineers, exceed both schedule and fee projections. Organizations may want to include a facilitator on the project team to assist with communication and ensure streamlined decision making.

Team Collaboration and Partnering

Small or large, the best projects involve team relationships, shared successes, shared failures, and tolerance for human error and project complexities. Adversarial or autocratic relationships often lead to failure. Success is much more likely when an organization and project partners engage in collaboration—working closely as a team, generating ideas, exploring solutions, discarding bad ideas, and mutually reaching conclusions.

Planning should always be collaborative. Such collaboration has many advantages, including the following:

- Market, infrastructure, and operation issues are defined early.
- Various kinds of expertise inform and identify issues and solutions.
- Approval processes are streamlined on every level.
- A fact-based case can be made for capital investment.

In large projects, however, collaboration can be challenging: With many constituencies and finite resources, conflicting needs inevitably will surface at different points during the planning phase. Causes of conflict include the relative importance of specific project elements, current needs versus anticipated patient demands, and organizational concepts of the project. The factors forcing these issues are the initial determination of a project budget, the sequencing of construction, and the proposed physical location of services. The needs of the surgery service, for example, should be balanced against the needs of other services, including those necessary to support surgery. If these issues are not addressed during the planning phase, they will reemerge during design, jeopardizing the project scope and timetable along with the entire team's morale.

Common Level of Understanding

For the planning phase to work, all participating team members must have a common level of understanding. This includes some common base of knowledge, mutually understood goals, and shared experiences. Relevant literature, research, and field trips to innovative facilities can establish this common ground. Following are some areas in which there should be a common understanding from planning onward:

- ***Health care facilities projects:*** A shared language and understanding of health care facility projects facilitates communication and decision making. This can be achieved through thorough documentation of the guiding principles, design elements, and other features of the master facility plan (see page 9). It is important that anyone asked to sign off on plans has the information, background, and time needed to make a thoughtful decision.[2]
- ***The health care organization:*** To facilitate collaboration, before beginning the planning phase, all project team members should acquaint themselves with the organization's mission, strategic plan, planning assumptions, and objectives, so there are clear-cut agreements and a mutual understanding of the goals and objectives of construction planning efforts. This is a good place to begin identifying the organization's existing operational and facility infrastructure.
- ***The project goals:*** As teams begin the planning phase, they should specify all goals. Unstated objectives can throw a process off track and result in miscommunication and misunderstandings. This can lead to "project creep"—

Overarching Issue

Project Size

Team selection, as well as several other components of the planning phase, are affected by the size of a project. Many of the success factors for large projects apply to small projects as well but are more limited in scope and involvement. Small projects typically entail renovations or conversion of existing space to new use space.

Small Projects

Differences for small projects usually are reflected in the number of external consultants used for the project. For work on small projects, organizations often select architects and contractors who have worked with the organization before: An established record of good communication and sound decision making is critical when quick decisions are required with minimal owner input. Some organizations use smaller projects to assess or evaluate a firm prior to deciding if that firm is appropriate for a larger project. It is a good way to evaluate communication and other functions that contribute to future successes.

Organizations may also have the in-house capability to complete some parts of the planning and construction process. Project management of all components is critical for both large and small projects, but for small projects, careful coordination of tasks must be established to minimize potential conflicts between in-house and contracted projects or providers.

In addition, small projects are subject to wider variations in cost than are large projects as measured by percentage variance. Larger projects can absorb cost variances within a smaller contingency allotment. A large contingency fund (20% or more of the total budget) should be maintained throughout a small project.

Many small projects are completed within an operational health care facility. It is critical to bring all key stakeholders together to determine project impact on patients, visitors, staff, equipment, and circulation.

Also, just because a project is small does not mean there are no significant risks to be assessed. In fact, small projects often have the most complications because organizations may overlook the risks involved. For example, a simple cabling project may require drilling through fire walls, interrupting utilities, and/or generating significant noise and vibration. An organization should begin to address risks in the planning stages and follow through with preconstruction risk assessments (see Chapter 3), just as it would identify risks for larger-scale projects.

Large Projects

Large projects are complex and require strong project management skills from a number of the key involved constituents. The organization must identify an experienced administrator to oversee the process on its behalf. At the same time, key partners need to demonstrate excellent project management skills as well. These include the lead architect, construction contractor, and various suppliers of infrastructure and major equipment. All must work together for the project to be successful.

Documentation of all decisions and changes is critical due to the long-term nature of large projects. Research has shown that frequent leadership changes occur over the life of a project, making documentation a means to communicate the project efficiently to new team members.

Unlike small projects, contingency amounts are often reduced throughout the life of the project as key milestones are met and risk of variation is reduced. This often frees reserved funds for use on a list of add-ins or desired elements for the project.

For large (and small) projects with an existing organization, communication of the project's goals and status needs to be frequent with key constituencies such as staff, community, and regulatory bodies.

add-ons and other unscheduled delays—that can derail a project. For example, an organization may have an unstated goal of constructing a building that does not look overly expensive, so patients will not raise questions regarding the cost of health care. At the same time, the architect(s) may aspire to win a design award and consequently may focus on design visibility. These unspoken goals need to be candidly shared before a line is put to paper. Architect and client can achieve a shared understanding of building image by viewing notable works of architecture together or by

carefully studying slide images to determine client and community desires. A quality design will result in firm balance between architectural features and infrastructure. (See PLANNING FOCUS: Design Outcome Plan™.)

Mutual Respect

Trust and chemistry between the organization and the project partners are as important as the partners' skills. For a facility construction project to be successful, the team must be able to work closely together, not only with mutual understanding but also with mutual respect, to share successes and to work through failures. Team leaders must recognize and rely on the strengths of participants, ensure open communication, and make timely decisions with respect to project scope and budget. This approach will best position the project for success.

Partnering

Many organizations approach larger projects with the concept of partnering in mind to proactively coalesce complex teams of in-house staff and consultants. The key characteristics of partnering in the project process include the following:

- Identifying individual goals and resolving conflicting goals
- Building lines of communication and mutual trust among project team members
- Setting common goals and project milestones relative to project scope, quality, and timing
- Establishing methods for later conflict resolution

Partnering can also occur between a hospital and the community itself. See Project Gallery: Community Partnerships below to learn how one children's hospital partnered with local cultural and arts organizations.

Project Gallery

Community Partnerships

Ann & Robert H. Lurie Children's Hospital

The Ann & Robert H. Lurie Children's Hospital of Chicago opened in June 2012. Based on evidence that art in health care facilities can improve patient outcomes, the hospital partnered with more than 20 local museums, cultural organizations, and civic institutions to create a unique creative arts program. The resulting Lurie Children's Creative Arts Community Partnership Program (https://www.luriechildrens.org/en-us/our-home/Pages/community-partner-spaces.aspx) was supported by more than $1 million from donors inspired by the initiative.

Before construction of the new hospital began, the partnership program was launched with 125 of Chicago's cultural and civic icons brainstorming concepts for patient, family, and public spaces in the facility. A hospital advisory board and the hospital's Kids Advisory Board reviewed these concept proposals and provided feedback. Working closely with the hospital and design teams, the group then contributed time and talent to create exhibits that would invite exploration, reflect the character of each organization, and appeal to children of all ages, backgrounds, and abilities.

As a result, families can enjoy interactive displays, wall-size images and murals, and care stations that feature three-dimensional diorama boxes at the eye level of young children. All displays are configured to accommodate the specific needs of a clinical environment—accessibility, safety, infection control, and space constraints—and are integrated with the wayfinding, interior design, and architectural elements of the building. Each of the hospital's 21 floors feature contributions from various donors and participants, including the John G. Shedd Aquarium, the Adler Planetarium, the Chicago Botanic Garden, and the Lincoln Park Zoo; a number of Chicago museums and theater companies; and several children and teen art programs.

The Ann & Robert H. Lurie Children's Hospital of Chicago partnered with numerous local organizations to create its unique creative arts program.

Chicago's Lincoln Park Zoo provided the mural and egg play set on Level 19 of the hospital.

The Red Moon Theatre contributed an interactive display in the waiting area of Level 21.

The Chicago Cultural Alliance contributed a video installation featured in the Level 12 lobby.

Step 3: Gathering Project Data

The data collection process familiarizes the project team with the organization, its services, and its facilities. The process should identify a wide range of goals, facts, and issues that will affect or be affected by the planning, design, construction, and commissioning process. Data collection activities usually involve detailed graphic and written documentation of the following:

- Type and volume of existing services
- Current and anticipated operational structures
- Anticipated health care market trends
- Property boundaries and features
- Current facility issues
- Desired facility elements

Organizations should also consider existing research on health care facility design to use as evidence during the design phase. Research could focus on the specific needs of the particular building type and patient population. For example, an organization planning construction or renovation of a neonatal intensive care unit (NICU) might search for literature on NICU design and the impact on patient outcomes and staff efficiency.

Existing Facility and Site Conditions

Documenting the layout, size, and function of existing facilities is necessary to understand current use and condition, as well as the future needs of the facility. As part of this effort, the project team may want to develop narrative and graphic histories of each facility, including changes in the physical plant. The team should look at existing drawings and verify their accuracy. In some cases, an on-site survey, with measurements of each department, floor, building, and site, may be necessary.

Areas for Evaluation

Organizations should evaluate the current physical condition of all existing facilities and review their potential for continued use, whether in existing form or as renovated space. Three specific areas should be evaluated:

1. ***Systems and infrastructure:*** Evaluating the condition of a building involves identifying, or verifying, the types of materials and functional systems used in the original construction and subsequent renovations of the building, as well as its general condition. Special features or qualities and notable deficiencies should be documented. At this point, it may be appropriate to have engineering consultants evaluate the condition, life expectancy, and future capacity of existing buildings, sites, and, perhaps, off-site systems.
2. ***Compliance with standards and codes:*** A code analysis should be conducted to verify each building's code classification, its allowable occupancy load, its allowable height and area limitations, and its conformance to codes and standards related to seismic design, flood issues, evacuation processes, life safety, accessibility, and so on. The results of this assessment often play a significant role in determining the future use of facilities and their need for renovation or replacement. See FOUNDATIONS: Standards and Regulations for more information on codes.
3. ***Functional and operational space needs:*** There should be a functional assessment to determine how existing facilities accommodate the functional space needs of each department or service. The process usually involves evaluating surveys conducted during meetings with departmental staff or their representatives on the project team. Information should be gathered about each department's services and functional relationship with other departments. The functional analysis should consider the location and accessibility of all departments, and determine how location affects the functionality of each. The bottom line is that the functional assessment should analyze whether current departmental space can accommodate existing and future needs.

Workload Analysis

As part of the data collection process, a project team should conduct a workload analysis. This analysis can help determine the space needed for specific components of the project, such as the size of operating rooms (ORs), patient beds, or examination rooms. If the project scope and size allow, team members may wish to create a five-year profile that details historical workload, staffing, and other measures for each service, along with an analysis of operational policies, functional requirements, patient care objectives, and growth assumptions. This picture will help in understanding overall trends, seasons of peak demand, and the link to operational goals. These must be tempered with an understanding of changing health care patterns.

It is important to exercise caution when using past data and workload factors to size and design future spaces. Many facilities that undertake new construction are functioning in

outdated, inefficient built environments. Designing to fix those problems may not be the goal of the organization. Process improvement or revision activities are strongly recommended at this stage (see PLANNING FOCUS: RPI and Change Management and Chapter 2).

Guidelines and Requirements

As part of the data collection effort, organizations should research the local, state, and national regulations that will affect the design, content, and layout of the facility. These regulations will vary depending on where an organization is located and the type of facility being built. The scope of this chapter does not allow for in-depth discussion of all the possible regulations and guidelines organizations around the world must consider. See FOUNDATIONS: Standards and Regulations for information that organizations can and should consult.

Step 4: Devising a Project Plan

Every specific project must have a plan that fits within the master facility plan. At this point in the planning phase, this plan is known as the preliminary facility plan (or preliminary facility program). The activities involved in creating the plan are often referred to as *programming*, which is another term for predesign, the part of planning that deals with specific projects (see page 10). A preliminary facility plan is used to determine a project's scope and anticipated facility care needs, phasing and scheduling, and estimated project budgets for early phases. Preliminary facility plans usually do not include a detailed space-by-space list of needs; instead they identify general departmental or functional area needs. Development of a much more detailed facility plan will result from the master facility plan after a project is initiated (see page 9).

Preliminary Facility Plan Elements

In addition to a statement describing the overall intent of the project, the preliminary facility plan typically includes the following elements:

- Phasing and scheduling
- Space needs (existing space measurements and the project's general goal for spatial/physical organization)
- Cost-benefit analysis (both long- and short-term) of the specific project and related projects
- Future growth projections

A wide range of computer modeling tools and other guidelines is available to help create a preliminary facility plan.

Other Preliminary Facility Plan Considerations

Although examining different physical and functional relationships is important, other areas of a facility or campus should be considered while creating the preliminary facility plan. The areas of safety, equipment, and utilities are summarized here:

- ***Safety:*** Standards and regulations related to safety in health care facilities require performing risk assessments to identify safety issues that can result in harm to patients, staff, and visitors. Many also relate to built-environment remedies to address those risks. During the planning phase, it is helpful to perform the required safety risk assessments if there is an existing facility for baseline information. Safety risk assessments can be an iterative process for design review as well. This will be covered in greater detail in Chapters 2 and 3. Also see FOUNDATIONS: Standards and Regulations.
- ***Major equipment:*** Large equipment planning is an essential and time-critical element of health care facility planning and development. Existing and new equipment, such as an x-ray machine, often affects the size and layout of a planned space in a project. As part of the predesign process, a preliminary equipment list should be developed to determine the equipment space and design needs for the preliminary facility plan. The list will not only identify appropriate space considerations, but it can also be used as a preliminary pricing guide for the budget. More about equipment considerations follows in Chapter 2.
- ***Utilities:*** The project team should ensure that the project's utilities, including its mechanical, electrical, and air-handling systems, are determined early in the process and coordinated with existing systems. This is true regardless of whether the project is a new building, an addition, or a renovation. If the organization has not considered the cost, location, and functionality of utility systems early in the planning phase, unpleasant surprises can emerge as cost estimates are developed. All too often, organizations order equipment without considering the utilities required to run the equipment or keep it temperature controlled. This can result in utility costs that surpass the cost of the equipment. Consulting engineers can determine a project's utility requirements.

Schedule

As noted above, part of the preliminary facility plan should include estimates of the length of time necessary to complete each phase in the process: planning, design, construction, and commissioning. Schedules should reflect a realistic time frame for completion of the entire project.

To create a project time line, the team must identify and schedule the major milestones and the stages of the project within each phase. Typical early milestones include points of organization input and key go/no-go decision points for the organization's board of directors or governing entity. Each stage within the phases of planning, design, construction, and commissioning consists of a specific set of tasks or activities that should be defined and organized. This requires identifying each activity and estimating its duration and interdependencies to establish an accurate overall timetable. It is wise to allow for some float time in the schedule as a contingency for unforeseen events, such as delays in obtaining geological surveys, weather delays, negotiating contracts, securing financing, and obtaining necessary agency approvals.

Representing the Time Line

After time estimates and interrelationships for each activity have been defined, the schedule needs to be formalized in a format for reference. Several effective tools are available to represent the overall time line. The simplest employs a bar chart with a scale representing logical units of time. This is typically represented in weeks for planning, but it may take months for large projects. The anticipated start date and duration of an activity are represented by the location and length of a bar extending across the graph. The bar chart has found wide acceptance, primarily due to its simplicity and ability to illustrate an entire process in compact form. The major weakness of a bar chart is that it fails to identify the activities whose completion or delay will have an immediate effect on the duration of the project.

Detailed Space Plan

Again, part of the preliminary facility plan addresses existing and projected space needs. Organizations should therefore create a detailed accounting of the space needed to meet the project's goals and objectives. Such an outline can use forecasted workloads and likely scenarios to estimate key patient care spaces (patient beds, exam rooms, and ORs) and develop estimates of the other space elements necessary to support these areas. This outline is often referred to as a detailed space plan (or detailed architectural program). It can be generated through working sessions with departmental representatives, tours of similar facilities, and examples from previous projects. It typically includes the following:

- ***Summary list:*** A list that identifies department, building, and project area subtotals and totals. The list should also include a room-by-room space list that is organized by department, functional area, or physical component of the building or project. At a minimum, this list should identify the name, number, and size of every room, space, area, and department that will be included in the project.
- ***Narrative description:*** A narrative description for all key spaces identifying how the size and character of each is determined. This detailed information should also be recorded on separate forms called room data sheets, which are developed for each room. For more information on the detailed space plan and room data sheets, see Chapter 2.

Benchmarking for Estimating

Teams should be wary of using simple rule-of-thumb guidelines to estimate schedules, space needs, budgets, and other aspects of the preliminary facility plan. For example, space estimates based on inpatient beds or other simple statistics can easily overlook unique characteristics of an institution and the enormous changes occurring in health care. Benchmarking is a good tool to identify potential inefficiencies in use of space. The design team can use the benchmarking information to find outliers and determine whether the variance can be justified. Benchmarking may also be useful to test an early budget estimate. Comparing it against industry benchmarks can show substantial variation based on facility type and geographic location. For example, in the United States, health care projects usually include a total project cost-to-construction cost multiplier of 1.25 to 1.4, depending on the engineering requirements. A specialty facility or smaller project may require a significantly higher multiplier.[3]

Step 5: Determining a Budget

Underestimating, or failing to identify and predict, total project-related costs is one of the biggest obstacles to successfully completing a project. Careful financial and data analysis is therefore an integral part of the planning phase. Determining a budget is a core step, and it is important to note that a project budget is more than just a construction

budget. It includes all other costs associated with planning, design, construction, and commissioning. A good budget includes critical costs related to land, construction, professional fees, interest, start-up, moving, equipment, furnishings and other finishes, and contingencies.

Anticipated Critical Costs

Following are some critical costs that make up the project budget. These must be considered during planning and readjusted as necessary throughout the project process.

Construction Costs

The largest element of the budget, construction costs, may account for 60% to 80% of total project costs. Construction estimates are typically based on an approximated cost per square foot. Factors applied to this estimate reflect the geographic location, building occupancy classification (per life safety regulations), relative complexity of construction for each component of the project, and type of construction (for example, new or remodeled; wood, concrete, steel, or composite). It is also important to remember that major construction or renovation requires several years between budget development and ground breaking, and costs may rise due to demand or inflation.

Equipment Costs

Equipment is often the second most expensive item in the budget, but the cost of major medical equipment can be among the most difficult to estimate in the early phases of a project. The specific services included in the project and the potential reuse of existing equipment can cause the estimate to range between 15% and 40% of the total cost. An inventory of existing equipment, including an estimate of its remaining life expectancy, should be completed early in project development. Special consultants for equipment planning are often available for large projects, and there are several software programs that can be helpful in developing equipment budget requirements.

Finishes Costs

Finishes in construction account for a large portion (32%) of the initial construction cost of a health care facility.[4] The cost of finishes may be part of the construction budget or it may be a separate budget item. This is often determined by who is providing the finishes budget. Because cost for finishing details (such as wall and flooring surfaces, furnishings, and window treatments) varies greatly depending on design decisions, many firms separate out costs of finishes. This allows project managers better control and oversight of the various cost drivers.

Professional Fees

This category covers professional services for all planning/predesign, design, construction, and commissioning services, including consultants not traditionally listed in the basic architectural or engineering categories. For example, the fees for construction management or a materials management consultant are not defined as basic architectural or engineering services.

Permit Fees

The local building department, the regional utilities, and the state's department of health each levy their own fees to review and approve the project plans and construction. These permit fees are typically based on the construction cost and should be accounted for in the project budget.

Escalation Fees

These fees come into play when there are unreasonable or unpredictable delays in the project, or when the general time frame is long. To account for escalation, projects are often estimated to the midpoint of completion, which means the schedule must be known in detail prior to budgeting. When setting an escalation factor, the risk is shared by the organization and the construction team. On a large project extending across a number of years, even a modest escalation factor of 3% per year can result in a significantly higher cost estimate for the project.

Budget Contingencies

Because of the complex nature of projects, as well as the impossibility of predicting exactly what conditions will be encountered during a project, organizations must allow for contingencies related to the budget. If an organization has an absolute limit on the amount of money it can spend on a project, the initial allowance for all contingencies should be larger. If cost overruns are of little consequence, more money can be budgeted for the project itself and less for contingencies. Following are contingencies that should be considered during the budgeting step of the planning phase.

Design Contingency

Generally, a design contingency is established early in the predesign stage of planning or in the design phase to cover unforeseen conditions. This contingency should be largest

during the predesign stage, but it can be reduced as design and documentation progress. Design contingencies for renovation projects vary considerably, depending on knowledge of such conditions as the presence of asbestos, concealed mechanical and electrical systems, and building code changes.

Construction Contingency

A construction contingency should be budgeted to cover field coordination and unanticipated conditions during construction. For new construction, a rule of thumb is to initially budget construction contingencies at 2% to 4% of construction cost; for remodeling, 4% to 10% is typical.

Owner Contingency

In addition to construction and design contingencies, the organization as "owner" should carry a contingency. Owner contingencies are often used for changes in project scope that occur after consultant bids are received. These can vary from 5% for new construction to 10% for smaller remodeling projects. As the design moves forward, firm pricing on construction and equipment serves to reduce risk, and the contingency should be reduced accordingly.

Step 6: Finalizing the Master Facility Plan

The goal of master facility planning, as explained at the beginning of this chapter, is to develop a definitive master facility plan. The project team develops a final conceptual plan that addresses all the planning goals and issues for all projects. This plan, if developed properly, will be flexible enough to meet the evolving needs of the organization for several years. A well-crafted master facility plan provides guidance and information needed by the project team members as they work with organization leadership to continue making critical facility-related decisions, many of which will have lasting consequences.

Because an organization's master facility plan may embrace several projects, a particular project may be the first one in that master facility plan or a later one. Regardless, any preliminary facility plan and the more detailed project plans based on them (see Chapter 2) must work within the master facility plan, which is created first; the projects are part of the phasing in of the overall master facility plan.

Implementation in Phases

As the planning phase draws to a close, an organization needs to consider how the master facility plan will be implemented. Implementation of most master facility plans must be accomplished in several phases, due to limits on available resources as well as operational and physical constraints. Phasing is a major planning factor and can have an immense impact on timing, schedule, and cost. It can also have a major impact on the care and comfort of patients and staff. Note that phasing of a master facility plan is of broader scope than the schedule phasing of a particular project, as explained on page 10.

The first step in the master facility plan phasing process should be communication with staff and the public that something major is about to happen. Subsequent steps will bring forward new or revitalized services and spaces, as recommended in the master facility plan or in the predesign part of the planning for a specific project.

Step 7: Ensuring Regulatory Compliance

Regulatory process requirements vary from state to state and country to country. It is critical to any project that the various regulatory requirements for approving and constructing a health care facility be identified and all relevant stipulations met.

Most jurisdictions within the United States and internationally have several review steps that span the project process. Often this includes preliminary approval of the project, intermediate approval of plans and costs, final approval of plans, and occupancy permitting. This chapter does not attempt to discuss each of these requirements; instead it recommends that any partner chosen for the project be knowledgeable about the associated regulatory requirements. Regulatory review processes can add months or even years to the project schedule. See FOUNDATIONS: Standards and Regulations.

Certificate of Need

One activity to complete before proceeding to the next step is securing a certificate of need (CON). This involves justifying to the state why a project is necessary. It allows states to provide a balance of services across health care organizations and ensures that each one is adequately serving its community. Some states require this; others don't. If a state requires one, organizations should have a preliminary review with CON

hearing staff early in the planning process and allow extra time in the schedule for the CON hearing process. Presenting a master facility plan as part of the review will show the scope of the organization's plans and may facilitate CON hearings for all projects in the master facility plan.

Step 8: Documenting the Master Facility Plan

All project plans must be documented in a manner that is not only easy to understand but also easy to use, share, and store. This documentation serves multiple purposes, such as providing the historical perspective of selection decisions and rationales, and orienting new partners and organizational team members.

Form and Format

A master facility plan may be documented into a book (physical or digital) that includes a text narrative, tables, and drawings. This book should contain an executive summary that highlights key goals, facts, issues, assumptions, facility needs, concepts, and master facility planning proposals for specific projects. An executive summary should enable key decision makers to digest the most important information and make informed decisions without reading the entire document. The body of the document should be organized to reflect the key steps in the planning phase and the findings that resulted from each step. The body provides the substantiating evidence for the master facility plan proposals. Documentation of the steps in the planning phase may be located in an appendix and include such information as the work plan and schedule, meeting minutes, and background information.

For Communicating and Training

Other ways to document the planning phase include slides or other multimedia presentations, large presentation drawings of the plan proposals, and models (including three-dimensional presentations), that reflect the physical implications of the plan. These are useful for communicating the master facility plan to a broad range of constituencies in a variety of venues. Planning presentations are often used to present to community groups, staff, board members, and the media. The ability to communicate the master facility plan with these groups is critical to successful implementation.

Documenting the process is especially important when there is staff turnover affecting the makeup of the team. Whenever a person leaves the team, his or her replacement must become familiar with the project's history, goals, description, elements, phases, status, and so on. Without thorough documentation, valuable time and knowledge can be lost, which opens the door for poor, uneducated decisions and potentially increased costs for time overruns and error remedies.

Build or Renovate?

As planning progresses through to finalization of a master facility plan, organizations evaluate whether to build new facilities or renovate existing ones. In some cases, organizations can renovate and convert existing space for less money than they can build new space. Often, however, renovation costs may exceed construction costs, due to unforeseen conditions, phasing, scheduling, or logistical complexities.

A wide variety of physical conditions will determine the viability of renovation, including the following:

- Amount and type of space available for renovation
- Mechanical and electrical system limitations
- Ability to work within the existing building's boundaries
- Location of structural columns and walls
- Location of vertical penetrations (such as mechanical shafts, elevators, and fire stairs)
- Location of staging area (either close in proximity or some distance away from the site)
- Temporary parking for staff and contractors
- Abatement of hazards (such as asbestos in older buildings)

Renovation Issues to Consider

Other issues to consider when deciding whether renovation is the best option are listed below. The Project Gallery: Major Renovation on pages 26-27 describes how one hospital dealt with some of these complex issues during a major renovation project.

- *Functionality*
  - How will the space function to support the mission of the organization and its role in the community?
  - How large is the discrepancy between the current space and the desired functionality?
- *Adaptability*
  - How can the space be adapted for the desired use?
  - How much will it cost to adapt?
  - What systems or services will be compromised by the renovation?

- *State of the facility*
  - Can the infrastructure support the new technology?
  - Will the utility systems need upgrading or expanding to meet the demands of the new space?
  - What hidden costs might arise, such as removal of hazardous materials?
- *Ability to meet current requirements*
  - Will all systems meet current fire and safety code requirements for the new space, or will they need updating?
  - Will the renovation affect the organization's ability to meet accreditation standards?
- *Physical age*
  - How much useful life is left in the major construction elements of the facility (for example, heating, ventilation, and air-conditioning [HVAC], boilers, windows, roof)? Will they need replacement?
  - Is it cost-effective to replace aging utility systems with new, more efficient versions?
- *Future-proofing ability*
  - How long will it be before the renovation needs updating? How long for new construction?
- *Cost of downtime*
  - Will the project deter patients from using the facility?
  - Will temporary facilities be needed to avoid a break in services?
- *Possibility of hybrid approach*
  - Can the organization renovate some of the existing elements and replace others?

Project Gallery

Major Renovation

Hamad Bin Khalifa Medical City

To respond to the needs of the growing population, Hamad Medical Corporation (HMC) in Doha, Qatar, was concluding the renovation of a health care facility as 2014 came to a close. Known as Hamad Bin Khalifa Medical City, the facility consists of three hospitals, a Translational Research Facility, and a Bio-Bank. This project, which began with a shelled building, was designed as a children's hospital, women's hospital, rehabilitation hospital, and skilled nursing facility. However, four years after the start of the project, three of these buildings changed use and had to be redesigned.

From the beginning, this project was a challenge from both a clinical services and a facility perspective. In the harsh environment of Qatar, many of the components in the existing building had to be replaced or upgraded due to inactivity over a long period of time. New room layouts did not always fit the existing space. To incorporate new technologies, existing elements like columns had to be relocated. Also, the weight of new equipment necessitated adjustments to the concrete slab and load-bearing columns.

As clinical models and patient flows were analyzed, the connectivity between the buildings had to be amended. While the original design gave connectivity at ground level and basements only, new connections were incorporated at the higher levels to improve staff efficiency and provide flexibility between the spaces. This change also helped to support the new initiatives for education and research.

Different Standards

Still another challenge the project faced was the use of different standards in the design. Using mixed sets of standards is common in the Gulf States. In this case, the

facilities were designed to Facility Guidelines Institute (FGI) American standards (see FOUNDATIONS: Standards and Regulations), but the services were designed to British codes. For example, the head units for the beds purchased for the ward bedrooms were designed under the FGI *Guidelines*, while the pipe work for the medical gases was designed under the British code. The result was two sets of pipe work in different sizes. This triggered some difficulty in defining ultimate responsibility in commissioning the system (see Chapter 4). Going forward, HMC adopted one set of consistent standards to avoid this problem in future facilities.

Design for Flow and Access

This project was executed under a design-and-build contract. The original designer finished at the schematic design stage (see Chapter 2), and the contractor engaged a different design team. This discontinuity led to delays. To solve the problem, HMC engaged a consultant team to provide coordinated room data sheets (see Chapter 2).

When designing the women's hospital, the consultant team analyzed patient flow to find ways of simplifying and reducing patient journeys through the facility (see DESIGN FOCUS: Designing for Safety and Reliability). One example is the design of the LDR (labor/delivery/recovery) rooms. These are birthing rooms designed for comfort and support, where labor and delivery can occur without moving to another room or bed. Rooms are relatively large, and each has a dedicated equipment room and bathroom. Each room is decorated in soft colors and warm tones to help create a relaxed and homelike environment. Three operating suites for cesarean delivery are in close proximity to the LDR area, as is the neonatal intensive care unit. This hospital has a dedicated entrance for obstetrics and gynecological urgent care, which is separated from the outpatient entrance.

The facility's Ambulatory Care Centre is designed to provide HMC with a high-quality, safe, and cost-effective approach to day surgical health care. Providing day surgery, combined with new methods of imaging and point-of-care testing (POCT), alleviates the immediate need for inpatient beds, thus taking the pressure off the existing tertiary hospitals. The POCT can also facilitate reduced waiting times in the outpatient clinics. The patient care process is designed to produce the best possible clinical outcome, maximize patient convenience, and offer as many treatments and procedures as possible on an ambulatory basis. This facility is linked to the Women's Wellness Centre at four levels, which gives ease of access to shared services and opportunity to use theaters and bedrooms should a sudden need for surgical or other services arise during the births.

Growth Challenges

HMC has evolved over the last decade into a major provider of acute and continuing care, and it continues to grow at a very fast pace. As is true for many successful international hospital providers, that growth has produced a number of challenges for the organization. The challenges can be grouped into two areas:

- Managing a series of service and facility changes successfully to open three new hospitals and a research facility while making the best use of the total available resources in the short and long term
- Developing the clinical services across HMC into a corporate model that will support an Academic Health System, encourage internationally recognized best practices, and build a hub of highly specialized, high-impact services

Transfer of Services

As the project neared completion, managing a staged transfer of services was expected to be a challenge, with 3,400 new staff members slated to be integrated into the system (see Chapter 4). HMC developed a Clinical Services Reconfiguration Programme to manage this complex change process. This program was created to simultaneously develop clinical leadership capacity and reform practice within and across recognized clinical specialties. To help achieve this goal, the organization developed and adhered to the following set of guiding principles:

- Provide facilities that will give HMC international recognition as a health system that integrates excellent treatment, care, education, and research.
- Ensure safety in treatment and care, and the best experience for each individual patient.
- Ensure that services and facilities will be used to optimize competitive pricing of activity in readiness for an insurance-based funding model.
- Develop a system of lower-impact acute and specialized services as fully integrated satellites from the central hub.
- Provide a transition of services from current to new locations with minimal loss of availability.

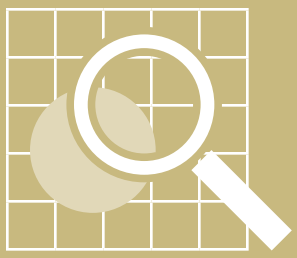
Although renovating an existing building has its challenges, HMC overcame them without compromising patient care delivery, with the end result of improving the patient experience.

Exit Note

This chapter has outlined the types of planning and myriad steps in the master facility planning and predesign process for health care facility projects, as well as vital considerations related to that process, such as collaboration. Whether a project is small or large, a new build or a renovation, the first or the final proposal in the master facility plan, the planning steps are essentially the same. These steps require the same degree of mutual understanding and respect from internal organization and external partner team members to fulfill the health care organization's mission and goals in the project, which are focused on the community it serves.

References

1. International Facility Management Association (IFMA). S*trategic Facility Plan: A White Paper*. Houston: IFMA, 2009. Accessed Jul 6, 2015. http://www.ifma.org/docs/knowledge-base/sfp_whitepaper.pdf.
2. Reno K, et al. Lessons learned: Clinicians' post-occupancy perspective of facility design involvement. *HERD*. 2014;7(2):127–139.
3. Healthy Environment Research Group, Georgia Institute of Technology. A Project Planning Guide for Healthcare Facility Owners. Walrath B, Augenbroe G. May 2007. Accessed Jul 6, 2015. http://herg.gatech.edu/Files/lsu_report.pdf.
4. Lavy S, Dixit MK. Wall finish selection in hospital design: A survey of facility managers. *HERD*. 2012;5(2):80–98.



planning focus

RPI and change management

FOCUS Outline

Robust Process Improvement® (RPI)

RPI's Four Elements of Change Management

- Plan Your Project
- Inspire People
- Launch the Initiative
- Support the Change

TERMS

change management
process improvement

Any project, whether a minor renovation or completely new building, is a change. Although not a requirement, change management—the processes, tools, and techniques for managing people during change—should therefore be a consideration before any planning or design happens, and it should continue through all phases of the project. It becomes particularly important during efforts at process improvement (or business process improvement), a series of strategic actions to identify, analyze, and improve existing processes or create new ones within an organization to meet new goals and objectives.

It is recommended that several iterations of process improvement be undertaken during a facility construction project. The first is in the early planning phase to inform the predesign (see Chapters 1 and 2). During design development (see Chapter 2), processes can be tested through stakeholder involvement and the use of mock-ups to test assumptions. Once the design has been finalized, alignment between the chosen elements and desired processes must occur. These process redesign exercises offer rich opportunities to initiate change management activities for the involved staff. Research has shown that without adequate attention to change management, staff may resist new processes and designs that support those processes. This can lead to failure of the new processes to achieve goals as well as costly physical change requests to re-create the "comfortable" old environment. A structured, planned approach to change management therefore needs to be considered early in the project. Many organizations have committed to a process improvement model.

Robust Process Improvement® (RPI)

Adopting a plan to manage change is essential to maximize the ease, efficiency, sustainability, and overall success of a project. The Joint Commission uses the Robust Process Improvement (RPI) model, which shares elements of Lean and Six Sigma process improvement approaches.

RPI is a set of strategies, tools, methods, and training programs for improving its business processes. Application of RPI increases the efficiency of business processes and the quality of its products and services. A process is robust when it consistently achieves high quality in the following ways:

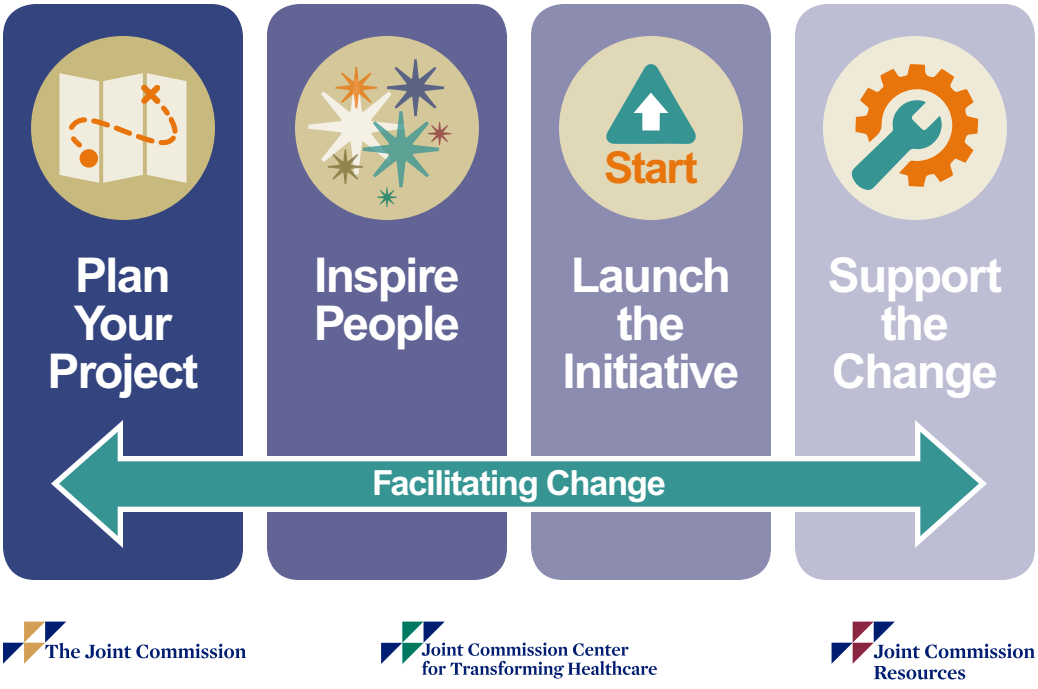
- Recognizing and seeking the voice of the customer
- Defining factors critical to quality
- Using data and data analysis to design improvement
- Enlisting stakeholders and process owners in creating and sustaining solutions
- Eliminating defects and waste
- Drastically decreasing failure rates
- Simplifying and increasing the speed of processes
- Partnering with staff and leaders to seek, commit to, and accept change

The RPI change management method focuses not only on process improvement but also on behavioral changes required to support process improvement.

RPI's Four Elements of Change Management

RPI relies on four key elements of change management, all of which should be considered when working through a project. These are illustrated below and followed by a brief description of each.

Facilitating Change Model™



The Robust Process Improvement® (RPI) business model adopted by The Joint Commission focuses on these four key elements of change management, which can be applied to any construction or renovation project.

Plan Your Project

Starting off right is critical to successful change initiatives. Taking into consideration some key elements in planning a project—such as assessing the culture for change, defining the change, building a strategy, engaging the right people, and painting a vision of the future—will build a strong foundation for change.

Inspire People

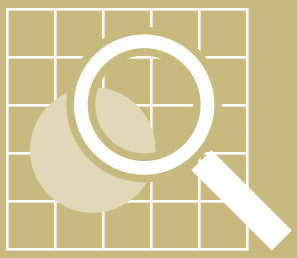
Change is not something that just happens. Instead, it takes place as the result of a series of individual actions that together create something bigger. By soliciting support and active involvement in a change initiative, an organization can begin to obtain buy-in and build accountability for the outcomes. Leading change is critical to a successful process. However, this is also the time to seek out and identify resistance to the change initiative and, if necessary, to develop an action plan or strategy to work through any resistance.

Launch the Initiative

The foundation of all change initiatives is operations. If that foundation is not strong, the change will last only a short time before the cracks start to show. Aligning operations before launching the initiative ensures that the organization has not only the ability but also the capacity to change. Ensuring that operational aspects are aligned with the change initiative empowers staff to function freely in the new state without hitting operational roadblocks.

Support the Change

An organization must have the capacity to support the change. If there is no support, the project will experience failures along the way. Keeping people informed at all stages of the project helps avoid those failures. Monitoring the gains to be sure that the change is both successful and sustainable, and to be sure that the organization shares results with the team at all levels, is vital. Supporting the team and those working through the change initiative by recognizing their work and efforts is integral to sustaining change.



planning focus

alternative facility delivery models

FOCUS Outline

Integrated Project Delivery Model
Construction-Manager-at-Risk Model
Design-Build Model
Design-Assist Model
P3 Model

TERMS

construction-manager-at-risk model
design-assist model
design-build model
integrated project delivery (IPD) model
P3 model

Traditional facility delivery models follow the design-bid-build model described through the pages in this book. Many organizations, architects, and construction companies, however, are using alternative models of facility delivery. These models have their origin in several objectives. One is speed of process. The time from planning to occupancy often spans several years, and if regulations change during the process, project completion can take even longer. Few designs can successfully weather these long time spans, which greatly increase the cost of renovation before occupancy. Another objective for the new models is to create stronger "team ownership" by forming a coalition to build a facility. Access to capital is still another objective addressed by the new models. This is becoming much more of an issue for health care organizations in the United States due to recent downgrading of those organizations by bond markets.

Some of these alternative models are described here.

Integrated Project Delivery Model

Perhaps the most complex new model is that of the integrated project delivery (IPD) model. This model calls for creating a new contractual business structure that includes several of the significant partners of the project, such as a health care entity, the architectural firm, and the construction management firm, all coming together to create a limited partnership (see Chapter 1). The American Institute of Architects describes this model as one that "integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce

waste, and maximize efficiency through all phases of design, fabrication, and construction."[1(p. ii)]

The benefit of this model is that it transforms the traditional unilateral approach (design, then handoff to contractors), which is often fragmented and ineffectively linear, into one that provides early inclusive team efforts, is collectively managed, and encourages multilateral collaboration. The drawbacks to this model are that developing the necessary legal entity is complicated, financial risks and rewards are difficult to determine, and sustaining relationships can be a challenge.

Construction-Manager-at-Risk Model

In the construction-manager-at-risk model, a qualified construction manager is contracted prior to the completion of design and construction drawings (see Chapter 2), which provides the opportunity for collaborative teamwork among the owner, designer, and construction contractor. This model can provide several benefits, such as a closer alignment of the team on cost, quality, and project outcomes; shortened time frames for completion; increased owner confidence in the construction process; and often a guaranteed maximum price (GMP). A GMP reduces risk to the owner, but it requires that there be no major decision changes in the facility design.

Design-Build Model

The design-build model is used mainly when one entity is contracted to design and build a facility. The owner provides the project goals and specifications, then works with the design-build firm to complete the project. A slight variation to this is called "bridging," in which a designer may be hired to begin the design, with the build partner being brought into the project early to begin the design-build process. This variation on the design-build model is not unlike the construction-manager-at-risk model. This type of model is employed often when a project is very time sensitive and somewhat standardized, such as a medical office building. It should be pointed out that in a design-build model, the design team generally works for the contractor or builder. This can place design decisions into a compromised environment, in that the designer's contract is held by the builder, and not the health care facility. Very careful attention, as in all team arrangements, must be paid the business and service attitudes in the relationship makeup of this type of design and construction approach.

Design-Assist Model

The design-assist model is used when a design has a specialty need or in an effort to save design and construction time and secure time-sensitive materials for delivery for the project. Specialty subcontractors may be brought on board the team to advise and assist with the design of particular systems or details (glazing, MEP [mechanical, electrical, and plumbing] systems). This can help control cost as well as save time during shop drawing and the fabrication phase. The design-assist contractor helps in developing specifications and cost estimates, and scheduling for the specialty portion of the project. The design-assist model is always used in conjunction with one of the other models, most often with design-build or construction-manager-at-risk models.

P3 Model

The P3 model involves a public-private partnership that creates a relationship between public governmental units and a private contractor to finance, design, construct, and operate a project without up-front capital from taxpayers. In the United States, this model has gained momentum from cash-depleted governmental agencies as a financing source. The objective of a P3 model is to gain its return on investment from the operations during the concession period, the time contracted for operating the facility. Critical issues for the private entity include the viability of the project for projected revenues, increased liabilities for the project, and long-term warranty issues for the concession period. Internationally, these partnerships are seen as less of a capital procurement issue and more as an opportunity for rapid deployment of services to regions needing health care services. This is particularly useful when the expertise for developing health care systems may be limited within the country.

Reference

1. American Institute of Architects (AIA). *Integrated Project Delivery: A Guide*. Washington, DC: AIA, 2007.

design outcome plan™

FOCUS Outline

Project Vision
Guiding Principles
Design Elements
Processes
Metrics
Baseline
Targets
Outcome

TERM

Design Outcome Plan™ (DOP)

Postoccupancy research conducted both in the United States and internationally cites project leadership turnover as one of the biggest issues for a timely project completion.[1] These changes in the organizational participants often cause a loss of project focus and direction. In addition, nearly all projects start out with an idealistic set of goals, but budget realities sometimes limit the ability to realize all the desired elements chosen for the design. Increasingly, facilities will also serve as models for innovative design features that need to be evaluated postoccupancy to determine their impact on care- or operations-related outcomes.

With this in mind, Joint Commission Resources' Safe Health Design Service℠ developed the Design Outcome Plan™ (DOP), which is a process that documents the project vision and target goals, enlivens those goals through design element choices, identifies process changes driven by the design elements, and evaluates the results of those choices. The DOP provides a sense of continuity throughout a project. DOP documentation should begin during the planning phase (see Chapter 1) with identification of the project vision and guiding principles. Selected design elements are added during the design phase, and any process redesign (see Chapter 2) is determined from final element selection. The evaluation metrics for current measures and target measures are determined prior to facility occupancy, either from internal sources or external benchmarking. Once the facility is occupied and operating, outcomes can be measured against the target. This information is useful for process redesign as well as for subsequent element selection for new projects. The figure on page 35 shows a completed DOP. A description of the individual sections of the DOP follows the figure.

Sample Design Outcome Plan℠

Project Vision:

Outpatient Facility—One-Stop Health Care in Every Community

Inpatient Acute Facility—Building to ensure the best in health care outcomes for our patients and community.

Guiding Principles	Design Element	Process	Metric	Baseline	Target	Outcome
Outpatient Facility Expand ambulatory services in continuum of care provision.	• One-stop diagnostic center for lab and routine radiology tests	• Modify schedule processes to accommodate one visit.	• Increased market share • Visit time for dual testing	50% in secondary 2 hours	70% in secondary 45 min	TBD
	• Outpatient CT and MRI capability	• Reorganize acute care setting schedule for reduced loads due to outpatient option.	• Ratio of inpatient to outpatient exams on campus	1:2	1:0.5	TBD
	• Primary care and referral specialty physician in office space of facility	• Negotiate with physicians to create the "center" approach for leasing the space.	• Percentage of leased space in new facility	0%	100%	TBD
Acute Care Facility Focus on reducing harm from hospitalization.	• 90% single-bed patient rooms	• Modify nurse assignments.	• Paid hrs/PT day (PH/PD)	6 PH/PT. day	5.3 PH/PT. day	TBD
		• Eliminate consultation rooms. • Move consultations, registration, and exams to take place in rooms instead of other spaces.	• Reduction of on-unit patient support space	10% of current space	< 2% of space	TBD
	• Staff hand sinks in every room and treatment space	• Move staff hand washing to rooms instead of corridors.	• % compliance	75%	100%	TBD
			• Reduction of hospital-acquired infections (*C. diff*, MRSA)	40/1,000 days	0/1,000 days	TBD
	• Entry to patient toilet rooms visible from patient bed	• Keep toilet doors open with low light on 24 hours a day.	• Reduction of in-room patient falls	30/1,000 days	0/1,000 days	

This chart shows the components of a completed Design Outcome Plan™ (DOP) for two kinds of facilities (TBD [to be determined] for the outcome is considered appropriate for the plan). The components demonstrate the process of documenting goals and enlivening them through design element choices, and then identifying process changes (process redesign) and evaluating the results.

CT, computed tomography; **MRI**, magnetic resonance imaging; **c. diff.**, *Clostridium difficile*; **MRSA**, methicillin-resistant *Staphylococcus aureus*.

Project Vision

The first step an organization should take is to put into words what the project is meant to accomplish. Another way to think about the project vision is as a mission statement. This is a "big picture" statement that is contextual, inspirational, educational, and marketable. It should be written to reflect the specific project under consideration at a particular organization, as opposed to merely reflecting the organization's vision. Examples are shown in the figure on page 35.

Guiding Principles

These are the aspirational goals or objectives of the project. They create the framework that is fleshed out by specific design element selections (see below). The stakeholders (described in Chapter 2) should provide ideas on what the guiding principles should be. These principles identify for the project executive team (see Chapter 1) the outcomes that design decisions need to uphold. In addition to the examples in the figure on page 35, following are some other examples:

- Serve the community through distributed sites.
- Provide age-appropriate care in all settings.
- Provide support for the patient's family/significant others.
- Incorporate evidence-based design principles.
- Select best practices for process and design decisions.
- Provide patient- and family-centered care in all services.
- Contribute to a healthy sustainable environment.

Design Elements

This is the part of the DOP creation that adds the muscle to the plan. These are the design elements chosen to support the goals embedded within the guiding principles. Because the design elements require specialized knowledge and research, the stakeholders who provide input should be selected based on their expertise on the matter under consideration. This is a place where negotiations can happen regarding needs as opposed to wants. Following is just a small sampling of such design elements, in addition to those shown in the figure on page 35:

- 100% single-patient rooms
- Combined labor-delivery-recovery (LDR) concept for obstetrics
- Pneumatic tube system and robotics for supply transportation
- Central sterile supply and distribution (CSSD) support for all reprocessing needs for equipment
- Hybrid operating room (OR) with MRI and/or CT
- Seismic infrastructure to meet codes

The guiding principles and design elements provide a valuable format for discussion during any value engineering activities (see PLANNING FOCUS: Value Engineering (VE)). Any major changes or modifications to the design elements should be evaluated against the chosen vision, guiding principles, and design elements to determine whether changes will have an acceptable impact on the overall project goals. These discussions should be conducted by the project executive team.

Processes

The chosen elements for the design will most often demand that new processes be created or current ones redesigned to meet the operational needs of the design elements. There may be multiple process changes for each element, depending on the element chosen. Often these are phrased as directives or actions. Following are some examples of process changes based on chosen design elements in addition to those in the figure on page 35:

- Redesign supply and medication flows in response to a design element selection to incorporate the use of a pneumatic tube distribution system.
- Institute safe operation of MRI processes in an OR environment in response to a design element selection of an MRI-hybrid OR.
- Revise transportation of contaminated instruments and equipment to and from the sterile processing department in response to a design element selection of a centralized reprocessing system.

Metrics

Any new facility can have hundreds if not thousands of metrics to track outcomes. It is important to identify the key metrics expected to improve in response to design and process decisions made during development of the design (see Chapter 2). This may require identifying many potential metrics and then conducting a priority-setting exercise to determine those most important for informing leadership on investments in the element—either for potential process redesign or for future project element selection. This is particularly important to systems that may be contemplating multiple facility expansions. Kaiser Permanente has developed a unique competition for creating its "small hospital template" for just this reason.[2]

Baseline

After the metrics are chosen, it is important to identify the baseline performance, using either internal or external benchmarking. Replacement facilities or renovation projects can collect internal baseline data that will inform the postoccupancy review process (see Chapter 4). New facilities will not have internal data to draw on, and may need to go to external sources such as the US Centers for Disease Control and Prevention and other agencies for government-reported statistics. For international organizations, the World Health Organization offers data from global sources. The chosen metric will be the baseline from which to evaluate the organization's change once the facility is in operation.

Targets

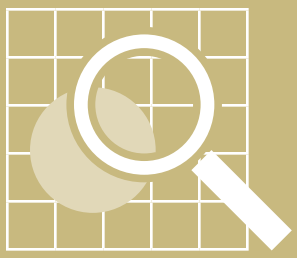
When the metrics and internal/external benchmarks have been selected, organizational performance targets should be defined. The data benchmarks (baseline) and project goals (guiding principles) should inform decisions about what performance numbers would be appropriate targets. For example, if the average organization has an 80% rate of patient satisfaction with noise levels, an organization trying to create a healing environment might aim for a 90% rate. Methods of data collection should be determined early in the metric-selection process. The target setting should be done together with the visioning. It is part and parcel of setting the goals for the project. There are many ways to collect the necessary data, including patient and/or staff surveys, observation by performance improvement teams, and analysis of records.

Outcome

Postoccupancy evaluation of the performance outcomes on the chosen metrics is generally conducted after a minimum of six months of operations. This time frame gives the facility a chance to pass through the postoccupancy phase and have processes stabilize. Some measures will be one-time events; others will need to be cyclical and completed on a predetermined time frame (for example, annual utility costs). The outcome data can be used to inform process redesign, future projects in the master facility plan, and even revision of some design features if results are negatively affecting desired outcomes.

References

1. Reno K, et al. Lessons learned: Clinicians' post-occupancy perspective of facility design involvement. *HERD.* 2014;7(2):127–139.
2. Kaiser Permanente. Small hospital: Big idea competition. Accessed Jul 6, 2015. http://design.kpnfs.com/.



value engineering (VE)

FOCUS Outline

Planning
Design
Methodology and Approach
- **Five Key Steps**
- **VE Benefits**

Construction
Conclusion

TERM

Value engineering (VE)

Value engineering (VE) is a conscious and explicit set of disciplined procedures designed to seek out optimum value for both initial and long-term investment. First used in the manufacturing industry during World War II, it has been widely used in the construction industry for many years.

VE is not a design/peer review or a cost-cutting exercise. VE is a creative, organized effort that analyzes the requirements of a project for the purpose of achieving the essential functions at the lowest total costs (capital, staffing, energy, maintenance) over the life of the project. Through a group investigation, using experienced, interdisciplinary teams, value and economy are improved through the study of alternate design concepts, materials, and methods without compromising the functional and value objectives of the client.

The Society of American Value Engineers (SAVE) was formed in 1959 as a professional society dedicated to the advancement of VE through a better understanding of the principles, methods, and concepts involved. Now known as SAVE International, SAVE has grown to more than 1,500 members and currently has more than 350 active Certified Value Specialists (CVSs) in the United States. Requirements for registration as a CVS were developed by SAVE at the request of the US General Services Administration in the early 1970s.

VE can be applied at any point in a project, even in construction. However, typically the earlier it is applied the higher the return on the time and effort invested. The three main stages (or phases) of a project and VE's application are described below.

Planning

At the planning stage of development, there are additional benefits to be derived from a VE workshop. An independent team can do the following:

- Review the program.
- Perform a functional analysis of the facility.
- Obtain the owner/user's definition of value.
- Define the key criteria and objectives for the project.
- Verify/validate the proposed program.
- Review master facility plan utility options (central utility plant versus individual systems).
- Offer alternative solutions (square footage needs per function, adjacency solutions).
- Verify that the budget is adequate for the developed program.

There are a number of benefits of applying VE at this initial stage of development. These include the following:

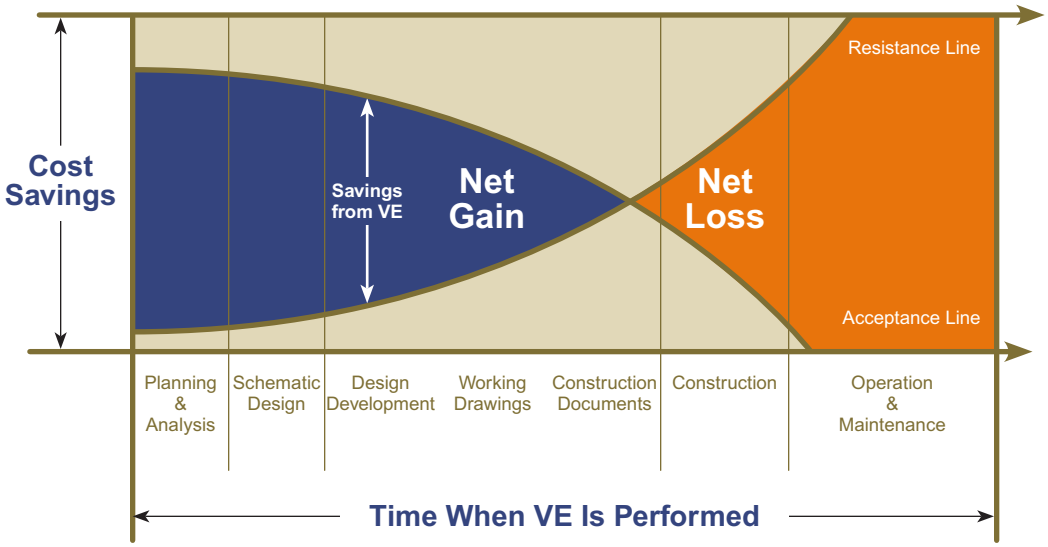
- Any changes to the program at this phase have very little if any impact on schedule and architecture/engineering (A/E) time and redesign costs.
- The project will be developed with fewer changes and redesigns and a greater understanding by all parties of what the final function and space allocations will be.
- An independent team can bring a fresh outside view of alternate solutions from other similar projects.

Design

This is the stage in which most VE participants are used to becoming involved, when the design has at least made it to the schematic stage (see Chapter 2). Most government agencies require at least one VE session at the design phase on projects over a certain monetary amount. The primary tool available to the VE team is the workshop—typically a 40-hour session (or less for smaller or less-complex projects).

The workshop is an opportunity to bring the design team and client together to review the proposed design solutions, the cost estimate, and proposed implementation schedule and approach, with a view to implementing the best value for the money. The definition of what is good value on any particular project will change from client to client and project to project.

Potential Savings from Value Engineering (VE) Applications



This graph shows one major benefit of applying value engineering—the potential for reduced costs as the project moves through essential functions.

Methodology and Approach

During the actual workshop portion of the VE study, the five-step job plan is followed, as prescribed by SAVE International:

Five Key Steps

The VE job plan follows these five key steps:

1. Information Phase
2. Speculation (Creative) Phase
3. Evaluation (Analysis) Phase
4. Development Phase (Value Management Proposals)
5. Presentation Phase (Report/Oral Presentation)

These five key steps are described as follows:

1. *Information Phase*

   At the beginning of the VE study, it is important to do the following:

   - Understand the background and decisions that have influenced the development of the design through a formal design presentation by the design A/E.
   - Analyze the key functional issues governing the project. The functions of any facility or system are the controlling elements in the overall VE approach. This procedure forces the participants to think in terms of function, and the cost and impacts associated with that function.
   - Define owner's objectives and key criteria governing the project.
   - Determine owner's definition of value.

2. *Speculation (Creative) Phase*

   This step in the VE study involves the listing of creative ideas, as follows:

   - The VE team thinks of as many ways as possible to provide the necessary function within the project areas at a lesser initial or life-cycle cost (LCC), which represent improved value to the client.
   - Judgment of the ideas is prohibited.
   - The VE team is looking for quantity and association of ideas, which will be screened in the next phase of the study.
   - Many of the ideas brought forth in the creative phase are a result of work done in the function analysis. This list may include ideas that can be further evaluated and used in the design.

3. *Evaluation (Analysis) Phase*

   In this phase of the project, the VE team, together with the client and/or users, does the following:

   - Defines the criteria to be used for evaluation
   - Analyzes and judges the ideas resulting from the creative session

   Ideas found to be impractical or not worthy of additional study are discarded. Those ideas that represent the greatest potential for cost savings and value improvement are developed further. A weighted evaluation is applied in some cases to account for impacts other than costs (such as schedule impacts, aesthetics, and so on).

4. *Development Phase*

   During the development phase of the VE study, many of the ideas are expanded into workable solutions. The development consists of the following:

   - Description of the recommended design change
   - Descriptive evaluation of the advantages and disadvantages of the proposed recommendation
   - Cost comparison and LCC calculations
   - Presentation of each recommendation with a brief narrative to compare the original design method to the proposed change
   - Sketches and design calculations, where appropriate

5. *Presentation Phase*

   The last phase of the VE study is the presentation of the recommendations in the form of a written report. A briefing/oral presentation of results is made to the client and users, as well as the design team representatives. The recommendations, the rationale that went into the development of each proposal, and a summary of key cost impacts are presented at that time so that a decision can be made as to which value management proposals will be accepted for implementation and incorporation into the design documents.

VE Benefits

In addition to the monetary benefits, a VE workshop provides a valuable opportunity for key project participants to come together, then step aside and view the project from a different perspective. The VE process therefore produces the following benefits:

- Allows an opportunity to explore all possible alternatives
- Forces project participants to address "value" and "function"
- Helps clarify project objectives
- Identifies and prioritizes client's value objectives
- Implements accepted proposals into design
- Provides feedback on results of the study

Construction

During the construction phase, VE is still possible through the use of Value Engineering Change Proposals (VECPs). Contractors can be provided monetary incentives to propose solutions that offer enhanced value to the owner, and share in the financial benefits realized. Clearly the owner must consider contractor-generated proposals very carefully, from a life-cycle perspective and a liability perspective. The A/E team must be brought into the decision-making process to agree to the proposed change as not having any negative impact on the overall design and building function. The evaluation of a VECP is treated similarly to any change order during construction, with issues such as schedule and productivity impacts being considered along with the perceived cost savings generated.

Conclusion

In the final analysis, VE is not only beneficial, but essential because of the following:

- The functionality of the project is often improved as well as producing tremendous savings, in both initial and life-cycle costs.
- A "second look" at the design produced by the architect and engineers gives the assurance that all reasonable alternatives have been explored.
- Cost estimates and scope statements are checked thoroughly, ensuring that nothing has been omitted or underestimated.
- It helps to ensure that the best value will be obtained over the life of the building.

Source: Cullen S. Value Engineering. *Whole Building Design Guide*. Washington, DC: National Institute of Building Sciences, 2010. Accessed Jul 6, 2015. http://www.wbdg.org/resources/value_engineering.php. Used with permission.

the design phase

Chapter Outline

TERMS

architectural drawings
bubble diagrams
building information modeling (BIM)
building sections
civil/landscaping plans
clash detection
communication drawings
construction documents
construction documents preparation
contract conditions
design development
electrical plans
elevations
enlarged floor plans
equipment plans
fire-protection drawings
floor plans
functional plan
HVAC plans
interior design
interior elevations
life safety plans
mock-ups
phasing and demolition plans
plumbing plans
preliminary specifications
process redesign
project specifications manual
reflected ceiling plans
revised building plan
room data sheet
schematic design
site plan
space planning
specifications
structural drawings
title sheet
wall sections

Traditionally in the United States, facility construction or renovation projects have followed a phased approach known as the design-bid-build model. However, in many other countries, organizations, architects, and construction companies are moving from a linear progression through the planning, design, construction, and commissioning phases toward new models of facility delivery (see PLANNING FOCUS: Alternative Facility Delivery Models). Whether the phases of a project occur in a linear fashion or simultaneously, it is important to complete the activities identified for each phase—the various stages within that phase—to ensure a safe, functional facility.

Predesign

As described in Chapter 1, the planning phase may include various types of planning that are necessary prior to design development, including project predesign planning (sometimes called programming). Because predesign is a fluid process, some architects view many of the steps during master facility planning (for example, visioning, goal setting, research, and project requirements) as *part* of this stage. And indeed, master facility planning and project predesign planning are often done concurrently, as explained in Chapter 1.

The general goal of predesign is to visualize the project's objectives and compare them to constraints or limitations. During this stage, the designer works with the organization to create a detailed space plan (see Chapter 1) that serves to identify the number, types, and sizes of spaces that will be needed in the new or renovated facility. Adjacency needs or departmental spatial relationships should be identified, drawn as bubble diagrams (or block diagrams). These simple flowchart-style sketches are usually not drawn to scale, nor are they proportionally accurate. They are used simply to organize elements within a design and help provide direction for the layout and organization of the spaces and systems of the facility related to process, organizational, operational, and functional relationships. The designer should base this work on the guiding principles developed during the master facility planning activities (see Chapter 1 and PLANNING FOCUS: Design Outcome Plan™).

The Functional Plan

Another type of plan created during the predesign phase is the functional plan. The functional plan (sometimes called the program plan or architectural plan) is defined by the Facility Guidelines Institute (FGI) *Guidelines* (see FOUNDATIONS: Standards and Regulations) as "an initial planning document in which the purpose of a project, along with key project requirements, is recorded."[2] This simple definition belies the length and depth of the functional plan, which architects call "the book." The 2014 edition of the FGI *Guidelines* modified the requirements for the functional plan that should be completed during this phase. Per this most recent revision, the functional plan should include the following sections:

- Executive summary
- Purpose of the project
- Project type and size
- Construction type, occupancy, and building systems (see DESIGN FOCUS: Designing for Safety and Reliability for more on health care occupancies)
- Project components and scope (such as surgeries and clinics)
- Indirect support functions (such as utility plant and area transportation)
- Operational requirements
- Architectural space requirements

Like the preliminary facility plan (see Chapter 1), the functional plan addresses a specific project within the master facility plan. It is, however, much more detailed.

Risk Assessments During Predesign

The 2014 edition of the FGI *Guidelines* also increased the number of risk assessments that must be conducted during the predesign stage. Risk assessment is a necessary part of efforts aimed at ensuring safety and reliability in health care facilities (see DESIGN FOCUS: Designing for Safety and Reliability). It is therefore a natural part of the data-gathering efforts engaged in during planning and predesign for facility projects. The list of required Safety Risk Assessments (SRAs) in the 2014 *Guidelines* focus on patients and staff and includes the following:

- Patient handling and movement assessment
- Patient fall prevention
- Construction project infection control risk assessment (see Chapter 3)
- Security risk assessment
- Behavioral and mental health (psychiatric patient injury and suicide prevention)
- Medication safety
- Patient immobility

At the time of this writing, The Center for Health Design and a coalition of organizations are working together under a grant funded by the Agency for Healthcare Research and Quality to develop tools for conducting risk assessments, which can help to streamline the process of gathering and using the information from such assessments.

Process Improvement During Predesign

The predesign stage is also a good time for the organization to challenge current clinical and nonclinical processes, including those that may have come to light during risk assessments. This can be done through process improvement mechanisms, such as Lean, Six Sigma, or Robust Process Improvement® (RPI) (see PLANNING FOCUS: RPI and Change Management). Many projects employ process improvement methods very early in the process to ensure that designs reflect improved processes as opposed to the traditional process, as well as to ready staff for change. The Project Gallery feature on pages 45–48 discusses an organization that used the Lean approach to design and construction in the expansion of a children's hospital.

Overarching Issue

Process Redesign

An organization or a team must never be afraid to reassess information or processes, particularly in this era of rapid change. The project team must be willing to change its direction, reassess its assumptions and objectives, or stop for design or redesign. It is better to take risks in the planning and design phases than to build the wrong facility in the wrong place. This is particularly relevant when planning and designing for processes in a health care facility. Organizations should be willing to engage in any necessary process redesign, the complete overhaul of a key process with the objective to improve performance.

Postoccupancy research conducted by The Joint Commission's publishing, education, and consulting affiliate, Joint Commission Resources,[1] indicates that many organizations felt staff used predesign discussions with the designer to give a wish list for current processes, rather than to address innovation or ways to improve processes. This often led to a facility being built for ineffective and inefficient processes that might take up too much space in the new facility. Project leaders also claimed that they had not pushed hard enough for innovation in processes with their staff. It takes rigorous research and site visits to innovative facilities to help project leaders identify new ways of providing health care. In addition, project leaders wish they had committed to process redesign much earlier in the design process, ideally during the development of the functional plan's space requirements.

Process redesign can be extremely valuable during the planning and early design phases. It appears that there are higher costs associated with performing process redesign early, but anecdotal feedback indicates that it provides a return on investment during design development and in eventual renovation of new facilities.

Project Gallery

Lean Design and Construction

Seattle Children's Hospital

Lean design and construction integrates performance improvement with facility design optimization, with a goal of ensuring the highest and best use of the resources required to build and ultimately operate a new facility. Lean methods were implemented by Seattle Children's Hospital for both its major institutional master facility plan and its long-range/2030 master facility plan to grow the campus by 1 million square feet; as well as the phase 1 "Building Hope" expansion, planned to add a 330,000-square-foot bed wing and new emergency department.

Integrated Design Events (IDEs)

The hospital and its development team held more than 20 integrated design events (IDEs). These workshop events included hospital leadership, frontline staff, patients, and families who gathered to identify operationally efficient, flexible design objectives and to address campuswide issues to improve patient outcomes and minimize waste. The group identified patient and family safety, comfort, and satisfaction, and patient experience as primary factors in the success of any design outcome. Operational goals included increasing the time nurses spent in patient rooms and decreasing staff travel distance and search time by 50%. These goals and others were met or exceeded as of one year postoccupancy.

Steps Toward a Patient-Centered Care Environment

The IDEs became the essential tool in the project. This series of workshops brought key content experts into the same room to move through five basic steps in a process aimed at achieving an operationally efficient patient-centered care environment. These steps are described as follows.

Step 1—Assessment of the Current State

This step involves understanding the current state of operations and space to identify key areas that require improvement, as well as to identify what works well. A team can go to the organization's existing site to see where and how work is taking place (as opposed to how it "should be") and to identify waste in the system.

During on-site assessment of the Building Hope design, the team noticed some existing horizontal adjacencies and decided to broaden the 2030 expansion. A key campuswide strategy for phase 1 in the master facility plan retained core service areas (surgery, interventional radiology, critical care unit beds, and support) in their current locations to service both the existing beds and those being added as part of the expansion, thereby avoiding unnecessary and costly duplication. This also led to a decision to organize and optimize service lines in the new hospital horizontally, rather than by the more traditional vertical orientation, which locates core services on the bottom floors and beds on top. The horizontal orientation allows caregivers to function between inpatient and outpatient environments on a single floor, which improves throughput and quality of care, as well as minimizes patient and staff movements throughout the hospital. One year after opening Building Hope, nurses in the oncology unit were able to spend 62% more of their shift in the room than they could before.

Step 2—Soliciting Voice of the Customer

This step involves project teams identifying and understanding the voice of the customer. (The "customer" is broadly defined as the patient, the staff, and hospital leadership.) It helps establish a basis for evaluating improvement ideas to understand whether or not the space will support an improved process. Ultimately, the goal is to minimize work that provides no direct value to the customer.

For Building Hope, the team created guiding principles that served as benchmarks against which each design proposal was judged. The team constantly challenged itself to make refinements to better respond to the customer's voice. Leadership, for example, wanted to maximize the use of the facility. In the emergency department, the goal was for children and their families to be treated as quickly as possible. The target was to reduce time to provider by 20%. One year after opening Building Hope, the time-to-provider was 15 minutes, down from a baseline of 29 minutes—a 48% reduction.

Step 3—Addressing Space and Operations

Simultaneously. This step involves testing new work flow ideas by creating rapid prototypes of space.

Testing of work flow ideas was done on a variety of scales, such as campus models, tabletop floor plan models, and full-scale mock-ups of key spaces (see below and page 47), including the entire bed wing. In testing multiple ways of arranging beds on a unit, the concept of a pod of eight arose to help maximize visibility among a smaller working group. When mocking up different bed units, the team used full-scale models assembled on the roof of the parking garage. (See Figure 2-1.) The smaller pod concept proved to help minimize travel and maximize visibility.

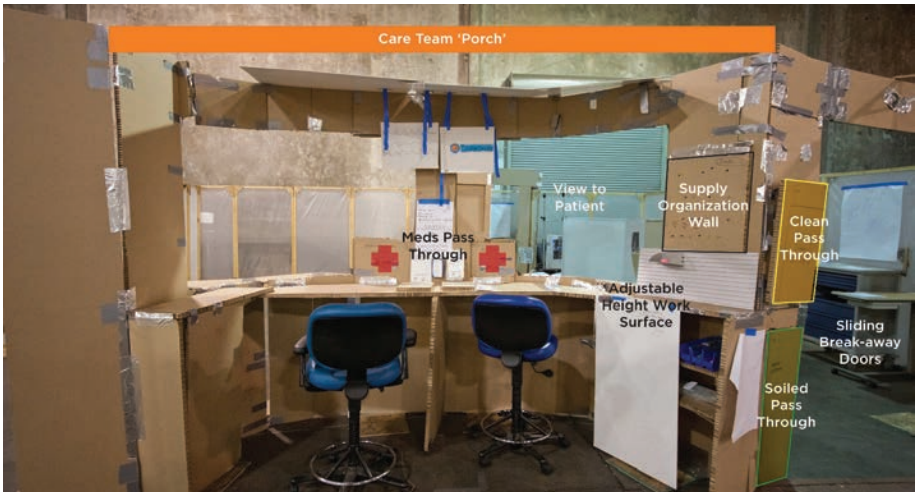
Step 4—Evaluation by Simulation

The content experts are those who do the job on a daily basis (physicians, nurses, medical assistants, laboratory technicians, pharmacists, registration clerks, information

Figure 2-1: Full-Scale Mock-Up of Bed Wing

This rooftop bed unit mock-up is used to assess various layouts.

Figure 2-2: Full-Scale Mock-Up of Workstation



A labeled mock-up of Care Team "Porch" (workstation) to be located outside patient rooms, was part of the testing.

Figure 2-3: Operational Workstation

This is the completed and equipped Care Team "Porch" as represented in the earlier mock-up.

technologists, materials managers, and housekeepers) and experience the care provided (patients and families). They are the best judges of when their job is made easier and safety and quality are improved. They should therefore be allowed to bring their own proposals forward for evaluation by simulation.

By bringing together cross-functional content experts, Seattle Children's was able to propose, test, and confirm which improvements were going to bring the greatest value to the overall system. By investing in this process, the content experts gained a better understanding of how the space and the work flow were intended to function. These same content experts also became advocates and educators for their colleagues during the implementation phase.

The true value of the Lean process became evident during full-scale mock-ups. By simulating delivery of medications and clean supplies, pickup of soiled items, and the experience of staff and family during all of these activities, the team was able to develop a scheme that balanced open central core and semiprivate areas to allow collaboration and maximize visibility among team and patients. The mock-up also helped refine the original goal of providing the nurses with supplies, equipment, and medications at the point of use in the rooms. Also, leadership asked the team to design a bed floor that could provide maximum flexibility, and as a result the full-scale mock-ups were able to test and create a universal bed unit with the same footprint to serve ICU, medical, surgical, and oncology beds.

Figures 2-2 and 2-3 illustrate an earlier full-scale mock-up of a centralized workstation outside patient rooms, and the completed operational version.

Step 5—Incorporate Improvements to Systems

By refining and implementing improvements into standards, work can become more predictable and minimize waste in the system.

During the final IDE, assumptions regarding flow and operational steps for the various units of work were documented, along with requirements to allow realization of the standards. After the IDE and construction, the next step was to implement the standard work flows in the new facility on the day the doors to the new facility opened. This can be achieved by simulating the work before the doors open to create a codified flowchart of steps, roles, and responsibilities for key operational components. Once the facility was operational, staff and leadership had the responsibility of continually monitoring, improving, and refining work. (Also see Chapter 4 to learn more about postoccupancy efforts.)

Lean IDEs for LEED certification

A component of the Lean process included IDEs that focused on sustainable design solutions and energy-use reductions. As part of its commitment to fostering healthy environments, Seattle Children's implemented new energy-reducing mechanical systems, and daylight, ventilation, and water-capturing utilities throughout the site, achieving LEED (Leadership in Energy and Environmental Design) gold certification (see DESIGN FOCUS: Forward-Thinking Design).

The predesign stage offers the designer and health care organizational team an opportunity to explore, debate, and clarify the envisioned end product for the project. The first projected project budget is often created at the end of predesign (see Chapter 1 for more on budgeting). The next stage of design is both more conceptual (in vision) and more concrete (in terms of documentation).

Schematic Design

The primary goal of schematic design (sometimes called conceptual design) is to create a clearly defined, feasible design concept that can be used to create a preliminary construction schedule and a preliminary construction budget (see Chapter 3). Schematic design is the stage in which the overall scope of a project is tested and confirmed. *Overall* is the key word at this stage.

Schematic drawings propose the functional external elements such as building site, vehicular circulation (from, to, and within the site) for all potential users, and parking and entry points to services. The facility's internal configuration and organization of component parts, (including adjacencies), internal movement of users, equipment, and supplies are established during this stage. Building materials or the exterior and structural systems and mechanical systems are proposed too. All of these elements are proposed at this stage in order for the organization to test the design against its strategic plan and guiding principles for the project.

STANDARDS SIDELIGHT

Patient-Centered Care

A patient-centered approach to care requires that patient safety guide all decision making. It includes involving patients and families as partners in their care, which may be directly or indirectly affected by project choices. When patients and families are invited to participate on project teams or are consulted by team members, this helps to ensure safer and more effective patient safety systems and practices.

PS

The "Patient Safety Systems" (PS) chapter in the domestic hospital accreditation manual focuses on helping organizations take a proactive approach to designing integrated systems for patient safety. It describes how standards from other chapters can be applied to achieve improved patient safety. Many are Leadership (LD), Performance Improvement (PI), and, particularly in relation to patient-centered care, Rights and Responsibilities of the Individual (RI) standards. The are no actual PS standards.

Testing Design Alternatives

As noted above, the creative process is often not linear; this is particularly true with complex design problems. In a project, the architect and consultant team test many ideas and develop alternatives. Schematic design is the time for testing those alternatives to allow the project team to identify the best design solutions. Team participation is critical because this is usually the first opportunity for organization leadership and key facility staff team members to understand the spatial implications of their planning efforts. (Project team membership is discussed in Chapter 1.)

Schematic Design: Documentation

When schematic design is complete, documentation should communicate all current design decisions in a format that can be easily visualized, understood, and evaluated by the project team. This documentation includes two- and three-dimensional information (drawings and models), narrative information (preliminary specifications), and tabular information (a space list, construction budget, and project schedule).

Schematic Design: Drawings and Models

Drawings and models are an architect's tools for creative exploration and the exchange of design ideas with others involved in the process. These tools are produced at a scale that clearly illustrates the overall concept. They frequently are used to make public presentations for fundraising and promotional purposes. Drawings developed in a schematic design can also facilitate coordination with consultants and engineers, builders, contractors, and regulatory agencies. Following are some typical types of schematic design drawings, with examples shown in Figures 2-4 and 2-5 on pages 51–52:

- ***Schematic design—site plans:*** A site plan is a drawing that includes the entire property. It illustrates the location and layout of existing and proposed buildings, roads, parking areas, utilities, property lines, zoning setbacks, easements, land contours, and other features of the design. Site plans may include tabular information on building and parking areas and narrative descriptions of zoning constraints.
- ***Schematic design—elevations:*** Elevations illustrate the appearance, size, and shape of significant exterior building walls or vertical elements. They indicate the grade and slope of the ground at the building face, door and window

sizes and locations, roof profiles, and other significant design elements. These drawings include overall (vertical) dimensions and floor elevations.

- ***Schematic design—floor plans:*** Floor plans illustrate the layout of each floor or level for each building. The amount of detail may vary depending on the size of the project. Each room, space, or area in the building program is placed and identified. The plans also show floor and window sizes and locations (unless the project is so large that the scale of the drawings does not allow for clear communication of this information). Floor plans at the schematic design stage usually include overall building dimensions.
- ***Schematic design—building sections:*** At this stage, building sections usually illustrate typical building conditions and special volumetric conditions, such as the view through an atrium or a lobby. These drawings indicate the exterior wall (or "skin" profile), floor locations and heights, floor/ceiling and wall thicknesses, and other important cross-sectional information.

Schematic Design: Preliminary Specifications

Specifications are detailed written data about a structure's materials, products, and systems (civil, structural, architectural, mechanical, electrical, and plumbing). They range from the details of the heating, ventilating, and air-conditioning (HVAC) system to the kind of window glass and doorknobs used in a building. At the schematic design phase, preliminary specifications are intended to provide a general description of the work, including major building components and systems, as well as basic materials selection. Specifications identify materials and systems without in-depth detail. This document is often in the form of a narrative. More detailed specifications come during the construction phase (see Chapter 3).

Schematic Design: Revised Building Plan

The revised building plan (or space list) is tabular information presented as a revision of the detailed space plan that was prepared during predesign or master facility planning, as discussed in Chapter 1. It may be formatted in a manner that allows for comparison of the area as documented in predesign versus proposed schematic design area on a room-by-room, departmental, or overall building area basis.

Schematic Design: Revised Budget and Schedule

At the conclusion of the schematic design stage, a direction should be chosen from the options proposed by the design team, which will be developed further in the design development phase. A revised budget projection should be made at the end of the schematic stage to reflect any changes. The schedule should be updated as well. (For more on the creation of the initial budget and schedule, see Chapter 1.)

Design Development

The primary objective of design development is to turn preliminary ideas created during the schematic design stage into a more detailed presentation of the proposal. All elements established in the schematic design are studied in greater detail before they are selected and a final complete design developed.

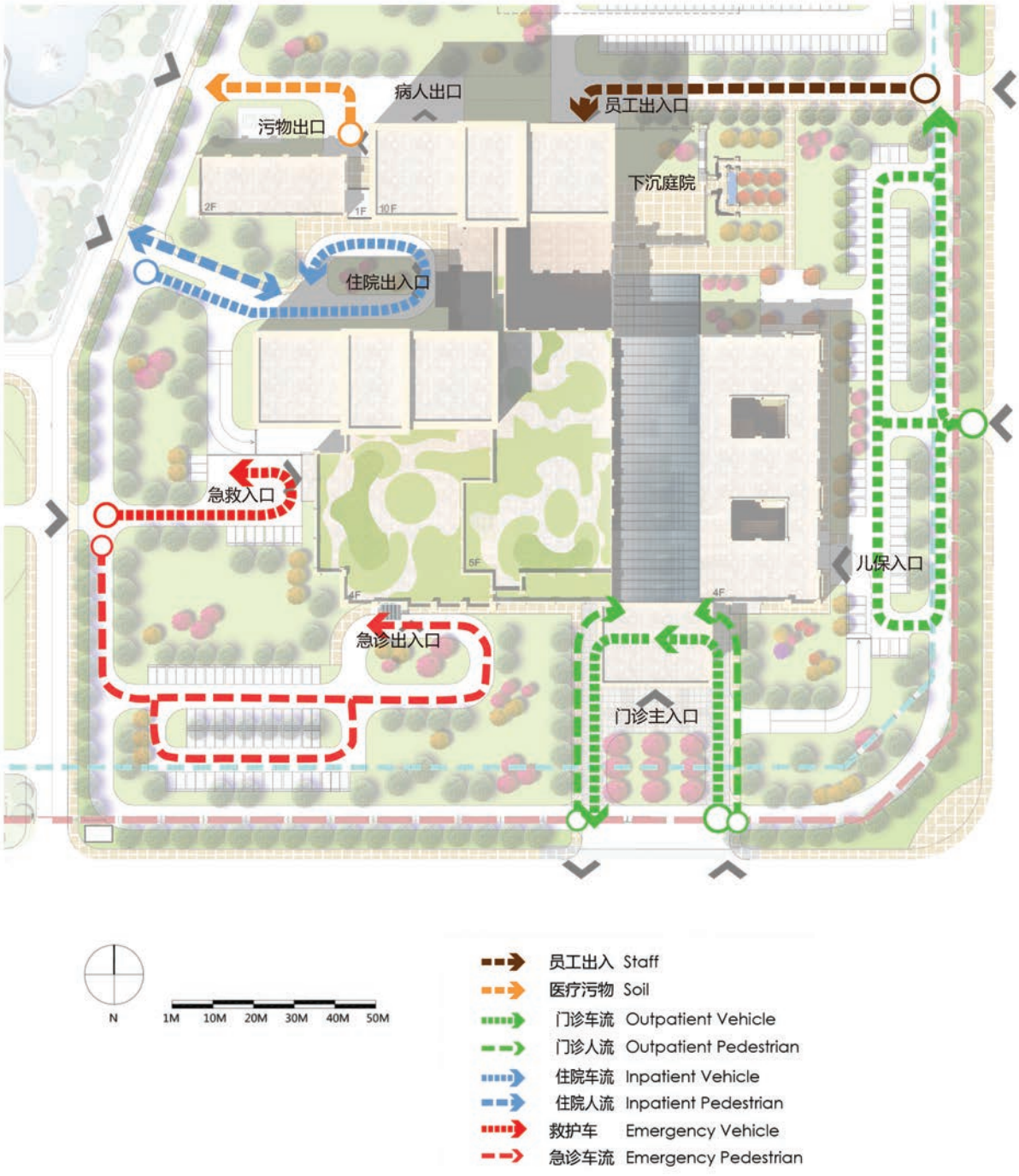
By the completion of design development, all significant elements of the project should be identified, defined, described, sized, and located. This detailed design information must be prepared in a format that all project team members can understand and approve. This is critical to the project delivery schedule because failure to communicate this information effectively can cause frustration, delay, and added expense later. Through the design development process, all project team members should acquire a common, detailed understanding of the project scope and design intent.

A Design Outcome Plan™ (see PLANNING FOCUS: Design Outcome Plan™) may be used to document the facility elements that are chosen. Facility elements should be evidence based and aligned with best practices. They should also enliven and individualize the guiding principles for the facility.

Extensive Interactive Teamwork

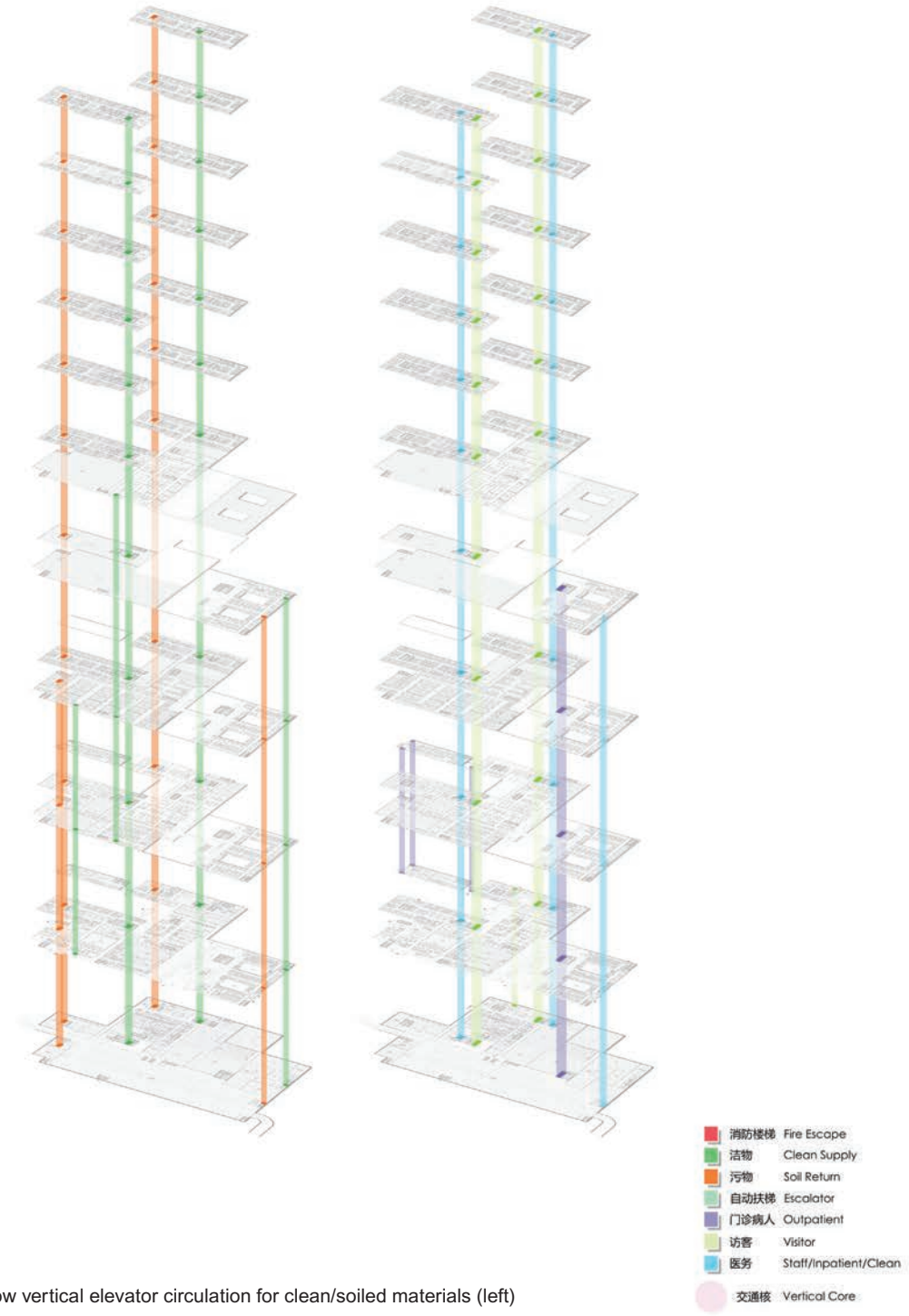
Design development begins after the organization has signed off on the schematic design proposal. In an interactive project process, organization leadership and stakeholders (see below) are involved with making recommendations and providing feedback on detailed design elements. Ideally, this exchange is an extension of the planning process started during master facility planning and predesign. Extensive interaction occurs between architects, structural engineers, mechanical engineers, electrical engineers, and other project consultants during design development. Frequent and effective communication is essential to coordinate the detailed design of interrelated building systems, assemblies, and equipment among the firms and individuals responsible for each area.

Figure 2-4: Schematic Diagrams—Site Plan



This schematic shows traffic patterns for various motorized and pedestrian usage, including the path for removal of soiled materials.

Figure 2-5: Schematic Diagrams—Elevations



These schematics show vertical elevator circulation for clean/soiled materials (left) and pedestrian usage (right).

Stakeholder Involvement

Today's design teams are working closely with many stakeholders in health care. Traditionally, stakeholders have been the key staff of the facility such as physicians, nurses, technicians, and pharmacists. Those groups continue to be key to design, but other stakeholders are increasingly engaged in the process as well. These include the following:

- ***Community members, prior patients, and family:*** These stakeholders bring a different perspective to the facility. Their experiences with the existing facility can inform replacement or renovation projects, or help envision a new facility.
- ***Key large vendor providers:*** Vendors can be tapped for their insights into what needs and advancements are on the horizon in their particular fields.
- ***Environmental groups:*** A wide range of environmental groups—local and global, profit and nonprofit—can assist in any sustainability goals.
- ***Local regulatory bodies:*** These entities provide in-depth insights into current and future code or legislative requirements.
- ***Experts:*** From feng shui to solar power, experts from within and outside of the health care field are available to expand conceptual thinking.

Space Planning and Standardization

Space planning involves determining the way a given space will be furnished, organized, and equipped. It may be provided or directed by the architect(s), an independent planning consultant, health care facility staff, or any combination thereof. As part of space planning, organizations should consider standardizing patient rooms to enhance safety and efficiency. Standardization can also reduce costs. Space plans should reflect such standardization. Following are areas involved in space planning in which standardization will likely be applied: interior design and medical equipment planning.

Interior Design

The detailed design of building interiors begins during design development. Interior design services involve the selection and coordination of interior finish materials, material colors, signage and graphic design, and furniture. These services may include the procurement of interior furnishings. Organizations should keep in mind infection prevention and control, fire and smoke ratings, and safety when selecting finish materials. In addition, organizations should pay close attention to colors, signage, and graphic designs to ensure the building promotes a healing environment (see DESIGN FOCUS: Designing for Safety and Reliability).

Medical Equipment Planning

Organizations should have begun discussions about medical equipment during the planning phase, which includes predesign (per Chapter 1). Ideally, the planning team developed a list of potential equipment. At the design development stage, the design team needs to know types, sizes, and supporting service requirements of equipment to fully define the spaces intended to accommodate major fixed and movable pieces. Medical equipment planning considerations include the following:

- ***Consultant services:*** Medical equipment planning is a specialty in itself. Relatively few architectural firms maintain the internal resources and ongoing expertise for substantive equipment planning and selection. Typically, an equipment planning consultant provides this service, contracting directly with the organization.
- ***Assignment of equipment costs:*** The assignment of major equipment costs to either the construction budget or another capital expense category is a critical issue. Equipment provided and installed under the construction contract should be included in the construction budget (as explained in Chapter 1). Major medical equipment purchased and installed under separate contracts should be identified as a separate line item in the project budget. In major medical equipment construction budgeting, the cost of preparing the architectural, structural, mechanical, electrical, and plumbing systems becomes part of the construction budget, but the organization retains responsibility for procurement and installation.

Regulatory Review

Most organizations begin to involve regulatory agencies and authorities having jurisdiction during the schematic design stage. This should continue during the design development activities. Early and frequent involvement of local zoning officials and building inspectors, as well as national and/or state regulatory agencies, will help organizations avoid regulatory problems and redesign. Organizations should also involve insurance agencies at this time. (Also see FOUNDATIONS: Standards and Regulations.)

Design Development: Documentation

Design development documentation builds on the information

contained in schematic design documents. This documentation provides a detailed representation of the project that can be understood and approved by the project team representing the organization and project consultants and contractors. It also establishes the design baseline that will become a guide for the preparation of construction documentation (see page 58), and provides a thorough documentation of project scope and complexity for estimation purposes.

Design Development: Drawings and Models

Graphic documentation at the design development stage should include revised versions of materials presented at the conclusion of the schematic design stage, along with a great deal of new information. It should have much greater detail and be drawn at a larger scale. Additional models or renderings should be provided to communicate key elements or spaces to the organization leadership and staff as well as to the public. Following are some common types of design development drawings.

- ***Design development—site plans:*** Site plans indicate all the information provided in the schematic design, but they are revised to reflect design changes and a more detailed design solution. Site plans for a phased project identify the scope and location of each project phase. Grading and site elevations are identified in detail. Surface materials and landscape design proposals are also represented.
- ***Design development—exterior elevations:*** Elevations illustrate all exterior building faces and include an update of information presented at the schematic design stage, showing greater detail. Exterior materials and the configuration of exterior building elements are also illustrated in detail. At times, this detailed information is portrayed in enlarged elevation drawings that represent typical portions of the facade showing such items as brick patterns, window or door trim configurations, and so on.
- ***Design development—floor plans:*** Building floor plans are provided for all floors or levels in the project, as in the schematic design phase. They are revised to illustrate the current status of design and are at a larger scale than plans presented in the schematics. Each space indicates door and window widths, door-swing direction, built-in cabinets and counters, plumbing fixtures, and major equipment layouts. Wall thicknesses are accurately portrayed. Each space is labeled, or keyed to a legend, to identify room names and numbers.
- ***Design development—building sections:*** Building sections are enlargements and revisions of the building sections that were developed during the schematic design stage. They illustrate design changes and a greater level of development. These drawings identify and distinguish structural elements, mechanical spaces, interior and exterior wall/floor profiles, and interior space configurations.
- ***Design development—reflected ceiling plans:*** Reflected ceiling plans illustrate the ceiling surface of interior spaces and are drawn at the same scale as corresponding floor plans. Their purpose is to indicate the layout, size, and profile of all ceiling systems and ceiling-mounted fixtures. These plans include light fixture types and patterns, other ceiling-mounted equipment, lay-in ceiling grid patterns, changes in ceiling height, and so on.
- ***Design development—enlarged floor plans:*** Enlarged floor plans are keyed to building floor plans. They are developed for the detailed study and presentation of important, complex spaces, such as patient rooms, diagnostic and treatment areas, and operating rooms. The plans are used to coordinate and illustrate space planning, equipment planning, and furniture layouts in response to functional criteria and other human needs for the space. Room standardization should be apparent in these enlarged floor plans.
- ***Design development—interior elevations:*** Interior elevations are prepared for spaces represented in enlarged floor plans and major public areas of the building interior. They illustrate detailed information, such as cabinets and other millwork, interior windows and other openings, wall surface details, equipment mounting locations, plumbing fixture arrangements, and medical gas outlet locations.
- ***Design development—wall sections:*** Wall sections are created to illustrate highly repetitive or common wall types. They can illustrate interior and exterior wall assemblies for cost-estimating purposes.
- ***Design development—equipment plans:*** Equipment plans are drawings limited to illustrating the layout and size of major medical, food service, reprocessing, or other kinds of equipment. They are prepared by the equipment planning consultants, or, in some cases, by the equipment vendors. Different consultants may be needed to create plans for specific equipment types.
- ***Design development—life safety plans:*** Life safety plans are drawings that visually represent how a US organization

complies with the *Life Safety Code*®.* Contents of such drawings include fire walls, smoke barriers, corridors, and exits, as applicable. See DESIGN FOCUS: Designing for Safety and Reliability.

Room Data Sheets

Many health care facility rooms and spaces have extensive requirements for specific equipment, furnishings, and heating and air-conditioning, electrical, plumbing, medical gas, and communication systems. These requirements need to be determined, recorded, and communicated to appropriate members of the project design and construction teams in a timely and detailed manner. A room data sheet is the standard format for recording the requirements of clinical and patient care areas. It can be prepared in several ways, depending on who is responsible for documentation. It identifies the type, scope, and location of all necessary room elements and systems on a single sheet for each room. It may also identify who will be responsible for purchase and installation (or this may be done as a separate document for the overall project). Determining and documenting room data may be a joint effort of health care facility staff, an equipment consultant, and the architect(s), or it may be prepared entirely by health care facility staff. Room data sheets should reflect any standardization desired between rooms.

Building Information Modeling

Documentation is becoming more electronically based. Many architectural firms are moving from a paper room data sheet to building information modeling (BIM) software programs. According to the National Building Information Model Standard Project Committee, BIM is "a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition."[3] BIM provides precise spatial three-dimensional placement of the room requirements. This provides a visual representation of the spatial design plan for stakeholders to review and use to inform thoughtful input. The same work processes for creating room data sheets are also used for creating the BIM room requirements. However, the architectural firms need to have the expertise and software capabilities to create the BIM model. This may be an important factor to consider during the architect and engineer selection process. One organization's experiences using BIM are described in the Project Gallery on pages 56–57.

A basic premise of BIM is collaboration among different stakeholders at different phases of the life cycle of a facility to insert, extract, update, or modify information in the BIM to support and reflect the role of each stakeholder. The National Institute of Building Sciences notes that, as a practical matter, BIM represents many things depending on one's perspective:

- ***BIM to a project:*** BIM represents information management—data contributed to and shared by all project participants. In other words, it ensures that the right information goes to the right person at the right time.
- ***BIM to project participants:*** BIM represents an interoperable process for project delivery—defining how individual teams work and how many teams work together to conceive, design, build, and operate a facility.
- ***BIM to a project design team:*** BIM represents integrated design—leveraging technology solutions, encouraging creativity, providing more feedback, and empowering a team.[3]

A study to determine the pervasiveness of BIM within the construction industry showed nearly 80% of respondents had moved to using BIM by 2013.[4]

Mock-Ups

Full-size mock-ups of key patient care or treatment spaces are an extremely important part of design development. Mock-ups are essentially full-scale models, but they are not a form of documentation; they are intended as design testing models, for simulation. It is important to provide mock-ups of spaces that will be replicated multiple times, such as patient rooms, toilet rooms, or unit work areas. In addition, mock-ups can be vital for designing complex rooms such as operating suites, interventional diagnostic and treatment suites, trauma rooms, or other new spaces where experience may be limited (see DESIGN FOCUS: Specialty Design). Postoccupancy research has shown that use of mock-ups can prevent flawed or awkward design layouts from being replicated hundreds of times (for example, in a block of patient rooms), or avoid a major safety and/or operational issue in the case of complex rooms. Those surveyed report that the catches that were made during mock-ups more than covered the return on the investment made to provide the mock-ups.[1]

* *Life Safety Code*® is a registered trademark of the National Fire Protection Association, Quincy, MA.

Project Gallery

Building Information Modeling

Northwestern Medicine

Northwestern Medicine (NM) is a Chicago-area health system that combines Northwestern Memorial Hospital, an 894-bed academic medical center; a 117-bed community hospital in Lake Forest, Illinois; Cadence Health, consisting of Central DuPage and Delnor Hospitals; and more than 25 urban and suburban outpatient clinical sites in and around Chicago. Such a large health system encompasses several million square feet of space and manages a large portfolio of projects small and large. NM strives to use its financial and personnel resources efficiently by applying building information modeling (BIM) to the traditional design, construction, and turnover processes.

NM recently mandated that BIM be used for all projects going forward. One of the first to do so was a new 1-million-square foot, 25-story outpatient building located on NM's downtown Chicago campus. Known as the 259 E. Erie project, it was a mixed-use facility involving diagnostic imaging, outpatient surgery, clinic, retail, and other uses, along with multiple phases. These factors made the project a good fit with BIM.

Some advantages, such as clash detection (checking to ensure that systems do not clash), visualization, and quantity takeoffs were clear to the design team from the very beginning. NM also came to understand that to fully realize the benefits of BIM, the organization had to take ownership of the BIM process. This required NM to determine its own capabilities and discover how the model could be truly useful to the project.

Focus on Asset Information

The NM design team wanted to minimize the cost of operations during the life cycle of the building, which can be more than 10 times the construction and design costs. The team set up a meeting between key departments—facility management, facility planning and construction, property operations, biomed, and information technology (IT)—to get an idea of the current challenges each of these entities faced, and to understand how BIM could potentially address those challenges.

One of the biggest challenges for an organization owner, especially a large owner, is to track asset information. This was a common concern across many departments. The operators of these buildings and the assets within are often given incomplete or disorganized information upon project completion. Consequently, they are unable to use the building data that existed at some point during the project because the handover is not mapped to legacy systems. NM decided to make organized facility asset information a focus for its 259 E. Erie project.

BIM Execution Plan

The first step was to use feedback from the end users of the building information to create a BIM execution plan (BEP) with the design team and construction manager. This BEP document, modified from standard industry templates, clearly described the intent for BIM processes and deliverables. One section of the BEP dealt with the software, model sharing, schedule, and level of detail/development. Another section dealt specifically with the uses of the model during design, including clash detection, visualization, quantity reports, energy modeling, and space reports. The last section dealt with the uses of the model during construction and beyond. Here, the NM team detailed the structure of the information for facility assets including not only MEP (mechanical, electrical, and plumbing) equipment but also medical, information technology, furniture, and even artwork elements.

This comprehensive BEP became a contractual amendment to both the architect's and the construction manager's contract—an instrument against which to measure BIM implementation. In fact, this BEP became a template for other project BEPs in the health system. These expectations are included in an enterprise BIM guidelines document that is attached to every request for proposal (RFP) for both design and construction scopes on any project.

Review Sessions, Asset Lists, Unique IDs

During design and construction, BIM review sessions allowed the clinical, facilities, and other support services staff members to review their future spaces. In fact, by bringing in facilities technicians to clash-review meetings for both design and construction phases, NM addressed many access and orientation issues for equipment without costly change orders, or worse, a lifetime of inefficient operation. The ability to access the model on the go, using laptops and tablets, was also helpful. Possibly the greatest value of BIM, however, may have been realized after building operation began. The model allows quick and easy access to all building data, a much better option than struggling to find this information in banker boxes in obscure storage rooms.

After extensive discussions with facilities staff that included both managers and technicians, NM created two lists. The first contained all equipment types that require preventive maintenance schedules, essentially telling the designers which model objects need to be identified uniquely in the BIM. The second list contained a set of equipment attributes that are needed for asset identification and maintenance. This list contained fields such as model number, bar code number, serial number, and warranty start and end dates.

The team quickly realized that a single key element was needed to tie the model element in the BIM, equipment attributes, operations and maintenance documents, and computerized maintenance management system (CMMS) asset information together. This key would allow the end user, the facility technician, to easily access all information. To this end, a unique ID was created. For example, CHI-259-VAV-04-12 is the fourth VAV unit on the 12th floor of the 259 E. Erie outpatient building. This ID is contained in the model, in the attribute spreadsheet, in the CMMS, and in the document management system, allowing NM to access maintenance data and documentation through website addresses contained within each BIM element. This system was so successful that the word quickly spread to other departments, and NM ended up applying a similar system to the biomed and IT departments. In time, NM plans to replicate this across its health system so that all facility information is accessible to those who require it.

Lessons Learned from BIM Application

NM has seen enough benefits from its BIM experience that it plans to use it in ever-increasing ways, such as reshaping energy management, regulatory approval processes, end user signoffs, and work flow optimization for both clinical and support staff. NM is running pilot programs in each of these areas to determine the cost of implementation and the return value potential. The following are some of the key lessons the NM team learned that can be applied to any owner organization using BIM:

- Describe expectations and close out deliverables in all front-end bid/proposal documents and contracts for BIM projects. A BIM guidelines or standards document is one way to do this.
- Have discussions with legacy vendors for project management, document management, and facility management to determine both capability and interest/willingness to open their systems to collaboration. If their vision is myopic, there may be a case for change.
- Develop internal resources and management commitment by demonstrating value internally. The goal is to build a critical mass for BIM by involving departments such as facilities, biomed, IT, property operations, materials management, and clinical groups.

Locations for Mock-Ups

Opportunities for mock-up space include unoccupied on-campus space, unleased commercial space, or nearby warehouses. Space should be sufficient to accommodate all the functional and spatial characteristics of selected areas for mock-up. Mock-ups can range from using tape to outline areas on the floor and walls, to mock-ups with nonfunctioning representations of cabinet work, furniture, equipment, plumbing and lighting fixtures, electrical and medical gas outlets, communications outlets, patient-handling equipment, and so on. Most organizations that use mock-ups start with very simple life-size diagramming, move to working models made from fabricated materials, and finally create a full-scale build-out that includes finish options, which informs decisions regarding cleaning and aesthetics. Some major vendors have been known to provide mock-ups with equipment simulators, such as operating room lights, hybrid room rail systems, and imaging systems, to name a few.

Of course, the ideal situation is in-place mock-ups, which allow for options to be tested in the current real environment, as opposed to merely simulating it. One such option was used

in the University of Princeton Medical Center replacement facility project that provided feedback on several patient room options in the organization's quest to develop the "Ideal Patient Room" as part of a Robert Wood Johnson Foundation grant.[5]

Advantages of Mock-Ups

Mock-ups are indispensable tools with the following advantages:

- ***Help communicate sense of the space:*** Mock-ups help to communicate the reality of space to the staff who will work there and patients and families who will use the area.
- ***Enable test-drives:*** Mock-ups allow staff, patients, and families to, in effect, test-drive the space to ensure that it accommodates its intended functions.
- ***Facilitate feedback:*** Mock-ups allow stakeholders to make informed recommendations for necessary design changes or improvements; stakeholders include staff, patients, and families.
- ***Ensure safety-focused design:*** Mock-ups help to ensure a safety-focused design that addresses intensive care needs, as well as ergonomic and security considerations (see DESIGN FOCUS: Designing for Safety and Reliability).
- ***Allow for process simulation:*** Mock-ups can also be used for simulation of current or redesigned processes. The processes can be routine, such as medication delivery in a patient room, or complex, such as those involved in an emergency code.
- ***Provide training for transition:*** Using the mock-up rooms for training until the completion of the remodeled or new space can be useful in minimizing transition errors (see Chapter 4 for more on postoccupancy transition efforts).

Mock-Ups for Major Projects

Many health care organizations use mock-ups when undertaking major capital projects that involve the use of new or renovated space, new furnishings, and/or new technologies. When used appropriately, mock-ups can significantly inform the design and operations of the space by providing the opportunity to investigate care innovations, examine spatial relationships, and determine the most clinically appropriate materials, finishes, and furnishings. To learn how one hospital used mock-ups in this way, see the Project Gallery on pages 59-60.

Design Development: Revised Budget and Schedule

The design development stage describes project construction content to a point that allows for detailed budgeting. Qualified builders or cost estimators can estimate the size and quantity of most significant building materials fairly accurately from a well-prepared set of design development drawings. They can quantify major equipment, special construction systems, and mechanical, electrical, and plumbing materials and systems. Construction budgets should still include contingencies; however, contingencies can be reduced to reflect more detailed understanding of the project (see Chapter 1). The allowance for inflation also should be updated and refined.

The project schedule requires updating at the end of design development to reflect revisions to the project scope, changes in construction start dates, and a better understanding of the complexity and duration of the overall construction effort.

Construction Documents Preparation

Construction documents preparation is also a primary stage of the design phase, as it finalizes plans and designs and makes it possible to transform those into concrete results during physical construction.

During this stage, construction documents are created to serve as a guide to the contractor or builder in how to build a particular project. Therefore, it is essential to a project's success that the construction documents created at this stage are accurately prepared. They will be the definitive source of all decisions made for the design and the final selection of elements. Once these documents are created, changes will be costly and time-consuming to the project. A simple graph of the relationship between cost and the project time line would show that as the project becomes more definitive, changes in decisions take on a much higher cost ratio.

Construction Documents: Documentation

Also called *contract documents*, construction documents are drawings, specifications, and general contract conditions that serve as the basis for a legally binding agreement between the organization and the contractor for the construction of a specific building, within a specific cost and time frame. The primary goal of this stage is to define and describe the materials, systems, assemblies, and configuration of all components and conditions of the project so the total body of construction documents forms a well-defined scope of work. This information allows the contractor to quantify

Project Gallery

Mock-Ups

Southwest General Health Center

The Pandrangi Tower of Ohio's Southwest General Health Center's (SGHC) main campus was completed at the end of 2014. This major project was positioned to help the hospital meet the growing needs of the community it serves, and has physically and operationally changed the face of the facility.

At ground level, the tower's emergency department (ED) has a large one-story footprint that minimizes travel distances from dedicated parking to entry and includes a canopied patient drop-off area. Strategically located on the four floors above the ED, a 24-bed critical care unit and three 32-bed medical/surgical units create a cantilever that provides a dedicated ambulance entry. Patient floors maximize daylight and views of the neighboring Metropark. An eight-bed "neighborhood" inpatient floor layout minimizes the number of steps from nurse stations to patient and equipment rooms, increasing patient visibility and improving staffing ratios.

Mock-Up Purposes

During master facility planning and the schematic design stage, the project's design partner worked with SGHC leadership to determine and prioritize performance goals, which were then used to drive the planning and the design of the addition. To test some of the design solutions developed in response to these goals, several inpatient spaces were mocked up in a medical office building across the street from the hospital. These spaces included an ICU patient room, a medical/surgical patient room, ED treatment and exam rooms, and open space to test nurse station and corridor arrangements and sight lines.

At several different stages throughout the ensuing design phase, stakeholders (including physicians, nurses, managers, support services, and others) had the opportunity to test the mock-ups during structured visits. The visits were paired with discussions focused on both the opportunities and challenges that the design presented. The discussions took place at a conference table in the mock-up space that allowed for the use of audiovisual equipment. The ability to hold large-group discussions in this space increased the design team's ability to get relevant firsthand feedback.

Mock-Up Phases

The mock-ups evolved across three distinct phases.

Phase 1

During the first phase, the team taped out an entire 8-bed inpatient neighborhood and critical zones within the emergency department on the floor. The staff and stakeholders could begin to understand the floor area of different features and the distance between them. During visits to the site, they were able to give feedback as to whether current dimensions were appropriate given the tasks, resources, and equipment that needed to be taken into account.

Phase 2

The second phase of the mock-ups included true-to-size foam core cutouts of key architectural elements and furnishings. This created a sense of scale and understanding of movement within and between spaces. Utilizing placeholders, teams also had a chance to brainstorm and give feedback on the equipment, technology, and accessories that would need to be provided at the patient room headwalls and footwalls. They had the opportunity to give direct feedback on the space through a structured, detailed survey with specific questions related to how different types of storage, accessories, equipment, and fixtures were laid out in the mock-up space.

Phase 3

During the third and final phase, the mock-up rooms were fully built out—reflecting preliminary selections for materials, finishes, and lighting. During this phase,

multidisciplinary teams had the opportunity to give feedback on the quality and appropriateness of certain materials, considering factors such as infection control, sustainability, and maintenance. This also gave the design team a chance to test its preliminary solutions and make adjustments as necessary.

Mock-Up Benefits

The benefits of the mock-ups are most clearly seen in the impact they had on both the operational and design solutions that addressed some of the performance goals SGHC identified early in the process (see Table 2-1 below).

Table 2-1: Benefits of Mock-Ups at Southwest General Health Center

Design Intent	Design Strategy	Mock-Up Advantage
Improve patient experience through the use of single-patient rooms.	Ensure that single-patient rooms are designed to meet care requirements.	Captured issues and concerns to address in the final design via surveys with specific questions related to how different types of storage, accessories, equipment, and fixtures were laid out in mock-up space.
Provide staff with direct visibility to patients as well as discreet teamwork areas.	Use a hybrid nurse station model with a combination of centralized and decentralized nurse stations to support direct patient observation, allow private staff communication, and optimize staffing ratios.	Tested sight lines and arrangement of teamwork areas in mock-up environment to optimize finalized layout.
Reduce the number of steps between patient rooms and support spaces, including clean, soiled, medication, nourishment, and equipment rooms.	Locate support spaces within 60 feet of every patient room, allowing caregivers to remain in close proximity to their patients.	Tested walking distances, corridor width, and sight lines in mock-up environment to optimize finalized layout.

materials and labor and determine the means of constructing the project, its cost, and the time needed to build it.

Typically, the preparation of construction documents begins after the owner has approved design development documentation. Contract documents are organized into three major categories: drawings, specifications, and conditions of the contract.

Construction Documents: Drawings

Construction drawings are visual images that identify and illustrate the location, configuration, assembly, and size of all project components. These drawings depict an integrated construction intent, and they do not distinguish among various suppliers, trades, or subcontractors. They reveal in much greater detail the information gained during design development, along with other detailed information. Additional documentation is prepared in the form of detailed plan and cross-section drawings, additional enlarged plan and

elevation drawings, schedules of materials, and so on. Drawings are organized into basic sections by content and intent. This enables the contractor and tradespeople to assess and understand the various elements of the work to be done. Most construction drawings are computer generated, printed, and bound in large-sheet format. Common components of construction drawings include the following:

- ***Construction documents—title sheet.*** The title sheet includes an index, general project information, a locator map, and building and zoning classification data; it may also include a rendering of the project.
- ***Construction documents—phasing and demolition plans:*** The phasing and demolition plans include drawings that illustrate the scope of distinct construction stages in multiphased projects and areas to be demolished, renovated, and newly constructed.
- ***Construction documents—life safety plans:*** Life safety plans (see page 54) include building floor plans showing fire exit and exit access, corridor locations, length of travel to exits, and location and size of fire zones or smoke compartments
- ***Construction documents—civil/landscaping plans:*** The civil/landscaping plans are site plans and drawings illustrating site utilities, excavation, grading, landscaping, and other nonarchitectural site improvements.
- ***Construction documents—architectural drawings:*** Architectural drawings include an architectural site plan, floor plans, exterior building elevations, building sections, reflected ceiling plans, enlarged floor plans, wall sections, plan and section details, various material (finishes) schedules, and interior wall elevations (see page 49).
- ***Construction documents—equipment drawings:*** Equipment drawings (see page 54) include plans and details to illustrate the scope, location, and installation details for fixed equipment to be installed or furnished under the construction contract.
- ***Construction documents—structural drawings:*** Structural drawings include floor plans, sections, material schedules, and details illustrating such structural elements as foundation, floor, roof, and wall systems.
- ***Construction documents—plumbing plans:*** Plumbing plans include floor/ceiling plans, distribution and layout diagrams, and details and plumbing fixture schedules (riser diagrams) for all plumbing systems, including water supply, waste, medical gases, and vacuum.
- ***Construction documents—HVAC plans:*** HVAC plans include floor/ceiling plans, details, and schedules for heating, ventilation, and air-conditioning, illustrating the location, layout, and size of mechanical distribution equipment, systems, and devices, including air distribution ductwork, heated/chilled water pipes, and steam lines.
- ***Construction documents—electrical plans:*** Electrical plans include floor/ceiling plan drawings, detailed wiring diagrams, and schedules that illustrate the location, layout, size, and type of electrical service distribution equipment, systems, light fixtures, outlets, switches, and other devices, such as lighting, primary power, emergency power, and low-voltage systems.
- ***Construction documents—communication drawings:*** Communication drawings include floor/ceiling plan drawings, wiring diagrams, details, and schedules illustrating the location, layout, size, and type of electronic communication equipment, systems, outlets, and other devices; these can include telephone, nurse call, monitoring, surveillance, computer networks, cable TV, and so on.
- ***Construction documents—fire-protection drawings:*** Fire-protection drawings include floor/ceiling plan drawings, distribution and layout diagrams, details, and schedules for all sprinkler and fire suppression equipment and systems, including piping, sprinkler head locations, fire department standpipe connections, exit signs, and fire hose locations.

Construction Documents: Specifications

Specifications (see page 50) are detailed written data about a structure's materials, products, and systems. The specifications complement and complete the construction documents by providing the necessary textual information. They are included in the project specifications manual, which is developed by architects, specification writers, and engineers. Contractors use the project specifications manual to bid on the project. They structure their material specifications based on the 50 standardized specification divisions developed by the Construction Specifications Institute (http://www.csinet.org), which include specifications for rapidly developing areas such as telecommunications networks, integrated automation systems, and electronic safety and security systems.

Construction Documents: Risk Management Measures

Many US organizations include construction-related risk assessments and risk management measures with the

construction documents (see Chapter 3). Doing so gives the contractor an up-front understanding of his or her responsibilities regarding implementation of those measures. Any potential issues with implementation should be discussed and resolved before work begins.

Construction Documents: Contract Conditions

Contract conditions are written definitions of the responsibilities and interrelationships among parties involved in the project as they pertain to the legal agreements between the organization and the contractor. These conditions reference general industry standards, building codes, and other requirements applicable to the project and contract documents. Conditions fall into these two categories:

- ***General conditions:*** General conditions address generic issues pertinent to all projects. When creating a general conditions document, an organization might want to consult the American Institute of Architects document *General Conditions of the Contract for Construction*, a highly recognized model that is well understood by design professionals, contractors, and construction lawyers.[6]
- ***Supplementary conditions:*** Supplementary conditions address specific project-related issues and facilitate modifications to general conditions. Examples of supplementary conditions include extensions of contract time due to changes in project scope, and implementing interim life safety measures (ILSMs) (US only) and preconstruction risk assessment measures (see Chapter 3). To ensure compliance with these measures, an organization might want to incorporate a mandatory adherence agreement into the construction contract. This should include penalties for noncompliance with ILSMs and other crucial measures.

Construction Documents: Separate Contracts

An organization may elect to enter into separate contracts for designated portions of the project, particularly for procurement and installation of expensive, highly specialized, technically sophisticated equipment. This is frequently done for data processing equipment, telecommunication systems, laboratory equipment, or radiological installations. These contracts should clearly identify the work as separately contracted and clarify its relationship to work in the prime construction contract.

Construction Documents: Revised Budget and Schedule

The construction documents stage completes the description of project construction content and supports a detailed construction budget. The size and quantity of significant building materials can be accurately estimated at this point in the process. Major equipment and special construction systems are also described and quantified, as are mechanical, electrical, and plumbing materials and systems. The quality level of significant materials and systems is defined. Construction budget contingencies can again be reduced to reflect growing understanding of the project, and the allowance for inflation should be updated and refined at this point. The project schedule also can be updated.

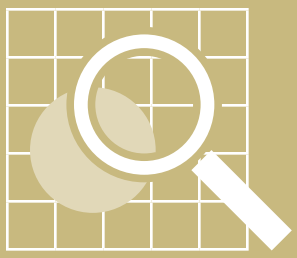
Exit Note

This chapter has outlined the design stages involved in the design phase—from predesign (programming) to schematic design to design development to construction document preparation. It has further outlined the various activities, such as risk assessments, as well as the plans and documentation involved in each stage. Synchronization of these activities, plans, and documentation across these stages, with flexibility for process redesign and continual stakeholder involvement, will lead to a thoughtful, purposed design, which is essential to a safe, well-functioning health care facility. Coverage of helpful approaches and methods, such as Lean design and construction and BIM have been offered to show how the design phase can always be improved, resulting in a smoother and more effective project process.

References

1. Reno K, et al. Lessons learned: Clinicians' post-occupancy perspective of facility design management. *HERD*. 2014(7):2,127–139.
2. Facility Guidelines Institute. *Guidelines for Design and Construction of Hospitals and Outpatient Facilities*. Chicago: American Society for Healthcare Engineering, 2014.
3. National Institute of Building Sciences. Frequently Asked Questions About the National BIM Standard-United States™. Accessed Jul 6, 2015. https://www.nationalbimstandard.org/faqs#faq1.

4. Building information modeling maturity in the United States. *BIM Journal*. 2013 Mar.
5. Eagle A. Safe and sound. Informed design approaches help to prevent patient harm *Health Facil Manage*. 2014;27(6):14–19.
6. American Institute of Architects. Contract Documents: A Series. A201-2007, General Conditions of the Contract for Construction. Accessed Jul 6, 2015. http://www.aia.org/contractdocs/about/synopsis/aseries/AIAB088229.



design focus

forward-thinking design

FOCUS Outline

- Patient-Centered Design
  - Planetree
  - Institute for Patient-Centered Design, Inc.
- Sustainable Design
  - LEED HC: A Sustainable Design Certification Program
    - The *Green Guide*: A Self-Certification Toolkit
    - International Programs in Sustainable Design
  - Incorporating Sustainable Design Principles
  - Sustainable Design Resources
    - Health Care Without Harm
    - Healthier Hospitals Initiative
    - More Resources
- Technology-Supportive Design
  - Computer-Aided Care
  - Decentralized Care
  - Technologically Complex Care
  - Technology Risks
- Adaptive Design

TERMS

adaptive environments
sustainable design

To be cutting edge in the construction or renovation of a health care facility and have the facility remain viable well into the twenty-first century, organizations must consider design aspects not directly related to meeting Joint Commission or Joint Commission International (JCI) standards. Forward-thinking organizations incorporate these considerations into their project plans and long-range master facility plans (see Chapter 1). A few examples of these include patient-centered design, integrating sustainable design principles in design and construction, and planning for flexibility in spaces that can adapt to constantly changing technology in health care. The decisions organizations make about these crucial issues today can impact generations to come.

Patient-Centered Design

Health care design has taken great strides toward considering the needs of patients and their families. A number of nonprofit organizations exist to further the research and understanding of what patient- and family-centered care should be. Two of these groups, described below, share a general goal of helping the health care field understand the importance of patient and family needs.

Planetree

Planetree (http://www.planetree.org) is a nonprofit organization that was founded by a patient in 1978. With a philosophy that care should be organized first and foremost around patients, Planetree guides providers through a structured process that enables caregivers to transform the health care experience they provide and create a truly person-centered organization supportive of the needs of both patients and caregivers.

Among the components of the Planetree model are patient education, food, spirituality, and design of the physical space. All these components inform facility design to create a patient-centered environment. In the Planetree model, each hospital and continuing care community is designed to incorporate the comforts of home, clearly valuing humans, not just technology. By removing architectural barriers, the design encourages patient and family involvement. Spaces are provided for both solitude and social activities, including libraries, kitchens, lounges, activity rooms, chapels, gardens, and overnight accommodations for families.

Originally US–focused, Planetree now has a growing international presence, with more than 500 of its organizational members in eight countries.

Source: Karin Jay, Planetree.

Institute for Patient-Centered Design, Inc.

The Institute for Patient-Centered Design, Inc., or the Institute (http://www.patientcentereddesign.org), is a nonprofit organization established to inspire creative design solutions that address the needs of patients and their families in the health care system. The Institute has identified the following principles that may be used to guide decisions regarding health care facility design:

- Respect privacy.
- Facilitate communication, collaboration, and trust.
- Encourage patient and family participation.
- Empower patients.
- Promote safety and security.
- Provide accessible accommodations.
- Create a comfortable environment.
- Facilitate healing.
- Support staff goals through design.
- Look for design opportunities to respond to unmet needs.

The Institute's primary programs include user group meeting facilitation, an interactive design lab, a quarterly e-publication, and maintaining its Lactation Design Initiative for breastfeeding mothers in the hospital, community, and workplace.

Source: Tammy Thompson, Institute for Patient-Centered Design.

Sustainable Design

In addition to a focus on patient-centered health care, environmentally sustainable health care is a growing concern. Buildings and the building process should not harm patients or the environment. In other words, health care facilities should not, under the guise of patient care, pollute the air, leach chemicals into the water, or overburden landfills.

According to the US Energy Information Administration, hospitals use more energy per square foot than other buildings in the commercial sector, such as offices or retail stores. Research published in the *Journal of the American Medical Association* suggests that 8% of the total greenhouse gas emissions in the United States are caused by the health care industry.[1]

When planning a construction or renovation project, an organization should consider how the project and the resulting structure would affect the environment. This is often referred to as sustainable design. Over the past 25 years, the concept of sustainable design has come to the forefront. It requires organizations to focus on environmental stewardship, social responsibility, and economic viability.

LEED HC: A Sustainable Design Certification Program

A significant voice in the sustainable design movement is the US Green Building Council (USGBC). This nonprofit organization is made up of a coalition of leaders from across the building industry whose mission is to promote buildings that are environmentally responsible, profitable, and healthy. To help health care organizations assess the environmental friendliness of their building projects, the USGBC introduced the Leadership in Energy and Environmental Design for Healthcare (LEED HC) certification program in 2009. This program provides a framework for assessing building performance and measuring sustainability goals. It offers third-party certification, a professional accreditation credential, training, and resources focusing on the industry-specific issues associated with health care construction. For more information on LEED HC, visit http://usgbc.org/leed.

To receive LEED HC certification, an organization's project is assessed for compliance in the following seven categories:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere

4. Materials and Resources
5. Indoor Environmental Quality
6. Innovation in Design
7. Regional Priority

The Green Guide*: A Self-Certification Toolkit*

LEED HC certification was developed through close collaboration with the *Green Guide* for Health Care, a project of Health Care Without Harm (see below, right), and the Center for Maximum Potential Building Systems (CMPBS). Whereas LEED HC is a third-party certification tool, the *Green Guide* is a voluntary self-certification toolkit for sustainable design. It helps organizations incorporate environmentally sound practices into the planning, design, construction, operations, and maintenance of their facilities. The *Green Guide* has two major components. The construction section is applicable to new construction, renovations, and additions. The operations section is a way for existing facilities to track their performance. A complete and current version of the *Green Guide for Health Care* can be found at http://www.gghc.org.

International Programs in Sustainable Design

Similar rating programs exist in other parts of the world including the United Kingdom's Building Research Establishment Environmental Assessment Method (BREEAM, http://www.breeam.org) and Green Building Council of Australia's Green Star (http://www.gbca.org.au/green-star/).

Incorporating Sustainable Design Principles

Although certain areas of sustainable design are not appropriate in health care facilities, many sustainable outcomes can be achieved by making minor changes in the design process. For example, certain building materials are more hazardous to the environment than others. By choosing more environmentally friendly materials (such as bamboo hardwood, recycled glass or gypsum board, and natural earth clay and plaster), health care organizations can contribute to preserving the environment. By designing recycling areas in health care buildings, organizations can make recycling convenient for both staff and visitors, thus eliminating some of the waste the health care industry produces.

Depending on the type of project, organizations can incorporate sustainable design principles in a variety of ways during design and construction. Following are a few that may provide a starting point for consideration:

- ***Recyclable materials:*** Use recycled/recyclable building materials to divert materials from landfills.
- ***Local materials:*** Use local building materials to eliminate the need to transport materials from significant distances.
- ***Shade locations:*** Use shady landscaping to reduce the amount of air-conditioning needed to cool a building, and water-efficient landscapes to reduce the amount of water needed to keep foliage alive.
- ***Energy-efficient equipment:*** Use energy-efficient equipment for heating and cooling systems, washers and dryers, and so on.
- ***Natural light:*** Design interiors to use natural lighting.
- ***Low-emitting materials:*** Use low-emitting materials to prevent off-gassing of volatile organic compounds and carcinogens into the air. In addition, "baking" the new building by elevating the heat to between 80°F (26.7°C) and 85°F (29.4°C) has become a common method to reduce toxins and speed drying times.

Sustainable Design Resources

Before beginning a project, organizations should investigate the types of interventions that can be used to protect the environment.

Various organizations can help provide support and resources for everyday green efforts.

Health Care Without Harm

Health Care Without Harm (http://www.noharm.org) is a global coalition of 500-plus organizations in more than 50 countries that are working to reduce environmental pollution in the health care sector. They focus on such issues as mercury, polyvinyl chloride, medical waste, food, electronics, chemicals, green purchasing, and reducing the health care industry's overall carbon footprint.

Healthier Hospitals Initiative

Many of the largest hospital systems in the United States teamed up with several health care organizations to launch the Healthier Hospitals Initiative (HHI), a coordinated effort to drive and measure environmental interventions in health care. The ultimate goal of the HHI is to demonstrate the positive financial and environmental outcomes associated with specific environmental improvement activities in six areas of focus.

The HHI uses more than 1,500 data points to demonstrate opportunities for proven environmental interventions in

health care, such as financial and environmental benefits to reducing energy, transitioning to healthier food systems, purchasing safer materials, and making less waste. But the work is about more than data. It also tells stories about people and how a healthier environment is quality, is safety, is community, is population health, and is fiscally responsible.

After enrolling in the free HHI and realizing reduced costs and improved performance, many hospitals join Practice Greenhealth. A membership organization, Practice Greenhealth expands the self-serve model of the HHI into a fully customized approach, with awards, benchmarking, technical assistance, and a variety of programs, such as "Greening the Supply Chain" and "Greening the Operating Room." Learn more about the HHI at http://www.healthierhospitals.org and more about Practice Greenhealth at http://www.practicegreenhealth.org.

Source: Janet Howard, Healthier Hospitals Initiative.

More Resources

Sources of information on sustainable design include the following:

- American Society for Healthcare Engineering (ASHE, http://www.ashe.org)
- Environmental Protection Agency (EPA, http://www.epa.gov)
- International Institute for Sustainable Development (IISD, http://www.iisd.org)
- World Academy of Science, Engineering and Technology (WASET, http://www.waset.org)
- Center for Maximum Potential Building Systems (CMPBS, http://www.cmpbs.org)
- The American Institute of Architects, Committee on the Environment (AIA COTE, http://www.aia.org/cote)

Technology-Supportive Design

Perhaps the only constant about technology is the speed with which it changes. The health care industry is flooded with new treatments, advances in diagnostic equipment, and refinements in digital imaging, not to mention more widely applicable technologies like high-speed communication and mobile Internet access. Organizations need to design facilities to do more than meet today's technological needs, or even tomorrow's. Instead they need to design flexible spaces that can adapt to a constantly changing world and support the new technologies of that world. Technology-supportive design may mean designing larger spaces that can accommodate more or larger pieces of equipment. It may mean including extra conduits for fiber-optic cables that will be needed in the future. It will certainly mean designing for the use of computer-aided care and mobile devices. Embedding flexibility into the design itself will save costly renovations or retrofits later.

Following are some areas of health care technology to be aware of when considering technology-supportive design in health care facilities.

Computer-Aided Care

Computers—and, increasingly, mobile devices such as tablets and smartphones—are used to communicate, store information, and prevent errors in almost every aspect of health care. For example, computerized provider order entry (CPOE) with clinical decision support systems (CDSSs), bar code medication administration (BCMA), automated dispensing machines (ADMs), electronic health records (EHRs), and electronic medication administration records (eMARs), all require computers to function. Even more basic than that, e-mail systems and evidence-based search functions require staff to have access—wired or wireless—to the Internet. Facility design should allow for centralized computer servers, computer terminals in patient rooms, docking stations for tablets and laptops, portable charting stations, workstations in physician offices, and so on.

Decentralized Care

Because technology has become so portable, there is less need for a centralized nursing station in acute care settings to monitor patients, and more need for areas adjacent to patient rooms for charting and observation. Also, some room-based technology may require more space—or a different configuration of space—than allowed in many current patient rooms. For example, physicians may want to review digital x-ray or MRI results at the patient's bedside, in the operating room (OR), or even in a remote location. This requires an information technology system that supports both large-screen monitors and handheld devices. These types of technology issues must be considered during the planning phase so that the equipment necessary to support these types of activities has its own "home."

Technologically Complex Care

Both medicine and technology are advancing at a phenomenal rate, a situation that brings a host of new technologically complex procedures. In addition, many existing procedures

have become more technically advanced. For example, open heart surgery and laser surgery are more common than ever, and both procedures are highly technical. Surgery and imaging are merging. Many facilities are building or converting to hybrid ORs that incorporate medical imaging and interventional radiology equipment, along with related technology such as touch screen monitors, high-speed streaming of audio and video, and digital archiving of images (see DESIGN FOCUS: Designing for Safety and Reliability).

Technology Risks

Technology presents opportunities for organizations to seek improvements in patient safety through automation and easier, faster communication. Providing caregivers throughout the organization complete and accurate information though mobile access to patient records can improve real-time treatment decisions, particularly with the use of CDSS. In addition, technology such as CPOE, BCMA, and radio-frequency identification can reduce the opportunity for human error in processes such as medication management. It is important to be aware, however, that technology can present its own set of problems, including concerns about privacy; unwarranted belief in the infallibility of new technologies; and daunting costs for equipment, infrastructure, implementation, and maintenance. Careful planning and security risk assessments during design can help organizations avoid these pitfalls.

Adaptive Design

The key component in designing to support technology is flexibility. Organizations must design new or renovated facilities so they are not out of date by the time they are built. By designing flexibility into the process, organizations can be better prepared to incorporate new technology as it becomes available.

Technology is not the only arena of change in health care: Rapid changes in the organization, cost structure, and function of health care mean that facilities may have difficulty keeping up. More patients are participating in the health care system, and they expect better outcomes with less expense. More than ever before, the design and function of health care facilities are expected to contribute to the quality of care. Adaptive environments are one avenue that may offer a solution.

In the 1960s, inventor Robert Propst, the first director of the Herman Miller Research Corporation, researched enormous changes taking place in work environments. He and his team developed a system of creating furniture and workplaces that "changed with grace." These are known today as adaptive environments. Adaptive environments are intentionally designed to change as the needs of the organization change. They use reconfigurable components that can be moved with minimal effort and disruption. This model of design can be applied to many areas of a health care organization, including laboratories, surgical suites, emergency departments, and ICUs.

Organizations should ask how these areas could, if needed, expand to accommodate new technology as well as other new approaches to health care. An organization may not have the capital on hand for all its proposed technology, but planning the infrastructure so technologies can be added or upgraded as resources become available should be a part of design and construction considerations. For example, building a unit on an outside wall with a clear space for expansion provides flexibility. Other examples include planning for space that can be adapted later for other uses or modular expansions for flexible spaces that are needed quickly, such as expansions to an emergency department.

Source: Roger Call, Herman Miller Healthcare.

Reference

1. Practice Greenhealth. Energy, Water & Climate: Background. Accessed Jul 6, 2015. https://practicegreenhealth.org/topics/energy-water-climate.

specialty design

FOCUS Outline

- Designing for Laboratories
  - Laboratory Biohazard Level
  - Laboratory Biosafety
  - Laboratory Security
  - Flexibility in Laboratory Design
- Designing for Pharmacies
  - Pharmacy Cleanroom
    - Engineering Factors of a Cleanroom
  - Hazardous Drugs in the Pharmacy
  - Pharmacy Storage
  - Pharmacy Regulations
- Designing for Hybrid Operating Rooms
  - Hybrid OR Location
  - Space in the Hybrid OR
  - Vibration and Noise in the Hybrid OR
  - Power and Cabling in the Hybrid OR
  - Flexibility in Hybrid OR Design

TERMS

cleanroom
dark fiber

As discussed throughout this book, health care facilities are extremely complex both in design and function. Nearly every area of a hospital could have been considered for inclusion for this FOCUS feature; however, those specialty areas included have been chosen for the significance of the impact that might result if they are not designed for safety. These are areas that designers and organizations struggle to design for safe, efficient operations. Each of these areas presents unique challenges in safety, such as infection control, security for dangerous or illegal diversion of chemicals or drugs, and complex integration of systems.

Designing for Laboratories

Laboratories are vital components of many health care facilities. The needs of a laboratory are distinctly different, however, from those of projects that deal mainly with patient care and support rooms. If a construction or renovation project includes a laboratory, it is important to involve laboratory management early in the planning process to avoid costly changes later. Laboratory representation should continue throughout the design phase because the needs of the laboratory change rapidly, and new issues could arise before the facility is complete.

Laboratory design entails special considerations in four main areas: safety and security, ventilation, storage, and ergonomics.

Laboratory Biohazard Level

Before planning for a laboratory project, laboratory and organization management should determine the laboratory's potential biohazard level. This will ensure that the laboratory can be designed and equipped to safely contain hazardous

materials appropriate to that level. The US Centers for Disease Control and Prevention (CDC) identifies four biosafety levels for laboratories that help organizations categorize their risks and determine which controls should be in place to appropriately contain those risks. Details on the CDC's biosafety levels are available on its website at http://www.cdc.gov/biosafety/publications/bmbl5/bmbl5_sect_iv.pdf.

A laboratory should also determine its hazard level based on the quantities of flammable liquids kept on site. This process starts with the creation of a list of flammable chemicals, organized by department and use. The quantities of flammable chemicals and size of the laboratory will determine the hazard level, which should guide specific fire separations. Organizations should also determine whether the quantities of flammable chemicals on hand meet criteria used by specific locales to ensure that those codes are met. Each laboratory must meet the most stringent code appropriate to its area, whether it is in the United States or elsewhere (see FOUNDATIONS: Standards and Regulations).

Laboratory Biosafety

Depending on the biohazard level of the laboratory, different safety precautions will be necessary. The scope of this publication does not allow in-depth discussion of each possible safety feature; however, following is a brief discussion of some of the most common safety controls.

- ***Biosafety cabinets and hoods:*** These units can provide a cleaner work environment, protect laboratory staff against aerosols, and contain the spread of infectious agents. The number and classification of these hoods will depend on the laboratory's assessed biohazard level and the specific procedures for which the hoods are used.
- ***Completely cleanable spaces:*** Carpets and fabrics should never be used in the laboratory. All surfaces should be easily cleanable, including flooring, walls, counters, and chairs.
- ***Hands-free hand-wash sinks:*** Due to the nature of the work in the laboratory, these sinks can minimize the spread of hazardous materials. The CDC requires hands-free sinks in laboratories designated as biosafety level 3 and 4.[1]
- ***Maintaining pressurization and security:*** When designing compartments and spaces within the lab, it is important to consider areas that will be negative pressure versus positive pressure (see DESIGN FOCUS: Designing for Safety and Reliability). Access doors should be designed to protect the pressurized areas and secure the lab from nonlaboratory personnel.
- ***Emergency showers and eyewash stations:*** The American National Standards Institute, the CDC, and the Americans with Disabilities Act (ADA) all have requirements about the proper design, location, and signage for emergency showers and eyewash stations (see FOUNDATIONS: Standards and Regulations).

Laboratory Security

Laboratory scientists deal with biohazardous materials every day, some of which can be dangerous and used as potential bioterrorist weapons. It is incumbent on organization management to protect its staff and the surrounding environment from exposure to hazardous material, regardless of its origins.

Some potential security issues are as follows:

- Biohazards such as bacteria, viruses, and fungi
- Radioactive materials from irradiators or radioactive testing (Note: In the United States, irradiators that contain radioactive isotopes must be contained in accordance with criteria from the US Department of Homeland Security.)
- Chemicals that might be used for terrorism or in illegal drug production

One of the primary methods for controlling these security risks is using locks on important components and equipment. Keeping the laboratory doors locked is the first layer of security; alternatively, the layout can be designed in such a way as to allow staff to maintain constant visual monitoring of the entrance. Locking freezers, refrigerators, and cabinets keeps stored specimens secure. Chemical storage rooms should be locked at all times, and radioactive-based irradiators should be kept in a separate, small, locked room, away from exterior walls. (See DESIGN FOCUS: Designing for Safety and Reliability.)

Flexibility in Laboratory Design

Clinical laboratories are changing all the time, and new technology and equipment are introduced frequently. As such, laboratories should be designed to be flexible in terms of space and potential for expansion. (See DESIGN FOCUS: Forward-Thinking Design.)

Designing for Pharmacies

Like laboratories, pharmacies have their own set of special needs that must be part of any construction or renovation project that involves the pharmacy. Cleanrooms (see below) are specific to pharmacy design, and storage is an important consideration as well. Due to the complex nature of cleanroom design regulations, pharmacy placement and layout must be considered carefully. Organizations that consider pharmacy location, position, and layout an afterthought will run into tremendous problems and expense later in the project. Pharmacy specialists need to be involved in the design process.

A key resource for pharmacy standards is the US Pharmacopeial Convention (USP), a scientific nonprofit organization that sets standards for the identity, strength, quality, and purity of medicines, food ingredients, and dietary supplements manufactured, distributed, and consumed worldwide. USP's drug standards are enforceable in the United States by the US Food and Drug Administration. These standards are used in more than 140 countries.[2]

Pharmacy Cleanroom

One sometimes confusing but crucial element related to pharmacies is the USP 797 "cleanroom." The International Organization for Standardization (ISO) standard 14644 defines a cleanroom as "a room in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation, and retention of particles inside the room and in which other relative parameters, [such as] temperature, humidity, and pressure, are controlled as necessary."[3(p. 8)]

Engineering Factors of a Cleanroom

The following are engineering factors of a cleanroom that should be considered in any pharmacy design:

- Size
- Air exchanges
- Particle counts
- Temperature
- Humidity

Hazardous Drugs in the Pharmacy

Exposure to hazardous drugs is another concern related to USP 797. At the time of this writing, USP has proposed USP 800 standards to protect against unnecessary exposure to hazardous drugs. USP 800 makes several changes to USP 797 that need to be considered during design. The key philosophy is to manage containment of hazardous drugs with "as low a limit as reasonably achievable." The key changes to the standard being recommended are as follows:

- Hazardous drug compounding now applies to both sterile and nonsterile compounding, which can increase the number of cleanrooms needed.
- The standard alters the coverage from the start of drug compounding through drug administration.
- Antineoplastic hazardous drugs are now to be stored separately from nonhazardous drugs.
- Hazardous drugs must not be unpacked, stored, compounded, or manipulated in any area with positive pressure relative to the surrounding area (see DESIGN FOCUS: Designing for Safety and Reliability).
- Laminar airflow workbenches or compounding aseptic isolators shall not be used for hazardous drugs (see DESIGN FOCUS: Designing for Safety and Reliability).
- There is no low-volume exemption from this standard.

Pharmacy Storage

In addition to cleanroom design, storage is a major consideration when designing a pharmacy. Because large quantities of chemicals, powders, medications, and diluents enter and must be stored in the pharmacy every day, storage capacity must be built into the design. Storage venues typically are cabinets or shelves. Refrigerated storage areas should also be considered—and controlling temperatures for refrigerated drugs—in addition to access and ease of cleaning. Typically, all products are cleaned prior to storage in the cleanroom to keep particle counts low.

A space separate from the main pharmacy and designated for uncrating pharmaceutical supplies should be designed to reduce the dust and debris caused by shipping boxes. For conservation of space, this can be in the same area where other supplies are uncrated.

Pharmacy Regulations

Other entities besides USP have specific standards for pharmacy facilities that must be addressed as well (see FOUNDATIONS: Standards and Regulations). They include the following:

- ISO
- National Institute for Occupational Safety and Health
- Occupational Safety and Health Administration
- US Food and Drug Administration

- State departments of health
- State boards of pharmacy

Pharmacists should familiarize themselves with all regulations before providing input on planning and design.

Designing for Hybrid Operating Rooms

As medical technology advances and surgical procedures become more intricate, there is a move toward integrating advanced imaging technology into surgical suites. These hybrid operating rooms (ORs) feature equipment such as MRIs, CT scanners, and cardiac interventional units, in addition to all necessary surgical equipment and instruments.

Hybrid ORs offer a unique design challenge. Because they blend two traditionally different functions—imaging and surgery—the mix of physical requirements is new and more complex than either one alone. The design team should seek early and frequent input from all potential users—surgeons, radiologists, anesthesiologists, nurses, and technicians—as well as architects, engineers, and consultants that specialize in acoustics, vibration, and audiovisual design. The design of a hybrid OR will vary based on the specific needs of the organization (including which procedures will be done there, by whom, and using which equipment).

Some issues to consider when planning and designing a hybrid OR are location, space allocation and configuration, minimization of vibration and noise, and adequate power and audiovisual cabling. Each of these issues is covered below.

Hybrid OR Location

A hybrid OR must be placed with consideration for structural and adjacency requirements. For example, it should be located away from high-vibration areas, such as mechanical rooms, to minimize the need for additional supplementary reinforcement and/or vibration isolation measures. Location of the room should also take into account the need for access in order to perform maintenance or the potential replacement of equipment.

Space in the Hybrid OR

Efficient, effective use of space is the primary challenge in designing a hybrid OR. A hybrid OR contains many pieces of bulky equipment, along with related monitors and control panels; it often requires extra staff members to operate the equipment. Space must also be allocated for all the workstations, control devices, central processing units, and power supplies.[4] That is in addition to tables, lights, carts, and other surgical necessities. The equipment must not only fit but also allow free movement through the space. Most hybrid ORs need nearly 1,000 square feet (93 square meters) to accommodate the procedures, people, and equipment. Configurations for shared equipment between rooms and ceiling-mounted articulating booms can assist in controlling space requirements.

Creating three-dimensional models early in the design phase can provide a clear vision of the functionality of the space (see Chapter 2). Later a full-scale mockup should be constructed to allow all stakeholders a chance to identify and address any inadequacies before construction begins.

Vibration and Noise in the Hybrid OR

Advanced imaging technology is extremely sensitive to vibration. The structure of a hybrid OR should be tested for vibration before equipment is introduced to determine whether isolation or further reinforcement is needed. Once equipment is installed, further testing by an acoustical consultant is required. This is crucial to ensure that the equipment will function to specifications in real-world conditions.

Noise in a hybrid OR is also an issue. The added equipment and staff increase the already elevated noise levels of a traditional OR. Acoustical consultants may design heating, ventilating, and air-conditioning (HVAC) ducts and systems to mitigate noise, isolate equipment noise, and even lower alarm and alert volumes.[5]

Power and Cabling in the Hybrid OR

The amount of equipment centralized in a hybrid OR affects the power supply. Extra care should be taken to ensure that regular and emergency power supplies are sufficient and properly placed. All wiring should also meet the requirements of the imaging equipment, such as nonferrous wiring for an MRI installation.

There are many audiovisual components in a hybrid OR: live high-definition imaging, still cameras for documentation, and streaming cameras and microphones for remote consultations or teaching purposes. Conduits and networks must be designed to accommodate the volume of data and location of equipment in the space, and how it all connects with the rest of the facility and remote locations. The design should account for network outages, similar to when there is a power loss.[5]

Flexibility in Hybrid OR Design

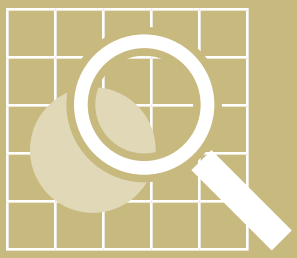
Technology changes rapidly, and hybrid OR design must take this into account. Flexibility should be built into every aspect of the room (see DESIGN FOCUS: Forward-Thinking Design). The following design elements are recommended:

- ***Integrated ceilings:*** These allow features such as lighting and access panels to be moved more easily if the room configuration changes. If the ceiling is also modular, it can accommodate changes in the location of suspended equipment without replacing the entire ceiling.
- ***Extra space:*** Planning for space beyond the minimum is strongly recommended. This allows for equipment to be upgraded or added as services expand or change.
- ***Dark fiber:*** Fiber-optic cabling laid in anticipation of future use is known as dark fiber. Using dark fiber in a hybrid OR minimizes the need for extensive recabling of the room as new technology is introduced and data flow needs expand.[5]

Building flexibility into the design of a hybrid OR will ultimately save the time, money, and inconvenience of renovation.

References

1. US Centers for Disease Control and Prevention. Section IV—Laboratory Biosafety Level Criteria. Dec. 2009. Accessed Jul 6, 2015. http://www.cdc.gov/biosafety/publications/bmbl5/bmbl5_sect_iv.pdf.
2. US Pharmacopeial Convention. About USP. Accessed Jul 6, 2015. http://www.usp.org/about-usp.
3. US Food and Drug Administration. International Standard ISO 14644: Cleanrooms and Associated Controlled Environments. Accessed Jul 6, 2015. http://drug.fda.moph.go.th/drug/zone_gmp/files/GMP2549_2/Aug2106/7.ISO14644.pdf.
4. Miller T. The hybrid challenge: Planning for imaging-enabled operating rooms. *Health Facil Manage.* 2012;25(7):23–27.
5. Perry J, Katz A. Two in one: Planning a hybrid operating room. Health Facil Manage. Mar 7, 2011. Accessed Jul 6, 2015. http://www.hfmmagazine.com/display/HFM-news-article.dhtml?dcrPath=/templatedata/HF_Common/NewsArticle/data/HFM/WebExclusives/2011/WebExclusives_TwoInOne.



designing for safety and reliability

FOCUS Outline

- Designing for Life Safety
  - Life Safety Units of Defense
  - *Life Safety Code* and Other Building Features
- Designing for Infection Control
  - Infection Control with Hand Hygiene
    - Use of Hand Gel
  - Infection Control with Airflow
    - Positive Pressure
    - Negative Pressure
    - Laminar Flow
  - Infection Control with HVAC Engineering
  - Infection Control in Water Supply Systems
    - Decorative Water Features
  - Infection Control and Waste Flow
  - Infection Control and Reprocessing
  - Infection Control in Finishes for Furniture
  - Infection Control and Carpeting
  - Infection Control and Wall Materials
  - Infection Control and Ceilings
- Designing for MEP Infrastructures
  - Fire/Smoke Dampers
  - Air Changes
  - Room Pressurization
  - Humidity Control
  - Redundancies
    - Water Supply Redundancy
    - Electrical Systems Redundancy
    - HVAC Redundancy
  - Emergency Power
  - Fuel Storage
- Designing for Security
  - Abduction and Elopement
  - Secure Mental Health Spaces
  - Secure Valuables and Belongings
  - Secure Entrances
  - Access Control
- Designing for Patient Flow
  - Wayfinding
  - Finding and Entering the Facility
  - Moving Through the Facility
  - Patient Flow and Acuity
- Designing for Emergency Management
  - Patient Flow in Emergencies
  - Security in Emergencies
  - Decontamination in Emergencies
  - Roadways and Parking in Emergencies
  - Convertibility in Emergencies
- Designing for Human Factors
  - Key Human Factors for Design
    - Human Factor 1: Tasks and Standardization
    - Human Factor 2: The Physical Environment
    - Human Factor 3: Technology
  - Places of Respite and Natural Environments
- Designing for Worker Safety
  - Lifting, Reaching, Bending, Twisting, and Stretching
  - Wheeling Across Carpeting
  - Working Under Poor Lighting
- Designing for Fall Prevention
  - Types of Falls
  - Design for Types of Falls
- Designing for Bariatric Needs
  - Bariatric Care Unit Design
- Evidence-Based Design
  - Incorporating Nature
  - Access to Natural Light
  - Reducing Noise
  - Privacy and Confidentiality
  - Social Support

Designing for Technology Safety
- Health Technology Hazards
  - Factors in Evaluating Technology Hazards
  - ECRI 2015 Top 10 Health Technology Hazards

Designing for Facilities in Developing Countries
- Water Supply
- Power Supply
- Hand Hygiene
- Access to Services
- Instrument Sterilization
- Laundry
- Waste Management
- Fire Safety
- Food Services
- Facilities for Family and Caregivers
- Staff Support Areas
- Outpatient Registration/Cashier
- Patient Triage
- Operating Suites
- Isolation Rooms

TERMS

acuity-adaptable rooms
acuity-convertible rooms
adverse event
air changes (ACH)
air curtain
alarm fatigue
bariatrics
compartmentation
dead ends
defend in place
elopement
Emergency Operations Plan (EOP)
ergonomics
evidence-based design (EBD)
hazard vulnerability analysis (HVA)
human factors
laminar flow
latent conditions
life safety
means of egress
monolithic ceiling
negative pressure
occupancy
patient flow
peer visualization
positive pressure
protective environment (PE) rooms
reprocessing
room pressurization
security-sensitive areas
wayfinding

Organizations have an opportunity during the design phase of construction and renovation projects to anticipate, address, and manage safety risks in new construction or renovation of a health care facility. The term latent conditions has been used to refer to things built into the physical environment itself through poor design decisions. These can lead to situations creating opportunities for an adverse event, a harmful or undesired effect resulting from a medical intervention. Designing to minimize or eliminate latent conditions is a proactive way to manage risk.

In its seminal publication on health care safety, the Institute of Medicine stated, "The health care organization must develop a culture of safety such that an organization's design processes and workforce are focused on a clear goal—dramatic improvement in the reliability and safety of the care process."[1(p. 166)] The Joint Commission has made high reliability a focused goal for health care. High reliability organizations focus on predicting and eliminating catastrophes before they happen, rather than reacting to them afterward. The design phase offers the perfect opportunity to build in reliability through design choices.[2]

This FOCUS feature highlights options to build in safety and reliability in health care facility design. While it is not the intent of this book to describe every potential design application, key considerations are introduced here that can serve as a starting point for further study and research.

Designing for Life Safety

The most fundamental design consideration in any health care facility project is life safety, fire protection provided by building features. The Joint Commission, through its Life Safety (LS) standards, requires all US facilities, whether newly constructed, renovated, or existing, to comply with the *Life Safety Code*®* developed by the National Fire Protection Association (NFPA) (see FOUNDATIONS: Standards and Regulations). Recent Joint Commission data on organization standards compliance reveal that compliance with the *Life Safety Code* is one of the most challenging requirements for hospitals and critical access hospitals.[3] Compliance with NFPA's *Life Safety Code* is not a Joint Commission International (JCI) requirement unless the organization, local codes, or country codes have adopted or require it. JCI does require all organizations to meet local and country laws and regulations as well as provide for a safe facility for occupants of the facility, which includes having a fire safety plan, per JCI Facility Management and Safety (FMS) standards (see FOUNDATIONS: Standards and Regulations).

Organizations in the United States must comply with the *Life Safety Code* in two ways during the project process:

- When an organization plans and designs a building, it must ensure that the building meets the requirements outlined by the *Life Safety Code*.
- During the construction phase, an organization must ensure that compliance is maintained throughout that phase by developing interim life safety measures (ILSMs). ILSMs are discussed in greater detail in Chapter 4 of this book.

Life Safety Units of Defense

As of this writing, the Joint Commission's LS standards are based on the NFPA *Life Safety Code* 101-2000.† Requirements vary, depending on occupancy. In life safety, occupancy is the purpose for which a building or portion of a building is used or meant to be used. Depending on the organization, NFPA–defined occupancies may include ambulatory care occupancy, business occupancy, health care occupancy, and residential occupancy. Hospitals fall under the health care occupancy, which employs a "defend in place" response model. This requires protection of occupants by moving them to safe areas within the building, using complete evacuation from the building as a last resort. The Joint Commission has identified five nested structural levels, or units, of defense related to this strategy with the goal being to contain the fire and smoke in as small a unit as possible. The details will vary by the type of occupancy, but in general, these units are as follows, starting from the first level of defense:

- ***Unit 1: Room.*** Closing the corridor door should provide the initial protection. Occupants in a room with a fire leave the room to the safety of the corridor, which is why door closing is so important.
- ***Unit 2: Compartment.*** The compartment (or smoke compartment) is a group of rooms and corridors separated from each other by continuous smoke barriers.
- ***Unit 3: Floor assembly.*** All shafts, chutes, and penetrations between floors must be constructed and protected in a manner to create an adequate building separation for the occupants floor to floor. This separation may involve fire dampers at the floor location or a protected vertical shaft.
- ***Unit 4: Building structure.*** Components of the building structure, such as fire-rated doors, smoke barriers, and features of fire safety (fire alarm, smoke detection, and so on) all contribute to the fourth level of defense for building occupants.
- ***Unit 5: Exits.*** At least two approved exits, which are remote from each other, must be provided for each floor or fire section. Approved exits for health care occupancies include doors leading directly outside the building, Class A or Class B interior stairs, smoke-proof towers, outside stairs, horizontal exits, Class A or Class B ramps, and exit passageways.

This "unit concept" relates to the NFPA concept of compartmentation, using building components (namely, barriers, doors, corridors) to allow staff and patients to "defend in place" in the event of a fire. The goal is not only to

---

* *Life Safety Code*® is a registered trademark of the National Fire Protection Association, Quincy, MA.

† Though newer editions are available, at the time of this writing The Joint Commission continues to require the *Life Safety Code* 101-2000 code because that is the edition required by the Centers for Medicare & Medicaid Services.

prevent the spread of fire but also to provide a safe means of egress, a continuous and unobstructed way to travel from any point in a building or other structure to a public way. Maintaining egress at all times—especially keeping corridors clear of clutter—is a challenge for many organizations, but it is vital for life safety. Designing adequate space for storage of equipment and supplies can assist organizations in maintaining a safe environment.

Life Safety Code and Other Building Features

The *Life Safety Code* also addresses the size, features, layout, and safety precautions associated with many other aspects of building design and layout, including, but not limited to, the following:

- Corridors
- Doors
- Vertical openings (elevators, escalators, linen and waste chutes)
- Sprinkler systems
- Utilities

Designing for Infection Control

Meeting LS standards is challenging, but perhaps the next most difficult thing in hospitals today is keeping patients and staff safe from infection, particularly health care–associated infections (HAI). Multiple Joint Commission standards and safety goals relate to infection control (see FOUNDATIONS: Standards and Regulations). The standards often require an organization to provide evidence that its infection rates demonstrate control of infections that originated in the community as well as HAIs. As is true of designing for life safety, there are many opportunities to protect patients from infection simply through thoughtful facility design. During the planning and design phases, organizations have the opportunity to design layouts and include equipment that helps prevent the spread of infection.

The Facility Guidelines Institute (FGI) *Guidelines* (see FOUNDATIONS: Standards and Regulations) recommend that an infection control specialist be involved at the beginning of the planning phase and also throughout design and construction. The specialist can assist with not only design but also safety practices and decisions during construction (see Chapter 3).

Organizations should consider the issues discussed below when designing for infection control.

Infection Control with Hand Hygiene

Hand hygiene is recognized as the most important factor in controlling infection in health care facilities. Yet, ensuring appropriate hand hygiene remains a challenge. For that reason, the Joint Commission Center for Transforming Healthcare selected hand hygiene as its first project in 2010 with the purpose of improving staff compliance in this area. In its study of hand hygiene noncompliance, 2 of the 10 identified hand hygiene factors were related to the physical environment: ineffective placement of dispensers or sinks, and hands full with no place to set items while performing hand hygiene. The FGI *Guidelines* call for clinical sinks in every patient room, while the World Health Organization's (WHO) hand hygiene material similarly recommends sink accessibility.[4]

Use of Hand Gel

Whichever hand hygiene guidelines an organization chooses (and they must identify which they choose, per Joint Commission standards), the goal of washing in and washing out should be met. This applies to the use of hand gel as well. That may mean compromising between the FGI and WHO guidelines by placing sinks in corridors so they are easily accessible to staff. Designs often show hand sinks in the back of a staff workstation, which requires staff to navigate doorways or other obstacles between the sink and the patient care area. Designers should consider the staff work flow and all the potential areas of contamination between leaving the patient room and accessing the sink.

Hand gel dispensers can be placed for in-and-out access, or even between patients to reduce the potential of cross-contamination between patients in the same room. One issue that has come up about such practices is the concern that alcohol-based hand gels are flammable, and The Joint Commission acknowledges this concern. However, NFPA studies indicate the typical alcohol gel and foam dispensers used in health care settings are of such limited size and volume that the alcohol gel's contribution to the hazard of accelerating development or spread of fire is negligible. Hand hygiene continues to be a process that requires research and diligence to improve compliance among health care providers.

Infection Control with Airflow

To control airborne infection, health care facilities may need to incorporate several different types of airflow strategies, depending on the patient and the space. Three key types are described here.

Positive Pressure

Patients with compromised immune systems from chemotherapy or other treatments need to be protected from possible contaminants in the environment by means of protective environment (PE) rooms. This is usually achieved through the use of increased positive pressure airflow from the patient's room to general areas, such as the corridor. Positive pressure forces air out of the room. PE rooms have a high air exchange rate per hour with recirculation. For patients who require a PE and airborne infection isolation, the preferred (but not required) design includes an anteroom that allows staff and visitors to change, wash hands, and tend to other care needs. This anteroom also serves as an air curtain area. An air curtain system uses two differing air flow patterns to reduce airborne infection around an area.

Negative Pressure

Negative pressure draws air in from surrounding areas. This occurs when a room's pressure is less than that of adjacent spaces, so that the air moves from a positive pressure area, through the negative pressure area, and is exhausted directly to the outside, allowing no recirculation of that air. Negative pressure is used for a number of clinical areas to protect against potential hazards. One use is to have negative pressure rooms for those patients with airborne infectious illnesses such as tuberculosis or chicken pox, as well as deadly viruses such as SARS and MERS, and any other diseases that may be transmitted through the air. Other negative pressure uses are in rooms holding hazardous waste, such as dirty utility and dirty linen rooms, and most laboratory areas, such as microbiology. As with PE rooms having positive pressure, anterooms for negative pressure rooms serve as an air curtain and/or space for staff to wash hands and change into protective clothing and are highly recommended but are not required by Joint Commission standards.

In any space where negative pressure is used, several concerns must be addressed to ensure its effectiveness. First, staff using these areas must be able to tell whether there is appropriate negative airflow. This means monitors should be placed outside the room—or equipment made available for staff to use to ensure negative pressure—even if there is a central monitor as part of the building management system. Second, air must be exhausted properly. Exhaust pipes need to be far away from air intakes and places people may congregate, such as gardens or outdoor activity spaces. Careful consideration of patient populations, contamination risk from external or internal sites, and therapy types must be evaluated to determine the appropriate number and placement of negative pressure areas or rooms.

In addition to negative pressure within patient rooms, patient intake areas may require negative pressure, especially given the potential for air contamination in areas such as the emergency department (ED) or disaster decontamination sites (see page 87). Some architects recommend a progressive zoning of these and other negative pressure treatment areas. This system enables whole zones of rooms or treatment areas to be quickly converted to negative pressure areas for protection of staff and other patients, depending on volume and needs.

Laminar Flow

In areas required to be extremely clean, such as major operating theaters and transplant units, laminar flow is common. In laminar flow, high-volume airflow is forced through filters, usually in the ceiling or wall, past the subject intended to be protected. For example, in an operating room (OR), the air is forced past the operating table with the intent of keeping the patient, staff, and surgical materials as free from contaminants as possible. It is important to identify the areas and uses of laminar flow in the facility to plan for appropriate heating, ventilating, and air-conditioning (HVAC) ducts and filters.

Infection Control with HVAC Engineering

An effective HVAC system can dramatically reduce the spread of infection. Conversely, a poorly designed system can drastically enhance the likelihood of cross-contamination. Effective HVAC systems may include multiple high-efficiency particulate air (HEPA) filtration units to help minimize particles in high-risk areas, such as the OR, intensive care areas, laboratories, and isolation rooms.

HVAC systems should be able to adequately maintain appropriate humidity, temperature, and air exchanges to address the needs of each area of the facility. FGI's collaboration with the American Society of Heating,

Refrigerating, and Air-Conditioning Engineers (ASHRAE) provides guidelines for appropriate air exchanges, humidity controls, and temperature ranges for acute care hospitals and ambulatory and residential care units. Consideration regarding where to place air-handling units, controls, and alarms must also be reviewed for ease of access, potential contamination during cleaning and maintenance, and noise. Emergency generator support should be considered for high-risk areas in the event of a power failure.

In the United States, ASHRAE provides the standards for HVAC systems. The standards are on ASHRAE's website at http://www.ashrae.org/standards-research--technology/standards--guidelines. Many local building standards use ASHRAE as a template as well, and the appendices of both the 2010 and the 2014 FGI *Guidelines* contain the HVAC standards from ASHRAE as they pertain to health care settings (see FOUNDATIONS: Standards and Regulations).

Infection Control in Water Supply Systems

Water supply systems have the potential of causing great harm and even death if they are not managed effectively for infection control. Engineering appropriate safety features begins with looking at both how water enters the facility and the quality of that water. Other safety issues involve the storage and distribution of water, the equipment used, and the management of wastewater.

Dead ends—places where water can stagnate and incubate harmful bacteria and other organisms—are a primary infection control concern when designing a water distribution system, particularly in a hospital. Dead ends are an important consideration when placing showers and faucets in areas that will be used infrequently, or when putting in decorative water features (see below). Maintaining appropriate temperatures for cold and hot water according to local regulations is also important. US Centers for Disease Control and Prevention's (CDC) Healthcare Infection Control Practices Advisory Committee guidelines recommend cold water be kept below 68°F (20°C) and hot water stored at 140°F (60°C). When these conditions cannot be maintained, measures such as chlorine treatments, copper-silver ionization, or ultraviolet lights are recommended.[5]

As important to address as standing water is water moving through a system. Equipment for water systems such as faucets, supply lines, mixing valves, p-traps, and drains are all under review by multiple agencies to determine which are most effective in preventing infections from the water supply. Current concerns center on equipment and materials that allow a buildup of biofilm that can be released into the water supply. Such equipment may include storage tanks, flexible supply hoses and mixing valves, and unused showers and faucets. The most current literature and standards on this topic should be reviewed when making system selections. For example, despite the assumed hygienic benefits of hands-free faucets, there has been evidence that these fixtures, being more complex, are more difficult to disinfect and thus may be more likely than traditional faucets to be contaminated with waterborne bacteria.[6] Newer hands-free faucet designs specifically address these concerns and are considered safer than previous models and traditional handled faucets.[7] Extra caution should be taken when deciding whether to use—and how to effectively clean—hands-free fixtures.

Decorative Water Features

Nowhere is moving water more obvious than in decorative fountains and other water features that are sometimes part of a building's interior design. These often serve as landmarks for wayfinding (see page 85) in health care facilities, but they may increase the risk of waterborne infections. Deaths from the bacterium *Legionella* have been linked to water features in health care facilities. ASHRAE recently published a standard that establishes minimum legionellosis risk management requirements for building water systems. Standard 188-2015 provides detailed requirements for what control strategies must accomplish, but does not restrict what specific strategies are to be used.[8] The 2014 FGI *Guidelines* recommend no open water features on the interior of a health care facility. Many companies have designed and developed closed water feature systems to replace those that may aerosolize water with bacteria and other organisms into the air.

Infection Control and Waste Flow

Health care generates enormous amounts of waste that must be handled safely and effectively. Considering the flow of waste (be it normal or hazardous) and its impact on infection control is critical during the design phase. When designing a facility, the issues of how to receive products, store clean products, distribute those products, and safely store various types of waste are vital processes to map and plan. Both the Joint Commission and JCI surveyors review waste flow—from dock to patient and back—to ensure that patients, staff, and visitors

are kept safe from contamination. Survey findings have identified the following particularly problematic to achieve:

- Clean-supplies pathways separate or protected from dirty paths of waste
- Appropriate holding areas, both departmental and general, for hauling all types of waste
- Safe disposal of pharmaceuticals and chemotherapy agents and equipment
- Appropriate processing areas for products received, such as rinse areas for fresh produce, or unpacking areas for supplies sent in bulk
- Clean storage areas that reduce exposure to dust or debris
- Appropriate type and number of eyewash stations and emergency showers for cases of contamination from caustic, corrosive, or body fluid splashes
- Appropriate fire and explosion protections for chemical storage

Infection Control and Reprocessing

Reprocessing includes cleaning, disinfection, and sterilization of equipment, devices, and supplies. To reduce risk of infection, sterile processing (reprocessing) departments have traditionally been located in out-of-the-way locations in hospitals. Today's new layouts have the central sterile services department (CSSD) as an extension of the surgical area, which is accessible to other users as well. This reduces the amount of storage necessary for reprocessed trays and supplies in the main operating room.

The change in CSSD location also reflects changes in use of immediate-use sterilization (previously called flash sterilization). This type of sterilization is a risk factor not only in the United States but also in the United Kingdom, where it is included in its National Health Service standards. Many facilities traditionally incorporated substerile rooms in surgical areas to accommodate this type of fast reprocessing. Since the Surgical Care Improvement Project measures were released in 2006,[9] immediate-use sterilization has been purposefully minimized or eliminated.

Another reprocessing consideration is the accountability for the cleaning and high-level disinfection of endoscopic equipment found in pulmonary, gastrointestinal, or gynecological labs, as well as dental clinics. Many of these areas set up their own systems for high-level disinfection. An important infection control factor is separating three stages of scope cleaning: gross wipe downs, initial flush of channels and disinfection, and final processing and drying. The gross wipe downs normally occur in the procedure room itself. Then the scope is flushed and disinfected in an area identified as a dirty area with negative airflow. The scope is then moved to the scope processing machine, which is housed in the cleanroom, as the scope has been disinfected. Some organizations use closed-container transport of the gross wiped down scope to the CSSD for processing. When considering consolidation of these services, one potential barrier is the competency of the CSSD staff to clean and transport the scopes without breakage.

Infection Control in Finishes for Furniture

Choosing materials and equipment that are easy to clean reduces the risk of contact-transmitted infections. Designers prefer certain types of these fabrics. These come in various colors and patterns and, more importantly, they are nearly indestructible through cleaning and wear. Cleaning and the number of rubs should influence material selection for furniture. Some materials and equipment incorporate inherently antimicrobial materials, such as metallic copper for sinks, toilet flush handles, grab bars, and cabinet hardware.[10] Others use antimicrobial finishes, such as silver ion in wood and metal furniture, to reduce infection risk.[11] Impartial research studies are inconclusive as to the long-term effectiveness of these new materials. If such materials are chosen, it is important that they be used and cleaned as intended to ensure maintenance of their antimicrobial properties.

Infection Control and Carpeting

In the past, the use of carpet was discouraged in health care environments because it was thought to increase the risk of bacterial and fungal growth. However, new materials in today's carpeting can actually trap airborne particles,[12] which can be vacuumed up using HEPA–filtered equipment. Carpet can decrease noise, glare, falls, leg fatigue, and heating costs.[13] When considering the relationship between falls and carpeting, it is important to note that there are two commonly used categories of falls: slip falls and trip falls. Carpeting is good for reducing slip falls, but can actually cause trip falls due to the resistance of the foot against the carpeting. (Also see page 89.)

In addition to considering slips and trips, spills are another carpeting concern: Carpeting is not recommended for areas with high risk of spills, such as laboratories or food prep areas, or where patients are at heightened risk of infection from

airborne pathogens, such as burn units, ICUs, or ORs. However, nursing stations, corridors, lobbies, waiting areas, and other high-traffic zones can benefit from the safety, noise reduction, and ergonomic properties of carpeting.[12]

Finally, if an organization chooses to use carpet, it must select the proper type of carpet. Low-pile carpet allows ease of movement for rolling equipment and minimizes tripping. Carpet tiles make it easier and cheaper to replace areas damaged by spills or wear. All carpet should have moisture-impermeable backing to keep liquid spills from soaking through to the subfloor.[12]

Infection Control and Wall Materials

Although evidence suggests walls and ceilings are not a major source of HAI, wall coverings should be fluid resistant and easily cleaned, particularly in areas where contact with blood or other body fluids may occur (for example, laboratories, ORs, emergency rooms). Caution should be exercised when choosing wall coverings with any type of perforations or indentations that could collect dust or bacteria. Paint, which is easily repaired or changed, is an economical way of adding color to any facility; most designers claim they use water-based paint due to its low volatile organic compound count as well as its cleanability. Tiled walls are often considered to meet the cleanability test; however, the grout may be difficult to seal or clean effectively. Unless special compounds can be found to meet cleanability standards, tile is recommended for use only in lower-risk areas such as lobbies, waiting areas, or dining spaces.[14]

Infection Control and Ceilings

Using the appropriate ceiling material for each area of the hospital is an important factor in reducing infection risk. A monolithic ceiling is one that is normally gypsum boards finished with a surface that can be scrubbed. This type of ceiling is used in ORs (around the laminar flow equipment), sterile processing, cleanrooms for medication admixture, cooking areas, or other areas that may need to meet high standards of cleanliness. Another area for monolithic ceilings is in behavioral health rooms to minimize opportunities for suicide by hanging.

Other types of washable, nonabsorbent, nonperforated lay-in or acoustical ceilings can be used in many places throughout a hospital. Tiles in the grids should be of sufficient weight (one pound per square inch) and gasketed or clipped down so there is no chance of displacement due to air currents. FGI provides guidelines for ceiling conformation for each area of the facility (see FOUNDATIONS: Standards and Regulations).[15]

Designing for MEP Infrastructures[16]

Infection control—and all other activities in a hospital—is also affected by the organization's utility systems, particularly the mechanical, electrical, and plumbing (MEP) infrastructure. Occasionally, the MEP infrastructure that serves health care facilities is given secondary importance when compared to areas with more obvious clinical and patient interaction. However, correctly designed and well-maintained MEP systems are crucial to a facility's ability to provide a safe and beneficial environment to staff, families, and patients.

Failure of MEP systems is not always immediately evident. Keeping the MEP system functional so that it performs when patients need it most, whether during an emergency or during everyday use, requires a facility staff with a thoughtful understanding of the system's function and benefits. There should be a proactive plan in place for the system's maintenance and ongoing validation. Typically, this would be part of an organization's management plans, as required by Joint Commission standards. Without such a plan, it will not be evident that a problem exists until there are negative consequences.

Some key MEP infrastructure topics are discussed in this section. The common theme is simple. MEP systems have a major impact on patient safety.

Fire/Smoke Dampers

Instances of catastrophic fire events in health care facilities have been all but eliminated through the advance in construction codes for sprinkler coverage and fire and smoke compartmentation, as well as advances in the interaction of HVAC systems with these building components.

Even a perfectly designed architectural smoke compartment, however, does not stand alone in most cases. It is usually necessary to the function and organization of the HVAC system that the smoke compartment boundaries be penetrated by ductwork. Fire, smoke, and combination fire/smoke dampers prevent fire and smoke from passing through

ductwork. These dampers require regular maintenance and verification, which can be a challenge given their hidden location above the ceiling. It is recommended that every hospital maintain floor plans showing the location of every fire and fire/smoke damper as well as the maintenance records for these devices. This will create a high level of confidence that fire and smoke barriers will work effectively during an emergency. The dampers should be shown on the drawings for fire suppression and management.

Air Changes

The term air changes (ACH) refers to the number of times per hour that the HVAC system for a given room replaces the entire volume of air contained within. For example, the entire volume of air within an OR designed for 20 ACH will be replaced 20 times per hour with new, filtered air. The higher the ACH rate, the quicker any potential contaminants or infection-causing particles will be removed from the room. Given that so many variables can potentially contribute to a hospital's rate of HAIs—hand washing, room cleaning practices, and so on—it is very difficult to isolate the effect of room air changes on actual observed rates of HAIs. Even so, removal of contaminants through the HVAC system is a strategy for reducing HAIs. The major health care design codes have settled on requirements for these values: 20 ACH for surgery and 6 ACH for an acute care patient room.

Good design, construction, and commissioning practices will ensure that the code-required ACH rates are provided when these spaces are first built and used for patients. However, multiple factors can contribute to this value changing over time, such as unrelated renovations in areas sharing the HVAC system, the incremental development of duct leakage, and control device degradation. It is essential that a hospital's facilities staff maintain a regular verification process on the ACH rate in the most critical spaces.

Room Pressurization

Room pressurization refers to the direction air is forced into or out of a room by the HVAC system when all doors are closed. Positive pressure (as defined on page 78) forces air out of the room, and negative pressure (as defined on page 78) draws air in from surrounding areas. Room pressurization is another strategy for protecting patients, staff, and the public required by the FGI *Guidelines*. As discussed above, certain spaces, such as ORs, PE rooms, and catheterization labs, are required to maintain positive pressure to protect patients from contaminants from adjacent rooms. Other spaces, such as isolation rooms, soiled utility rooms, and janitor's closets, are required to maintain negative pressure to protect staff, patients, and the public outside the room from the contaminants within a space known to have harmful contents.

Good design, construction, and commissioning practices usually result in correct pressurization initially, but these values can degrade or reverse over time without diligence and a proactive plan from the facilities group.

Humidity Control

As a very broad generalization, viruses thrive in low humidity and bacteria thrive in high humidity. In addition, static electricity can damage surgical equipment and procedures in low-humidity environments. For these and other reasons, many critical areas of a hospital—such as surgery, CSSD, and critical care patient rooms—have minimum and maximum humidity levels, again per the FGI *Guidelines*. Hospitals are equipped with both humidification and dehumidification strategies to meet these criteria. Because relative rates of humidity are more difficult to sense than temperature, humidity issues are less commonly tracked and identified. All health care facilities should be tracking humidity levels in these critical spaces and addressing issues when they occur.

Redundancies

Redundancies, or backups, must be considered as part of any health care project. A hospital must remain at full functioning capacity if it remains open. Several important redundancies are described here.

Water Supply Redundancy

Available clean water is essential to patient sanitation and safety. Yet city water service is not always 100% reliable. Many, but not all, jurisdictions require on-site water storage to mitigate a loss of city water service. A storage requirement of 12 gallons per bed is common. Such strategies should be considered even when code authorities do not specifically require it.

Electrical Systems Redundancy

Most jurisdictions do not require redundancy on the incoming electrical service to health care facilities. Even so, it is very good practice, whenever practical, to provide as much redundancy as possible in these systems. Incoming electrical

supply from multiple substations provides significantly greater reliability than simply providing multiple feeds from a single substation. While correlated failures still occur, electrical service failures are often isolated to a single source.

HVAC Redundancy

With the exception of redundant heating generation sources, required HVAC redundancy has not found its way into most health care design codes. This is unfortunate. It has been demonstrated that filtration, air turnover, temperature control, and humidity control are crucial elements of infection control. A certain failure rate is inherent to all rotating mechanical equipment. These devices are not designed to run 24 hours a day for decades. For this reason, N+1 redundancy (in which each component has at least one independent backup) should be in place on chillers, cooling towers, critical fans, and so on, whenever practical. With proper redundancy in place, expected maintenance and periodic failure of individual components will have no effect on patient care.

Emergency Power

Proper operation of the emergency power supply system for a health care facility is vital to ensure that patient safety is not compromised in the event of a short-term or long-term power outage. Success of this system depends on compliance and diligence by hospital staff at all levels.

A side of this system that is often overlooked has to do with the power receptacles themselves. When both normal power receptacles (often white or light colors) and emergency power receptacles (often red) are available, the emergency receptacles should be used only for items related to patient safety. In most US facilities, it is common to see emergency receptacles used for noncritical loads such as personal computers, convenience refrigerators, coffeemakers, phone chargers, personal fans, and so on. Every emergency power system has a capacity limit. Patient safety can be compromised when convenience items put excessive strain on the emergency power infrastructure. Avoiding these issues starts with adequate power receptacles and load for facility, and compliance training of all employees, but also requires an ongoing monitoring and enforcement plan if issues arise.

From an infrastructure perspective, without proactive testing, the generators and transfer switches themselves would only be exercised during an actual power failure, which is not the time for problems to be identified. Every facility must test and keep comprehensive records of generator and switch testing to ensure that these critical systems are functional when they are called upon to preserve the lives of patients.

Fuel Storage

Emergency power generators and boilers are perhaps most critical during a natural disaster covering a large geographical area. During such times, demand for replacement fuel for these systems is widespread, making fuel significantly less available than usual. For this reason, NFPA 101 and 110 require 96 hours of on-site fuel storage to improve the likelihood that a health care facility can remain operational until replacement fuel is available. While modern health care facilities have been designed with this storage capacity in place, the engineering staff must be diligent about ensuring that the appropriate amount of fuel is actually in the tanks at all times so that the 96-hour buffer required in Joint Commission standards is in place should an unanticipated event occur.

Designing for Security

Patients, visitors, and staff count on being both safe and secure in a health care facility. Safety includes security. Joint Commission standards require organizations to address their security risks (see FOUNDATIONS: Standards and Regulations). Whereas safety incidents, such as workplace injuries and infections, are often accidental, security incidents are often intentional—except in the case of a disaster situation where securing the campus is a priority (see page 86). Examples of security risks, in addition to those covered below, include workplace violence, theft, and unrestricted access to medications that results in drug diversion. Security incidents can be caused by individuals or events, either internally or externally.

It is important to keep security needs of a facility in mind as the design is developed. Line-of-sight issues, multiple unstaffed entrances and exits, pediatric and infant populations, and mental health services all increase concerns about security on a campus. Elements that address these risks could include appropriate alarm systems, door locks, keyless entry systems, closed-circuit televisions and security cameras, metal detectors, panic buttons, and safe hold rooms. The International Crime Prevention through Environmental Design website (http://www.cpted.net) provides an excellent resource for design considerations to enhance security of facilities.

Abduction and Elopement

Infant or child abduction is a reportable sentinel event for The Joint Commission (see FOUNDATIONS: Standards and Regulations). The rate of this occurrence has dropped dramatically with the implementation of electronic alarm systems that alert staff if a child is taken away from a protected zone. To retain a potential abductor inside the building, some systems shut down all elevators and lock stairwell doors when the alarm is sounded. Systems typically are in place on pediatric units, maternal child units, and neonatal intensive care units (NICUs). Elopement is an issue for behavioral health as well as geriatric dementia units. Elopement occurs when a patient or child wanders away or leaves a health care facility unsupervised and/or without permission. Some units are using systems similar to the child abduction system to alert staff when patients are attempting to elope. (A free download of the National Center for Missing and Exploited Children's 10th edition of *For Healthcare Professionals: Guidelines on Prevention of and Response to Infant Abduction* is available at http://www.missingkids.com/en_US/publications/NC05.pdf.)

Secure Mental Health Spaces

A frequently overlooked security issue is the risk involved in housing behaviorally disturbed patients in the ED. Safe holding rooms need to be developed that manage the anticipated volume of patients and protect patients as well as staff. A long list of protective elements for safe holding rooms and mental health units is available in the FGI *Guidelines, Design Guide for the Built Environment of Behavioral Health Facilities* (currently 7.0 edition as of May 2015), or at the US Veterans Administration website at http://www.cfm.va.gov/til/dGuide/dgMH.pdf.

Secure Valuables and Belongings

Safe storage for patient valuables and belongings is an important consideration as well. Some facilities are placing safes in patient rooms for valuables; others continue a centralized approach. Security for outpatient belongings during procedures is also an important design factor, as patients do not always have family members who are capable of, or willing to, monitor such belongings.

Staff requires security for personal items too: Lockers for staff for purses, coats, and other personal belongings should be easy for the employee to access during the shift. This includes identifying an adequate number for all staff using the facility, as well as some vendors and other contract staff.

Secure Entrances

Joint Commission standards expect organizations to have some control over who enters and moves about the facility. This can be achieved if there are control points at entrances where visitors sign in to obtain a badge or other type of identification. The number and placement of entrances needs to be strategically planned to provide easy yet secure access to services.

Access Control

Joint Commission standards require hospitals to identify security-sensitive areas. These are zones in a health care facility that require increased levels of defense to protect patients, staff, and visitors as well as dangerous materials and confidential or important data and information. New electronic access systems allow for more secure entrances to many parts of the facility than were available in the days of keyed locks. The access systems can be code activated. Some use biometric readers for pupils or fingerprints; others rely on card readers. One drawback to card readers is the cards are easily taken by unauthorized individuals. While most systems can quickly deactivate the particular lost or stolen card, the integrity of that security is based on the timing of when the card was taken. It may be hours or days before it is known that the card is missing. It is important to identify who needs access to which areas, as well as to determine the most secure way to provide that access.

Designing for Patient Flow

Beyond controlling where people are allowed to go in a facility there is the need to make sure people can figure out where to go and can get there quickly and easily, particularly when it involves patients. Joint Commission standards require hospital leaders to develop and implement plans to identify and mitigate issues that can interfere with efficient movement of patients across the continuum of care within an organization—patient flow. Joint Commission standards relating to managing safe and efficient flow of patients through the facility can be found in the "Leadership" (LD) chapter; JCI standards on this topic are in the "Access to Care and Continuity of Care" (ACC) chapter.

Achieving an effective flow of patients through a health care facility requires an appropriate matching of capacity and demand, efficient and effective work flow, and a care environment that optimizes patient outcomes and staff performance. How a facility is designed can have considerable

impact—either positive or negative—on patient flow. Before beginning design, team members should examine all processes critical to patient flow through the hospital system—from the time the patient arrives, through admitting, patient assessment and treatment, and discharge—and determine how design and layout can improve patient flow. In planning and design, some actions organizations can take include those described here.

Wayfinding

Wayfinding is a fundamental factor in productive patient flow. Wayfinding is all of the ways in which people orient themselves in physical space and navigate from place to place, whether through signs, maps, or other graphic or audible methods. In health care facilities, it's everything that encompasses and accomplishes the goal of having patients, staff, and visitors be able to easily find and navigate the facility.

Finding and Entering the Facility

When possible, facilities should be located in areas with convenient roadways for access and egress. Wayfinding signage should be thoughtfully placed to direct vehicular traffic to the facility. Traffic routes for private vehicles, emergency vehicles, and delivery vehicles should be mapped out so roadways can be designed to avoid any delays in emergency vehicles accessing the correct entrance. Some other issues to keep in mind include the following:

- *Separation of regular and emergency traffic:* If feasible, private vehicle and ambulatory traffic entering the emergency area should be separated from the ambulance traffic.
- *Clearly marked entrances:* Entrances should be marked using appropriate signage. Many organizations now have separate entrances for different patient population groups, which can be confusing if not signed well. Feedback from user groups is valuable when creating signage.
- *Easy entrance access and assistance:* Because many users of the facility need assistance in ambulation, easily accessible spaces should be designed near entrances to allow for storage of wheelchairs and even a few stretchers for emergencies.
- *Clear staff view of ED entrances:* Entrances to both the ambulance and ambulatory sections of the ED should be directly visible to ED staff. This will provide further assistance in emergencies as well as added security.
- *Triage stations at ED entrances:* Emergency ambulatory entrances should support the ability for staff to do a quick triage, or at least a screening, prior to a full triage to determine a patient's criticality. This requires a desk or station.
- *Quick wayfinding assistance at non-ED entrances:* Nonemergency patient entrances should provide immediate access to wayfinding elements to reduce patient stress. This is frequently an information desk or kiosk. User feedback on various available methods is helpful. All ages and ambulation issues should be taken into account. Desks should be at a height to easily see and respond to wheelchair-bound users.

Moving Through the Facility

Many hospitals and other health care facilities are large, complex environments that can be a challenge to navigate. Special considerations during the design process can help make navigation as easy as possible. Some issues to consider for patient flow inside the facility include the following:

- *Use of up-to-date wayfinding:* Wayfinding research should focus on current and state-of-the-art methods of assisting patients and families to the proper destination.
- *Different corridors for different purposes:* Many organizations are creating separate public and service corridors to manage the multiple types of user traffic, such as patient, supply/equipment, or visitor movement. The offstage service corridors also provide increased privacy for patients in their designated corridors.
- *Single entrances for multiple purposes:* Outpatients arriving for testing should ideally be able to enter one area for multiple purposes, including imaging and laboratory, to avoid multiple or lengthy travel distances to access services.
- *Accommodating elevators:* The number of elevators should be sufficient to accommodate the facility's volume of patients, visitors, staff, equipment, and supplies. Elevators should be large enough to accommodate the people and equipment that will go into each elevator.
- *Patient transport variables:* Consider staff time spent during the transport of inpatients to diagnostic or treatment areas. This should include elevator adequacy for volume of patient transports, length of transport, safety of transport, and number of staff accompanying the patient.
- *Ease of staff access to secure areas:* When devising secure access plans for staff to use when transporting, consider the space and process needed to reach a security device while pushing stretchers or wheelchairs, as well as the door swing. Eliminate unnecessary repetitive movement of patients by staff at these intersections.

Patient Flow and Acuity

Many organizations have realized they can save space, and consequently money, by providing alternative care areas based on patient needs. One example is the popular design plan of a "fast track" area in the ED. This allows for acute or trauma patients to be cared for in areas that provide more technology and support than may be needed for a less acute patient, such as one with a small cut or a fever.

Some organizations have made acuity-convertible rooms, as opposed to acuity-adaptable rooms. Convertible rooms can be converted from a medical/surgical room to a higher acuity care room with simple renovation, or even built out with the same types of head walls. All necessary gas, electrical, and suction is available in the walls. By contrast, an acuity-adaptable room is one in which the model of care keeps the patient in the same room regardless of care needs. Notably, many organizations that have attempted to provide acuity-adaptable models of care have discontinued the practice for a variety of reasons.[17]

Wayfinding and acuity concerns are especially important in emergency management. During emergencies, there is no time to be lost, and being able to easily and quickly accommodate space to handle a surge of acute care patients is critical.

Designing for Emergency Management

The 2004 tsunami in the Indian Ocean, the 2010 earthquake in Haiti, and the tornado that destroyed Joplin, Missouri, in 2011 are just a few disasters in the last decade that graphically illustrate no country is immune to emergencies. Frontline providers, including hospitals and other health care organizations, must be prepared to respond.

In addition to accreditation standards developed by The Joint Commission (see FOUNDATIONS: Standards and Regulations), the issue of emergency management is being addressed by the United Nations through its International Strategy for Disaster Reduction (http://www.unisdr.org) and by WHO (http://www.safehospitals.info/). In the United States, the CDC offers resources to help health care organizations prepare for natural and human-related emergencies.[18]

Weathering emergencies successfully requires proactive risk management. The Joint Commission requires both domestic and international facilities to conduct a risk assessment for potential disaster causes, whether natural, man-made, or technological. In the United States, the common term for this assessment is a hazard vulnerability analysis (HVA). The HVA is really a process for identifying potential emergencies and how they may affect the health care organization's ability to care for patients, given its size, geographic location, proximity to sources of danger, and so on. This analysis can also be an invaluable proactive tool to help the design team understand disasters from natural, technological, human, and hazardous materials sources.

Joint Commission standards require an organization to use the HVA to create an Emergency Operations Plan (EOP) that coordinates its communications, resources and assets, safety and security, staff responsibilities, utilities, and clinical and support activities during an emergency. These aspects of emergency management planning can be addressed through proper facility design. For example, by designing a building to handle patient surge situations, organizations can lessen the severity and impact of the emergency. The Joint Commission offers a guide for surge capacity called *Surge Hospitals* that provides issues and solutions to consider when designing for patient surges. It is available as a free download from http://www.jointcommission.org/assets/1/18/surge_hospital.pdf.

Patient Flow in Emergencies

How patients arrive at, enter, move through, and exit a facility is a vital consideration in emergency planning. During an emergency, the volume of patients increases, and so does the level of tension. Individuals may be rushed or panicked. Design should streamline patient flow to ensure the consistent movement of patients through the facility. In addition, the building should be designed so emergency medical professionals, such as paramedics, enter the building through a different entrance than ambulatory patients. This prevents ambulatory patients from getting in the way and also from seeing victims with more serious health issues. Most EOPs define modified pedestrian and vehicular traffic patterns in the event of a large-scale emergency.

Security in Emergencies

During an emergency, organizations will need to control entrance and egress activities. Most likely, organizations will need to lock down a site to maintain order and security. Systems need to be designed to quickly and efficiently take control of all entrances, exits, and major corridors. This is

often done through an electronic lockdown system built into keyed entrance and exit doors, and occasionally mechanized controls over the fire doors for extra corridor protection. Closed-circuit monitoring is currently used for many sensitive areas of the organization.

Decontamination in Emergencies

Depending on the type of emergency, an organization may need to decontaminate patients. The size, type, and location of showers (for example, inside or outside) will be critical when designing for decontamination. Separation of males and females in mass shower facilities should be addressed, as well as how and where to decontaminate children and the disabled. Organizations should determine how to keep contaminated patients away from those who are not contaminated and how to prevent contamination with hazardous agents. An organization may need to shut off the ED from the rest of the facility in certain situations to control possible contamination within the facility. Important elements of designing for decontamination include security doors that restrict movement through the facility, zoning of the air supply, and storage of decontamination supplies and equipment in a readily accessible area.

Roadways and Parking in Emergencies

An emergency typically creates an influx of ambulances and other emergency vehicles, the personal vehicles of staff and patients, supply delivery trucks, and other critical support vehicles. Organizations should consider vehicular access and control, as well as parking logistics in the design of facilities, to ensure the unimpeded entrance and egress of critical vehicles in emergencies.

Convertibility in Emergencies

The average ED would not be able to accommodate the surge in patient volume in the aftermath of a disaster. The design team should consider developing spaces that could be converted during an emergency into patient care, triage, or holding areas. Such spaces could include ambulatory surgery suites, office space, or meeting rooms. Organizations may want to design some of these rooms to be near the ED to avoid delays in care and improve throughput of patients. If an organization is at high risk for treating patients with chemical or biological contamination, a convertible area away from the main hospital may be the safest solution.

Be aware, however, that not all surges are immediate or short term. Following the Richmond, California, refinery fire in 2012, hospitals experienced a daily peak of 3,000 patients three days after the incident. As most of the injuries associated with this event were not critical, and many patients didn't seek medical attention until days later, the surge lasted 15 days.[19] While this was an unusual circumstance, design for convertible spaces should consider the potential conflicts that arise during long-term surges.

By considering these issues during the planning and design phases of a project, an organization can better ensure safety and appropriate, high-quality care during an emergency. If a building project includes an ED, the organization should consider hiring an architect who specializes in ED design. In addition to designing existing facilities to handle surge situations, organizations may want to consider designing surge capacity solutions, such as decontamination tents, that operate only during emergencies.

Designing for Human Factors

Everyday activities in a health care environment present almost as many opportunities for adverse events as emergencies do—mainly in the form of errors. Latent conditions become active errors when there is an adverse event at the interchange between humans and the built environment. Multiple efforts to understand the complex health care environment have included crucial research into human factors, the study of how humans interact with their environment. The research focuses on the interaction between an individual, the organization, and the environment; the individual's role within that organization; and the physiological and psychological characteristics that influence behavior. Patient and family dynamics add to this complex mix of relationships. When designing a facility, human factors should inform and influence design element selection. Many teams are contracting a human factors specialist to serve as an adviser to the team.

Key Human Factors for Design

Three key human factors should be considered during the design phase: what tasks providers will undertake, what individuals need from the physical environment, and how technology influences processes and work flows. Designing with these factors in mind can create a built environment that improves efficiency for the organization and reduces the workload and stress of the providers.

Human Factor 1: Tasks and Standardization

One important concept to remember regarding tasks is optimal cognitive load. Every person has an optimal amount of data and information he or she can process comfortably, effectively, and safely. It can be a challenge to create a design that reduces the cognitive load for health care providers through the built environment. A checklist is one helpful tool to make processes easier for providers to deal with; however, in the built environment, standardization can prove to be most useful. Research has shown that standardizing where supplies, equipment, furniture, or other items are located can reduce nurses' stress.[20] For example, in an outpatient treatment area, bedside supplies are kept in exactly the same place, down to the drawer configuration. Specialty equipment can be kept in the same drawer in every room; this way, even though the equipment itself is different, the same drawer will always have the specialty equipment. This improves efficiency and lowers stress.

Human Factor 2: The Physical Environment

Human factors related to the physical environment include close adjacencies for frequently accessed equipment and supplies, which reduces fatigue and stress. Reducing distractions due to noise and task site interruptions is also critical. The 2014 FGI *Guidelines* (see FOUNDATIONS: Standards and Regulations) describe a new medication safety zone that requires any area where medication is dispensed, either in the pharmacy or on the floor, to be free from distraction. Providing adequate space to accomplish care tasks is another critical consideration relating task and physical environment.

Human Factor 3: Technology

Adopting new technology has become a major factor in designing new facilities. Given the rapid pace of change in many technologies—diagnostic equipment, electronic records, and treatment and procedural equipment—there is little knowledge of the compounding effects of bringing together these various systems. One example might be the hybrid OR that has an operative MRI machine. The operating suite is no longer solely for performing surgery; it must now meet the additional safety standards of an MRI room, such as attention to nonferrous (nonmagnetic) materials. Another example involves clinical alarms. The multitude and myriad types of clinical alarms has created stress for providers, resulting in alarm fatigue, which occurs when staff becomes desensitized to alarms because too many go off too frequently. Prioritizing alarm system alerts can help to minimize alarm fatigue.

Places of Respite and Natural Environments

Another growing trend in human factors in health care is to provide staff with a place of respite, where they are unavailable to coworkers and patients. Some studies are recommending quiet, darkened spaces for staff to use for short naps. This field of inquiry is expanding rapidly, so it is important to research current findings before committing to a design. Increasing exposure to nature and natural light to help elevate mood, which contributes to staff retention, is another strategy health care facility design is incorporating (see page 90).

Designing for Worker Safety

Although most Joint Commission and JCI focus is related to the safety of patients, the standards do require organizations to preserve the safety of staff as well. Many of the previously mentioned safety improvement strategies will enhance the safety and satisfaction of both staff and patients. The following are related and additional concerns.

Lifting, Reaching, Bending, Twisting, and Stretching

Organizations can also directly address worker safety issues by considering the ergonomics of the built environment. Ergonomics relate to how a worker fits with his or her tasks, work environment, and the equipment needed to get the job done properly. Lifting is a common cause of worker injury; back injuries among nurses and support staff are the most frequent injury. Built-in lift equipment can help, and some states mandate that lift equipment (built-in or mobile) be available. It is, however, one major structural feature often debated due to cost. Annual workers' compensation costs related to back injuries should be factored in when considering return on investment for installing lifts.

Other ergonomic design considerations relate to standard work areas. Shelves that are too high, outlets that are too low, or computer workstations that stress the hands and wrists can all lead to worker injuries, absenteeism, and an unsafe work environment. Organizations that design environments to limit staff reaching, bending, twisting, and stretching can improve staff safety, health, and satisfaction.

Wheeling Across Carpeting

While carpet has been shown to reduce noise and prevent some falls due to slipping, staff often complain of the increased resistance when pushing wheeled equipment over carpet as opposed to a hard floor. This can lead to fatigue and, depending on the weight of the equipment, back strain. Solutions include selecting low-nap carpeting or hard flooring as well as increasing the circumference of the transport vehicle wheels.

Working Under Poor Lighting

Research has also shown that higher wattage of lighting in task areas reduces errors.[20] This should be taken into account in high-risk task areas such as the laboratory, pharmacy, or medication dispensing areas.

Designing for Fall Prevention

Although staff may hurt themselves in falls at the workplace, when discussing fall prevention in health care, the focus is on patient falls. Patient falls are increasingly a focus in health care. According to Agency for Healthcare Research and Quality data, nearly one million falls occur in US hospitals annually. Of those falls, between 30% and 50% cause harm. The Centers for Medicare & Medicaid Services no longer reimburses for hospital care that is caused by patients experiencing a fall while in the hospital.

Types of Falls

Falls can be categorized into four types[21]:

- ***Accidental falls:*** These occur when low-risk patients trip over an IV pole, fall out of bed when they reach to get something, or encounter another environmental hazard.
- ***Anticipated physiological falls:*** These are the most common type of patient falls. These occur in patients who have risk factors that can be identified in advance, including abnormal gait, high-risk medication, urinary frequency, or dementia.
- ***Unanticipated physiological falls:*** These occur in patients who have a low risk of falls in general but suffer an event—a seizure, stroke, or fainting episode—that results in a fall that could not have been predicted.
- ***Behavioral or intentional falls:*** These occur when a patient acts out.

Design for Types of Falls

Design should be able to assist with accidental and anticipated physiological falls. Little can be done in the built environment or processes for unanticipated physiological and behavioral or intentional falls. Fall risk assessments and processes that proactively protect the patient from these types of falls need to be devised.

Multiple research studies and reports have identified that the majority of accidental and anticipated falls in a hospital are falls that occur when a patient is moving to, in, or from a toilet room. This finding has launched many research projects on preventing falls. Gulwadi and Calkins, for example, provide a comprehensive study in their white paper "The Impact of Healthcare Environmental Design on Patient Falls."[22]

Designing for Bariatric Needs

Among the many health issues that are increasing are those related to a worldwide obesity epidemic. This epidemic is the underlying cause of many chronic diseases such as diabetes, high blood pressure, coronary heart disease, and arthritis. The medical field of bariatrics deals with the causes, prevention, and treatment of obesity. Health care facilities are particularly challenged to meet the needs of bariatric patients, those whose weight exceeds 300 pounds (just over 136 kilograms). During the patient handling and movement assessment (PHAMA) required under the FGI *Guidelines* (see FOUNDATIONS: Standards and Regulations), the expected number and type of obese patients, and the locations that are anticipated to serve them, need to be identified.

Lifestyle goals for obese patients as reported by Gabel and Musheno[23] are as follows:

- To get in and out of a chair independently
- To get on and off the commode independently
- To get washed and dressed with minimal assistance
- To mobilize short distances using a walker
- To be able to go to public places with minimal assistance

Bariatric Care Unit Design

Actions to take identified during the PHAMA and during subsequent planning and design include the following:

- *Space*
  - Designate some number of airborne isolation and PE rooms for bariatric patients.
  - Designate space for bariatric patients in these areas:
    - Cashiering/registration
    - Patient assessment or triage

    - Physical rehabilitation
    - Food service
    - Family interaction areas (family members are often genetically inclined to obesity)
  - Include special bariatric treatment rooms in the ED, outpatient areas, and clinics.
- *Equipment and furnishings*
  - Install the following:
    - A ceiling-mounted lift or have access to a portable lift capable of transporting 600 pounds (more than 272 kg) in bariatric rooms
    - Lift equipment in all care areas
    - High-capacity surgical tables with 1,000-pound (454-kilogram) capability
    - Larger exam tables with power-up-and-down ability
    - Bed scales with 1,800 pounds (816 kilograms) capability
    - Large-bore MRI/CT equipment
    - High PSI rating for flooring and plumbing
    - Seating with handrails that can support at least 400 pounds (181 kilograms)
  - Include extra storage for necessary equipment.
- *Room design*
  - Allow five-foot clearance around three sides of the bed.
  - Include bariatric care design elements in the toilet room, such as the following:
    - 60-inch door opening and turning radius
    - 24-inch clearance from wall to toilet
    - Floor-mounted toilets
  - Handrails that can support 400 pounds (181 kilograms)
- *Floor/Unit design*
  - Incorporate wider aisles, corridors, and doorways to accommodate extra-wide wheelchairs. Door openings to patient rooms should be 57.5 inches (1.46 meters).

Protecting the dignity of bariatric patients and family while providing safe care is increasingly a concern for health care providers as well. Designing with bariatric needs in mind can help organizations provide safe—and considerate—care.

Evidence-Based Design

While The Joint Commission does not have any direct standards for evidence-based design (EBD), its LD, Infection Prevention and Control (IC), and Performance Improvement (PI) standards, and JCI's Prevention and Control of Infections (PCI), Quality Improvement and Patient Safety (QPS), and Governance, Leadership, and Direction (GLD) standards, all require organizations to use current scientific knowledge to inform processes. EBD is defined by the Center for Health Design as "the process of basing decisions about the built environment on credible research to achieve the best possible outcomes."[24] Organizations use this approach to incorporate specific design principles shown to improve clinical and satisfaction outcomes for patients and staff and create safe and therapeutic care environments that encourage family involvement and relieve stress for workers. It is important to note that many of the EBD design features, especially those that promote a calm and relaxed environment, benefit staff as well as patients. They improve staff satisfaction, limit fatigue and burnout, enhance performance, and increase staff retention.

Conducting rigorous empirical research studies that can claim absolute cause-and-effect practices within the built environment is difficult, time-consuming, and fraught with confounding variables. However, a meta-analysis conducted in 2008[20] offers some design elements that have become somewhat mainstream for health care architecture today. Many of the findings of the meta-analysis have been provided in the preceding sections; others that have a major design impact are listed here. The complete study and more current research (more than 2,500 studies) can be found on the Center for Health Design's website's Knowledge Repository (https://www.healthdesign.org/).

Incorporating Nature

Access to nature in a health care facility can produce a number of benefits, including the following:

- Reduction of pain
- Reduced stress levels for patients, staff, and visitors
- Improved sleep for patients
- Increased positive feelings for patients, staff, and visitors

Access to Natural Light

Natural light or simulated natural light and diurnal rhythms provide many of the same benefits as access to nature. In addition, research has shown that natural light in a health care facility can do any of the following:

- Reduce patient stays
- Increase tolerance to pain
- Improve sleep patterns
- Improve mental orientation
- Reduce depression
- Facilitate chemical absorption

Reducing Noise

Reducing the noise levels in a health care facility is an important consideration for design. WHO recommends noise levels not to exceed 30 decibels for patient rooms.[25] Many hospitals routinely function in the 80–90 decibel range. Noise-reducing design features to consider include the following:

- Sound-deadening materials around high-noise areas such as workstations, ice machines, pneumatic tube stations, and other noise-producing equipment
- Systems to reduce overhead paging and loud alarms
- Private rooms to reduce roommate disruption

Privacy and Confidentiality

Safe care depends on complete and forthright information provided by the patient. Facilities can support this by providing speech privacy in areas where private health information is given to the health care provider. While private rooms solve that issue in an inpatient setting, this is not always practical or possible based on financial limitations and/or local regulations. The design team should do a careful review of the intake process and care provision spaces to determine the most critical areas for providing some type of speech privacy through the use of partial walls, directional seating, white noise technologies, or other devices.

Social Support

Research has also shown social support is important for both staff and patients. For staff, studies have shown peer visualization is important to patient unit staff.[26] The ability to see one's peers while providing care is important to reduce stress, because it means the ability to obtain support for workload or emergencies. Gently curving corridors diminishes the ability to view peers for assistance. Ideal placement of work areas is at corners of corridors, which allows both corridors to be used for peer visualization.

Patients also benefit from social support designs. Private rooms offer the ability to provide a family zone for patients. When private rooms are not used, other areas for patient social support from family should be made available. Many facilities are considering not providing a family waiting area if there are in-room accommodations for the family. However, family members still need respite as well as family conferencing space.

Designing for Technology Safety

The benefits of heath care technology outweigh the dangers, but the dangers should nonetheless be taken seriously and diligently addressed. By becoming aware of—and staying abreast of—the risks inherent in certain technologies, health care facilities project team members can plan and design for mitigating and even eliminating such risks.

Health Technology Hazards

Each year, ECRI Institute's Health Devices Group develops a list of the top 10 health technology hazards. This list highlights the technology safety topics that ECRI Institute believes warrant particular attention for the coming year. Some are hazards that occur with regularity. Others are problems that may become more prevalent given the way technology is evolving. Still others are well-known risks that periodically warrant renewed attention.

Factors in Evaluating Technology Hazards

When nominating topics for consideration, ECRI Institute staff—engineers, scientists, nurses, physicians, and other patient safety analysts—draw on the resources built up through the organization's 45-year history of analyzing health care technologies. They also rely on their own expertise, as well as the insight gained through examining health technology–related problem reports, evaluating medical devices and systems, investigating incidents, observing and assessing hospital operations and practices, reviewing the literature, and speaking with health care professionals and device suppliers. Staff then votes on the nominated hazards, weighing factors such as the following:

- ***Severity:*** What is the likelihood that the hazard could cause serious injury or death?
- ***Frequency:*** How likely is the hazard? Does it occur often?
- ***Breadth:*** If the hazard occurs, are the consequences likely to spread to affect a great number of people, either within one facility or across many facilities?
- ***Insidiousness:*** Is the problem difficult to recognize? Could the problem lead to a cascade of downstream errors before it is identified or corrected?
- ***Profile:*** Is the hazard likely to receive significant publicity? Has it been reported in the media, and is an affected hospital likely to receive negative attention? Has the hazard become a focus of regulatory bodies or accrediting agencies?

- *Preventability:* Can actions be taken now to prevent the problem or at least minimize the risks? Would raising awareness of the hazard help reduce future occurrences?

Any of these criteria can warrant inclusion of a topic on the list—although all selected hazards must, to some degree, be preventable; that is, health care facilities must be able to take existing measures to reduce the risks.

ECRI 2015 Top 10 Health Technology Hazards

The following is ECRI Institute's 2015 list of top health technology hazards[27]:

1. Inadequate alarm configuration policies and practices
2. Incorrect or missing data in electronic health records and other health information technology (IT) systems
3. Mix-up of IV lines leading to misadministration of drugs and solutions
4. Inadequate reprocessing of endoscopes and surgical instruments
5. Ventilator disconnections not caught because of mis-set or missed alarms
6. Patient-handling device use errors and device failures
7. "Dose creep" (unnoticed variations in diagnostic radiation exposures)
8. Complications in robotic surgery due to insufficient training
9. Insufficient cybersecurity protections for medical devices and systems
10. Overwhelmed recall and safety alert management programs

Designing for Facilities in Developing Countries

The design and construction of health care facilities in some developing or emerging countries provides some unique challenges, embracing many of the topics discussed in this FOCUS section. A discussion of some of these challenges follows.

Water Supply

Many health care facilities or planned sites for such facilities lack adequate water supply and/or adequate water-handling systems for patient care, laundry, equipment sterilization, sanitation, or hand washing. Design should include adequate and sustainable supply of clean water.

Power Supply

Some health care facilities are affected by frequent power outages, and/or do not have adequate or consistently functioning, well-maintained emergency generators to provide backup power. Design should include planning for adequate power supply relative to the size and load of the facility and equipment (for example, large equipment for laundry, sterile processing, and radiology). Backup generators and uninterruptible power source equipment should be sized appropriately. Any equipment purchases should consider the availability of spare parts, service requirements, preventive maintenance contracts, and training of facility personnel.

Hand Hygiene

Health care facilities in developing countries often lack not only fresh clean water but also functional hand hygiene supplies, such as hand-washing sinks, soap dispensers, or disposable towels. Design should include adequate and convenient hand-washing facilities for staff in all clinical and support areas. It is helpful to consider having one or more hand-washing sinks in each patient room or ward. Design should also include provision and location of dispensers for alcohol-based hand rub.

Access to Services

Often health care facilities or potential sites are located a considerable distance from main roads. Access roads are frequently unpaved and do not have adequate signage to direct patients to the hospital. Many hospitals are built on one or two levels with stairs and/or ramps to assist transport and movement of patients and supplies. They are often spread over a large enough area that transport and movement between buildings and services can be challenging. Designs should include planning for road access early in the design phase, including budgetary considerations for providing a paved road at the time of the facility's opening. Ramps used for vertical movement should have a gradient that does not compromise staff or patient safety, and should be covered to protect against inclement weather. If resources do not allow the installation of elevators, the number of patient floors may need to be limited; in that case, horizontal adjacencies of key departments and services will be critical to efficient patient flow.

Instrument Sterilization

Proper sterilization and cleaning of instruments can be a major challenge due to the lack of water, hand-washing sinks,

reliable power sources, proper equipment maintenance, and adequate separation between clean and dirty instruments. To counter this, design should include physical separation of washing and disinfecting/sterilization of instruments and adequate provision for safe, sterile storage for instruments.

Laundry

Adequate laundry facilities, which are critical to preventing infection, are frequently lacking in developing countries due to lack of water, power, equipment, or detergents. Design should provide for collection and delivery of linens; separation of clean and soiled processes; and adequate storage, equipment, and utilities, including water and electricity.

Waste Management

Incinerators frequently are undersized or not operational due to lack of maintenance or spare parts. Wastewater treatment is sometimes either not operational or ineffective. Effluents are often issued into neighboring environments. Equipment should be selected based on load/volume and availability of spare parts and repair services. Treatment facilities should be located so as to avoid contamination of adjacent areas.

Fire Safety

Fire safety features—detectors, alarms, firefighting equipment, or sprinklers—may be inadequate or nonexistent. Design should include adequate provision of these items, as well as clearly signed and accessible fire exits and consistent water supply.

Food Services

Patients in health care facilities in developing areas are rarely provided with food prepared by the health care facility. Existing structures are, however, usually equipped with facilities for safe food storage, preparation, or delivery. These should be provided for in the design.

Facilities for Family and Caregivers

Due to lack of adequate staffing, many patients rely on family members and friends to provide routine care and meals. However, no accommodations for these caregivers are provided. If this is the case, design should include visitor-accessible food storage; cooking facilities that are culturally acceptable, but also safe in terms of fire risk; laundry; access to nonpatient bathrooms; and overnight accommodation (as appropriate).

Staff Support Areas

Health care facilities may lack designated areas to adequately support staff. Design should include staff-accessible storage rooms, break rooms, lockers, toilets, and changing rooms (if applicable).

Outpatient Registration/Cashier

Outpatient areas are often overcrowded, particularly at peak times. Patients are required to go to the cashier before accessing services, and they frequently face long waits. There can be a lack of auditory privacy in areas where clinical information is to be discussed. Planning should consider expected patient volumes and related counter space and seating. Partitions or booths should be used to achieve auditory privacy.

Patient Triage

Adequate space for triaging emergency patients may not be available. To allow facilities to prioritize patients effectively, design should consider patient flow (see page 84), and make provisions for auditory as well as visual privacy and confidentiality during examinations.

Operating Suites

Most existing hospitals in developing countries lack adequate separation of zones as required for infection prevention. In addition, the ORs lack climate or air pressure controls. Design should include three designated areas—unrestricted, semi-restricted, and restricted—defined by the physical activities performed in each. There should also be controls for temperature, humidity, and maintenance of air pressure.

Isolation Rooms

Most hospitals in such countries lack an adequate plan for dealing with infectious patients. Often these patients are held with others who may have different or no infections. Many facilities lack the ability to isolate a patient in a single-patient room, and have no negative pressure rooms. Design should include negative pressure rooms for patients with airborne infectious diseases, in addition to planning for possible infection risks, including epidemics.

References

1. Institute of Medicine. *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press, 2000.
2. Chassin MR, Loeb JM. High reliability health care: Getting there from here. *Milbank Q*. 2013;91(3):459–490.
3. Joint Commission Resources. Top standards compliance data for first half of 2014. *Jt Comm Perspect*. 2014;34(9):1, 3–8.
4. World Health Organization (WHO). *WHO Guidelines on Hand Hygiene in Health Care*. Geneva: WHO, 2009. Accessed Jul 6, 2015. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf.
5. US Centers for Disease Control and Prevention (CDC). *Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)*. Atlanta: CDC, 2003. Accessed Jul 6, 2015. http://www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf.
6. Johns Hopkins Medicine. Latest Hands-Free Electronic Water Faucets Found to Be Hindrance, Not Help, in Hospital Infection Control. Mar 31, 2011. Accessed Jul 6, 2015. http://www.hopkinsmedicine.org/news/media/releases/latest_hands_free_electronic_water_faucets_found_to_be_hindrance_not_help_in_hospital_infection_control.
7. Healthcare Facilities Today. Faucet System Is Designed to Aid Infection Control. Apr. 11, 2013. Accessed Jul 6, 2015. http://www.healthcarefacilitiestoday.com/posts/Faucet-system-is-designed-to-aid-infection-control-Product-News--746.
8. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). Press Release: Legionellosis Standard Provides Guidance on Risk Management Requirements. Jun 26, 2015. Accessed Jul 7, 2015. https://www.ashrae.org/news/2015/legionellosis-standard-provides-guidance-on-risk-management-requirements.
9. The Joint Commission. Surgical Care Improvement Project. Oct 2014. Accessed Jul 6, 2015. http://www.jointcommission.org/surgical_care_improvement_project/.
10. Eagle A. Safe and sound. Informed design approaches help to prevent patient harm. *Health Facil Manage*. 2014;27(6):14–19.
11. Healthcare Design. Five Need-to-Know Trends Shaping Healthcare Design. Edmonson K.. Jul 22, 2011. Accessed Jul 6, 2015. http://www.healthcaredesignmagazine.com/article/ five-need-know-trends-shaping-healthcare-design.
12. Lorenzi N. Rolling it out: Selecting carpet for the health care environment. *Health Facil Manage*. 2011;24(4):34–38.
13. Eagle A. Rolling it out: Carpeting for health care environments. *Health Facil Manage*. 2010;23(5):32–34.
14. Lavy S, Dixit MK. Wall finish selection in hospital design: A survey of facility managers. *HERD*. 2012;5(2):80–98.
15. Facility Guidelines Institute. *Guidelines for Design and Construction of Hospitals and Outpatient Facilities*. Chicago: American Society for Healthcare Engineering, 2014.
16. Section contributed by Charles Griffin, president, American Institute of Architects.
17. Pati D, et al. Inpatient unit flexibility: Design characteristics of a successful flexible unit. *Environment and Behavior*. 2008;40(2):205–232.
18. US Centers for Disease Control and Prevention. Emergency Preparedness and Response. (Updated: Sep 30, 2014.) Accessed Jul 6, 2015. http://emergency.cdc.gov/planning/.
19. Joint Commission Resources. Trial by fire: Lessons learned from the Chevron fire's unprecedented patient surge. *Environment of Care News*. 2013;16(4):1–5.
20. Ulrich RS, et al. A review of the research literature on evidence-based healthcare design. *HERD*. 2008;1(3):61–125.
21. Butcher L. The no-fall zone. *Hosp Health Netw*. 2013;87(6):26–31. Accessed Jul 6, 2015. http://www.hhnmag.com/display/HHN-news-article.dhtml?dcrPath=/templatedata/HF_Common/NewsArticle/data/HHN/Magazine/2013/Jun/0613HHN_coverstory.
22. Gulwadi GB, Calkins, MP. *The Impact of Healthcare Environmental Design on Patient Falls*. Concord, Ca: Center for Health Design. 2008.
23. Gabel L, Musheno E. Understanding the Special Needs of the Bariatric Population: Design, Innovation, and Respect. Aug 25, 2010. Accessed Jul 6, 2015. http://www.readbag.com/ki-pdfs-understanding-needs-bariactric-population.

24. Center of Health Design. Evidence-Based Design Accreditation and Certification (EDAC). Accessed Jul 6, 2015. http://www.healthdesign.org/edac.
25. Advisory Board. High Hospital Noise Levels Hinder Patient Recovery: Study Finds Peak Noise Levels Rivaled a Chainsaw. Daily Briefing. Jan 11, 2012. Accessed Jul 6, 2015. http://www.advisory.com/daily-briefing/2012/01/11/hospital-noise.
26. Pati D, et al. An empirical examination of patient room handedness in acute medical-surgical settings. *HERD*. 2010;4(1):11–33.
27. ECRI Institute. Press Release: ECRI Institute Announces Top 10 Health Technology Hazards for 2015. Nov 25, 2014. Accessed Jul 6, 2015. https://www.ecri.org/press/Pages/ECRI-Institute-Announces-Top-10-Health-Technology-Hazards-for-2015.aspx.

the construction phase

Chapter Outline

TERMS

construction boards

infection control risk assessment (ICRA)

interim life safety measures (ILSMs)

preconstruction risk assessment

During the construction phase, safety becomes a primary concern because the construction work itself poses safety risks, particularly for infection control and life safety. Risk assessments and implementation of various measures address these risks as do other construction activities, including construction worker education.

Construction Bidding

The construction bidding stage is one of the first steps taken to move the project from design to reality. Activities during this stage involve inviting qualified construction contractors to review the construction documents and submit bids for their pricing as well as the quality of service to be provided. The organizational owner is responsible for the decisions regarding the choice of contractors. However, using a cost consultant for guidance can facilitate the process. Depending on the results of the bidding process, the design may need to be modified by value engineering to meet budget constraints, or the budget may need to be modified (see PLANNING FOCUS: Value Engineering (VE)).

This describes only the process of a nonpublic entity using the design-bid-build facility model. Public entities are often required to open the bidding to all qualified contractors. See PLANNING FOCUS: Alternative Facility Delivery Models for information on other approaches.

Beyond the price quoted by the bidders, it is important to consider the past performance of the bidder in job site safety, project outcomes, quality of workmanship, and subcontractor arrangements.

Construction Risk Management

The construction stage begins in earnest following completion of the construction documents preparation stage. This is when the building or facility is actually built. Before physical construction begins, however, a number of activities must be completed to ensure adequate construction risk management.

Preconstruction Risk Assessment

Any construction or renovation project requires careful consideration of risks posed to patients, visitors, staff, and construction workers. For that reason, certain construction-related risk assessments are required, including a preconstruction risk assessment. This risk assessment is critical for managing risks to patients and visitors, as well as hospital and contractor staff, and provides a safety oversight for the construction work happening in the construction phase.

Joint Commission and JCI Requirements

The Joint Commission and Joint Commission International (JCI) both require organizations to manage the environment during demolition, renovation, or new construction to reduce risk to those in the organization. Standards from both organizations specifically require that a preconstruction risk assessment be conducted as part of the planning phase of a project. This risk assessment should identify hazards in occupied areas of the organization's buildings during construction. The scope and nature of the construction activities will determine the extent of the risk assessment.

The criteria used to assess risk should address the impact the construction will have on the following areas:

- Air quality
- Infection control
- Noise
- Vibration
- Utility systems
- Emergency preparedness
- Other hazards that affect care, treatment, and service

FGI Guidelines

The Joint Commission and JCI are not the only organizations that require an assessment of project risks. In the United States, the Facility Guidelines Institute (FGI), through its *Guidelines for Design and Construction of Health Care Facilities*, also

requires risk assessments (see FOUNDATIONS: Standards and Regulations). These were listed in Chapter 2, as the risk assessments should begin during predesign and should impact choices during the design phase.

Infection Control Risk Assessment (ICRA)

One of the risk assessments the FGI *Guidelines* requires is focused on infection prevention and control during construction. It is referred to as an infection control risk assessment (ICRA).* The guidelines state that ICRA should be addressed during design and construction phases to determine the potential risk of transmission of various agents in the facility. Ideally, the ICRA should be a continuous process, starting during planning and continuing throughout design and construction—as should all project risk assessments.

ICRA Matrix

There are several ways to conduct an ICRA. Many organizations construct a matrix to make sure each risk has an appropriate response. A matrix typically includes the following ranked categories of information:

- ***Activities:*** Types of project activity (from minor to major)
- ***Patients:*** Groups of patients affected (from low- to high-risk)
- ***Issues:*** Classes of issues involved with the project and related precautions to minimize related risks (from simple to complex)

One widely used template for creating a matrix like this is available from the American Society for Healthcare Engineering (ASHE) on their website. Based on the matrix, the template prescribes precautions to use during construction and at the end of construction.

ICRA Plan

The owner and the contractor use the ICRA matrix as basis for phase plans that detail where various construction barriers (air infiltration, fire, smoke) are placed during that phase. Such plans also indicate the path that the construction teams use to enter the site and building and the path(s) used to bring in materials and equipment and take out debris.

STANDARDS SIDELIGHT

Infection Control

As in all other aspects of care in a health care facility, the physical environment has an impact on clinical care, particularly in the area of infection control. Facilities directors and clinical care leaders must continually work together on the intersection of these two facets of health care. Special attention, however, is required during construction. Infections associated with the dispersal of airborne or waterborne microorganisms during construction have been linked to such factors as new fireproofing insulation, carpet, ventilation system humidifiers, and many other items in the care environment.

IC and EC; PCI and FMS

The Joint Commission requirements for this collaboration can be found in the "Infection Prevention and Control" (IC) and "Environment of Care" (EC) chapters of the hospital manual, and JCI requirements are in the "Prevention and Control of Infections" (PCI) and the "Facility Management and Safety" (FMS) chapters of the hospital manual.

(Also see FOUNDATIONS: Standards and Regulations.)

* The ICRA is now often called a Project Infection Control Risk Assessment (PICRA).

ICRA Team

An ICRA is most effective when undertaken as an interdisciplinary team effort. Organizations will want to include people with expertise in infection control, of course, but also risk management, facility design, ventilation, safety, and epidemiology. Other members may be added, as appropriate, for a given situation. However, the infection control specialist plays a special role on the team and may be able to bring to the team an in-depth understanding of the affected patient population. He or she may even assist with educating the construction workers on infection control concerns (see page 103).

The Association for Professionals in Infection Control and Epidemiology (APIC) recommends that after a risk assessment team is selected, an authority should be assigned to coordinate the process. It notes that contractor accountability for attention to infection control issues should be written into the contract documents. Furthermore, APIC reminds organizations to focus not only on patients but also on the risks to health care workers, volunteers, and the contractors themselves.[1]

Implementing Preconstruction Risk Assessment Measures

When the preconstruction risk assessments are complete, it is up to the organization to implement recommendations (or measures) to reduce and control the risks inherent in the project. Furthermore, the measures instituted as a result of the assessment must be enforced and monitored. An organization should therefore revisit its assessment throughout the construction phase to ensure that all risks have been appropriately addressed (see CONSTRUCTION FOCUS: Construction Risks and Measures).

It is also essential that the risk assessment process be documented. The organization is ultimately responsible for conducting the assessment and implementing measures. But responsibilities for specification and implementation also lie with the contractor on the project, and these responsibilities should be clearly outlined in the contract. One organization's difficulties resulting from cleanliness levels in construction is profiled in the Project Gallery below.

Project Gallery

Cleanliness Levels in Construction

Kaiser Permanente

The LEED rating system requires health care facility construction to follow the FGI *Guidelines* and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 170. Standard 170 prohibits operation of the permanent heating, ventilation, and air-conditioning (HVAC) system during construction unless the air-distribution system is protected from contamination. As explained below, Kaiser Permanente's LEED-NC Gold hospital and specialty medical office building (SMOB) project in the Pacific Northwest had to operate the mechanical system during construction. Therefore, special inspection, testing, and cleaning were necessary before project completion. Following are some lessons learned from Kaiser Permanente's experience.

Two Contractors and Two Levels of Cleanliness

Kaiser Permanente completed construction on the 423,000 square foot hospital and SMOB campus in 2013. Using greener alternatives to sheet vinyl flooring necessitated drying of the floor slabs to achieve low moisture content for the rubber flooring water-based adhesives—yet this had to be accomplished without compromising an aggressive construction schedule. To do

so effectively meant the HVAC system had to be operated continuously to dry the slab during a very wet winter.

With strong corporate design standards and a good specification, the project construction management team assumed that the duct system would be fabricated to meet their indoor-air-quality expectations. However, two sheet metal contractors were subcontracted: one made the ductwork for the medical office building and the other for the adjoining hospital. The ductwork for the SMOB was fabricated on-site to an "Intermediate" level of cleanliness, whereas the hospital ductwork was manufactured in a shop and trucked to the site with the ends sealed, conforming to an "Advanced" level of cleanliness, as defined by the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

Cleanliness Testing

After the slab was dried and before the building was turned over, a visual inspection of the ductwork was conducted, and visible dust was found inside some of the SMOB ducts, prompting testing of key locations to determine the extent of the problem. The sampling plan concentrated on the supply ducts because these are at greatest risk of transporting debris past final filters (if any filters are in place). The SMOB has a plenum return so no sampling of the return system was conducted there, but a few samples were collected in the hospital return ducts.

To get the most value for the expense of testing, targeted high-risk locations were selected in the hospital; the actual duct location chosen for sampling was randomized. Those areas included airborne infectious isolation rooms, operating rooms, sterile processing work areas, and clean utility rooms throughout the hospital. The SMOB sampling plan included samples taken from each air handler, but not on each floor, during the first round.

All samples from the hospital were found to be below the clearance level; however, several of the SMOB samples failed. Additional testing was conducted on all floors in the SMOB to find out whether the problem was with a specific system component or the result of the on-site manufacturing process. The second round of sampling showed three of the four floors were in need of cleaning, so the entire HVAC system was cleaned. Testing after cleaning showed all locations were acceptably clean.

Cleaning and Testing Ductwork per Standards

Cleaning and testing of the duct surfaces was conducted as outlined in the National Air Duct Cleaners Association's "Assessment, Cleaning and Restoration of HVAC Systems" standard (NADCA ACR 2006). This is the only US–based standard published on duct cleaning and cleanliness acceptance criteria. A review of the standards and guidelines revealed that there is a lack of objective criteria for determining when cleaning is necessary. While it is logical that risks decrease when ducts are cleaned, the evidence is not clear that there is a particular level under which health is protected. Nevertheless, regardless of the lack of demonstrated causation, the precautionary principle advises taking prudent action in the absence of certainty, and especially in health care occupancies that contain immunocompromised individuals.

Three standards also recommend annual inspection of health care facility ducts after construction is complete and the facility is placed into operation. All recommend duct-cleaning activities based only on the results of those inspections and not on a regularly scheduled basis. However, simple visual inspections are not empirically objective measures of cleanliness; therefore, some jurisdictions have attempted to implement empirical duct cleanliness thresholds. For example, the Chartered Institution of Building Services Engineers' Hong Kong branch (Hong Kong CIBSE) adopted quantifiable limits. As an ongoing expense, regularly scheduled periodic duct cleaning is not widely recommended by the surveyed standards. Such a program would be unlikely to benefit the patients and staff commensurate to its costs. It would therefore appear that annual inspection (and cleaning when ducts are found to be contaminated) is a good approach to adopt.

US and International Ductwork Inspection Standards

Inspection of the ductwork, in US standards, includes a visual inspection for water damage or biological growth. International standards have defined levels of surface cleanliness in ductwork. It is not clear how these thresholds were arrived at, and whether there is a demonstrated link between these values and adverse health outcomes.

Ductwork Inspection for Health Care Facilities

Duct inspections for health care facilities are recommended more frequently than in most other building types, but no distinction is made between hospitals, medical office buildings, and ambulatory surgery centers. Health care facilities generally have more efficient filtration than other facility types, so it is logical to assume the more efficient filters would suggest a decreased risk of duct contamination. This suggests an abundance-of-care approach on the part of the standards-setting organizations, which may not have rigorously considered the opportunity costs of the recommendation.

Despite the absence of a clear prevailing standard for quantifying duct cleanliness, prudence dictates that hospital owners exercise ordinary care to protect ducts from contamination during both initial construction and daily operation. Given the time and expense of duct cleaning and the severity of potential adverse health outcomes from environmental pathogens, some of which can grow and be transmitted in HVAC systems if dirt or debris is allowed to accumulate, it makes sense to require all duct manufacturing for health care organizations to be at a minimum standard of the "Advanced" cleanliness level.

Contributed by: Erica J. Stewart, CIH, Kaiser Permanente; Travis R. English, PE, LEED-AP

Interim Life Safety Measures (ILSMs)

Another common and important preconstruction practice for addressing project risks is an assessment to determine compliance with the *Life Safety Code*®* (see FOUNDATIONS: Standards and Regulations). Construction and renovation projects are ripe for such compliance violations. Common deficiencies during construction involve the safety and accessibility of patient rooms, fire exits, and emergency departments, and operation of alarm and sprinkler systems. The Joint Commission has requirements regarding implementation of appropriate interim life safety measures (ILSMs) whenever a building is found to be out of compliance with the *Life Safety Code* and the deficiency cannot be corrected immediately, including during construction or renovation (see Standards Sidelight: Life Safety on page 102).†

ILSMs help reduce the risk of fire, bolster impaired fire protection systems, and, in the event of fire, ensure that occupants can be moved to a safe location and that emergency personnel can get in. Although a few ILSMs are geared primarily toward construction and renovation, most can be applied in any situation in which life safety is compromised. ILSMs should be considered an important part of overall risk management.

ILSM Options

As outlined in the Joint Commission Life Safety (LS) standards, there are numerous ILSM options, as follows:

- ***Exits:*** Inspection of exits in affected areas on a daily basis
- ***Signals and alarms:*** Making sure that temporary but equivalent fire alarm and detection systems are in place when a fire system is impaired
- ***Firefighting equipment:*** Providing additional extinguishers and other firefighting equipment, which should be adequately and safely stored in the affected area
- ***Construction barriers:*** Using temporary construction partitions that are smoke tight and fireproof/fire-resistant
- ***Surveillance:*** Boosting surveillance of buildings, groups, and equipment, with a special focus on construction areas and storage, excavation, and field offices
- ***Debris removal:*** Lowering the building's combustible load by enforcing debris removal practices
- ***Firefighting equipment training:*** Offering additional training to staff on the use of firefighting equipment
- ***Fire drills:*** Conducting one additional fire drill per quarter
- ***Inspection and testing:*** Inspecting and testing temporary systems monthly
- ***Education:*** Providing education to promote awareness of building deficiencies, construction hazards, and temporary measures implemented to maintain fire safety
- ***Fire safety features training:*** Training staff to compensate for impaired structural or compartmental fire safety features

Other Fire Protection Measures

Other fire protection measures outlined in the standards include the following:

- ***Alarm and sprinkler outage response:*** When the alarms or sprinklers are out of service for more than 4 hours in a 24-hour period, alerting the fire authorities and documenting

* *Life Safety Code*® is a registered trademark of the National Fire Protection Association, Quincy, MA.

† The *Comprehensive Accreditation Manual for Hospitals (CAMH)* describes ILSM as "a series of 11 administrative actions intended to temporarily compensate for significant hazards posed by existing National Fire Protection Association 101 - 2000 *Life Safety Code* deficiencies or construction activities."

when that notification occurs; conducting a fire watch also, making rounds of the area affected by the outage and documenting those rounds

- *Signage:* Posting signs about alternate exits from the building if an exit is compromised due to construction, blockage, or another reason

Implementing ILSMs

As noted, appropriate ILSMs should be implemented any time a lapse in *Life Safety Code* compliance is evident. By their very nature, however, ILSMs are intended to be temporary. An ILSM should be in place only while the compliance lapse exists. After an organization comes back into compliance with the *Life Safety Code*, the ILSM can be eliminated. Therefore, if an organization is taking a phased approach to a construction process, it needs to implement the ILSM during the phase in which the *Life Safety Code* lapse is present. Each time there is a *Life Safety Code* lapse, an ILSM must be implemented.

Statement of Conditions™ (SOC)

To comply with Joint Commission LS standards, an organization should have in place a specific policy that determines when and how it will assess *Life Safety Code* compliance and respond to deficiencies during construction, including use of ILSMs. To conduct the ILSM assessment, organizations can complete the Joint Commission's Statement of Conditions™ (SOC) document. The SOC is a proactive tool that can help an organization carry out a critical self-assessment of a facility's current level of compliance with the *Life Safety Code*. It also helps the organization develop a plan for resolving related deficiencies with ILSMs. For new construction, the SOC may not provide a benefit. For work that impacts existing facilities, however, routinely updating the SOC can be helpful for monitoring compliance to the LS chapter.

ILSM Team

When conducting a *Life Safety Code* assessment for a construction project, an organization should have an

STANDARDS SIDELIGHT

Life Safety

When construction or renovation activities are taking place, the safety of patients, staff, and other occupants of a facility can be compromised. The work can involve flammable materials and "hot work" permits, such as those for welding and soldering. In addition, fire detection, suppression, and alarm devices may be out of service, and normal exits and escape paths may be blocked. These conditions present threats to the safety of all occupants of the facility or worksite and must be addressed. To do this, Joint Commission standards require organizations to develop and implement interim life safety measures (ILSMs). These are activities that protect occupants during periods when a building does not meet the applicable provisions of the *Life Safety Code* for a set period of time, and they may change over time as the project proceeds. Failure to meet the required ILSMs can jeopardize accreditation status.

LS and EC

The Joint Commission requirements for implementing ILSMs can be found in the "Life Safety" (LS) chapter of the hospital manual. Other related requirements for fire protection can be found in the "Environment of Care" (EC) chapter of the hospital manual.

(Also see FOUNDATIONS: Standards and Regulations.)

Sample ILSM Team

- Safety officer
- Construction manager
- Facility director
- Infection control practitioner
- Risk manager
- Security manager
- Administration representative
- Representative of affected staff in construction area
- Architect(s)
- Engineers
- Contractor and appropriate subcontractors (mechanical, electrical, and so on)

interdisciplinary ILSM team review the construction documents drawings of the facility and look for areas of noncompliance. This group should also determine which ILSMs are appropriate for addressing identified lapses in compliance.

Some organizations choose to use the same team to conduct their ILSM assessment and their ICRA at the same time. Although The Joint Commission does not require this, it may be a helpful way to ensure both assessments are coordinated and no critical areas are overlooked.

Construction Activities

The construction process is multifaceted and requires participation from all members of the project team, including organization leadership, staff, architects, engineers, contractors, and construction personnel (see Chapter 1). The specific responsibilities of each member or group of members will vary according to the size and scope of the project; however, certain activities must be performed during the construction phase of any project. These may begin before physical construction begins and will continue throughout the construction phase—and some may continue beyond into the commissioning phase (see Chapter 4).

Project Team Kickoff Meeting

Before beginning physical construction, the project team should meet to discuss final preparations (this is frequently referred to as a kickoff meeting). At this meeting, participants should do the following:

- Review project procedures, schedules, and budget.
- Identify any necessary subcontractors.
- Discuss plans to secure necessary building permits.
- Determine actions for establishing project site security.
- Confirm that site conditions are acceptable for completing the project as proposed.

Other areas of discussion should include the following:

- Storage of building materials
- Contractors' access to occupied areas
- Relocation of furniture and equipment
- Above-ceiling access in occupied areas
- Barrier construction and placement
- Reaction or disaster plans for undesirable events
- Travel paths for contractors and deliveries
- Contractor and construction worker education
- Contractor parking

An organization might want to consult the local fire marshal for any additional issues to discuss.

As discussed earlier in this chapter, before physical construction begins, the project team, working with an ILSM team or facilities staff, must also implement relevant ILSMs and others measures that were developed in response to the preconstruction risk assessment (see page 97). Therefore, both the ILSMs and preconstruction risk assessment should also be reviewed at this time to determine the emergence of new risks that may need to be addressed.

Construction Worker Education

Although the general contractor on a health care facilities project should ideally have health care experience, not all construction workers are familiar with the unique issues associated with such projects. For example, a utility shutdown, for whatever purpose, is something that must be carefully planned and coordinated in a health care facility. Workers can't simply cut the power at a moment's notice, as serious safety implications could result.

Topics to cover in construction worker education include the following:

- Life safety risks and ILSMs (when required by regulations)
- Infection control risks and measures to address those risks
- Security issues
- Fire watch procedures
- Fire alarm activation
- Parking and building access
- Patient privacy
- Proper waste handling
- Cell phone use
- Equipment and materials

Overarching Issue

Communication

Communication is the most important thing a health care organization can do to ensure a smooth-running project. Effective communication can mean the difference between a safe and successful project that is completed on time and one that is plagued with delays, safety issues, budget overruns, and frustration. Organizations should ensure effective communication with and between the project team, organization staff, patients, and the public.

Communication within the Project Team

The project team discussed in Chapter 1 should be meeting and communicating regularly, and may want to meet at least weekly once construction begins to discuss the following issues:

- The status of the project
- The effectiveness of interim life safety measures (ILSMs) and other safety measures in preserving patient safety
- Any emerging safety concerns, such as infection control risks, fire safety risks, and so on
- Any changes to the work
- Project budget
- Project schedule

Issues that come up between meetings could be addressed via teleconference, videoconference, or e-mail. Team members should also visit the site on a regular basis during construction to become familiar with the progress and assist in determining whether the work is being conducted according to the construction documents. Organizations should document these tours to monitor the progress of the project.

Communication with Organization Staff and Patients

To prevent frustration, confusion, and risks to safety during a construction or renovation project, organizations must ensure effective communication with and between staff and patients.

Information that should be provided to both groups includes the following:

- The nature of the project
- The time line involved
- The areas that will be affected
- Responsibilities of staff during the project
- How to safely enter and exit the building
- How to report safety risks observed during construction
- The precautions in place to preserve patient and staff safety, such as ILSMs and infection control measures
- New developments in the project

Organizations can use a variety of effective tools to communicate with staff and patients during the project process, including staff training, an organization newsletter, a website, and construction boards. Construction boards share information, including safety information, about the construction or renovation project with anyone coming into the facility.

Communication with the Public

In addition to providing information to staff and patients, organizations should communicate with the public about the nature, time line, and projected outcomes of a project. Depending on the particular project, the public may be significantly affected by such issues as altered traffic patterns and increased noise levels. By taking a proactive approach to communication, an organization can prevent miscommunication and confusion that could lead to an adverse relationship between the organization and the public.

Information about a construction or renovation project can be disseminated to the public through a variety of venues, including press releases, commercials, public announcements, organization newsletters, and the organization website.

- Radiation safety, if applicable
- Hazardous materials
- Utility/electrical safety
- Smoking
- Violence
- How to seek help and report issues

By including the ILSMs and preconstruction risk assessment in the construction documents (see Chapter 2), a contractor can be aware of many of these issues and their risks and educate construction workers on both risks and preventive measures. A weekly construction worker meeting also provides opportunity for education. Some organizations require individual construction workers to receive training before they enter the construction site. This education might take the form of group training sessions or self-study guides. Contractors may keep a book that documents worker education so organizations can be assured that everyone received the proper education before coming on site. In smaller projects, the responsibility for construction worker education might fall to the facilities director, safety manager, or infection control professional.

Implementing Safety Measures During Construction

During construction, it is critical to communicate information about the implementation of safety measures. The following are points to keep in mind to make implementation successful:

- ***Data for process redesign:*** Gather data on the functioning of systems and processes for risk reduction to be used in the redesign process of current systems. This helps to ensure a data-driven design and redesign process, as discussed in Chapter 2.
- ***Contractor involvement:*** Contractors should be involved in the implementation process. Contractors are, in fact, often in charge of implementation, but organizations should verify that this implementation actually does occur.
- ***Posting measures:*** Share measures with the organization. This could include the use of informative posters and construction boards placed near the entrance to the construction site. An organization that has a project website should also consider posting measures on that site.
- ***Educating construction workers:*** As previously mentioned, the contractor may be in charge of educating construction workers, but organizations should reinforce education about safety measures during weekly construction meetings.
- ***Educating staff:*** Educating staff could involve training staff members on any identified safety risks; measures to address those risks, including ILSMs and infection control measures; and how to report activities that occur without the proper risk prevention measures.
- ***Stopping work:*** Based on reports from staff or during regular construction site visits, organization leaders, facility directors, infection control professionals, and safety officers may learn of a hazardous condition that needs prompt attention. These individuals should have the authority to stop all work until the issue is addressed, if that is what is warranted. In addition, a person or persons responsible for air and water quality monitoring must be given authority to stop the construction work if a problem develops.

Cleaning Up

Organizations should make sure the construction team takes adequate steps to clean the site throughout construction and after. There are too many stories of soda cans and cigarette butts being sealed in walls because of inadequate cleanup. These items can lead to mold, fungus, and bacterial problems. For this reason, it is important to make sure cleaning agreements are established before construction begins.

Cleaning During Construction

During construction, a contractor can keep the construction area clean by taking the following actions:

- Have staging areas properly allocated for materials being delivered to and stored on the site.
- Keep absorbent materials protected from moisture.
- Suppress dust with wetting agents or sweeping compounds.
- Clean up immediately after activities that produce high dust levels (or at the end of each day the activity continues).
- Replace any absorbent materials that become exposed to moisture during construction.
- Vacuum stud tracks prior to application of a second surface of gypsum board, to remove dirt and potential mold food sources.
- Maintain temperature and humidity levels whenever possible.
- Keep duct ends sealed with plastic to reduce dust infiltration into the mechanical system when the system is not in use.
- Cover return air registers with filter material if the mechanical system must be used during construction.
- Restrict food and beverage consumption (except water) to a designated area that can be maintained daily.

Cleaning After Construction

Tasks that organizations should require of construction teams at the end of construction include the following:

- Remove barriers carefully to minimize the spread of dust and debris (do before other cleaning tasks).
- Dispose of barriers properly.
- Clear, clean, and decontaminate the area.
- Vacuum the work area with high-efficiency particulate air (HEPA)-filtered vacuums.
- Mop the area with disinfectant.
- Bag construction waste or transport it in covered carts.
- Unblock air vents.

Expert Cleaning Assistance

Although a larger organization may have a certified industrial hygienist on staff to provide assistance with construction cleaning, a smaller organization may need to contract with an expert. If a project requires frequent air and water testing to ensure no decontamination has occurred, for example, it is vital that such testing be performed by qualified personnel (see CONSTRUCTION FOCUS: Construction Risks and Measures). Staff should define culturing or sampling procedures before beginning work and establish parameters for interpreting collected data. It is important to perform as much real-time monitoring as necessary.

Exit Note

Construction is a time of increased risks to safety. This chapter has highlighted the importance of identifying and managing those risks. Organizations should use the many available tools to ensure safety—from preconstruction risk assessments and ILSMs to communication and education—throughout the project. Supporting the focus on safety during the construction phase are thorough, specific, and accurate construction documents, developed during the design phase, that guide the project and spell out contractor responsibilities.

Reference

1. Bartley JM. APIC state-of-the-Art report: The role of infection control during construction of health care facilities. *Am J Infect Control.* 2000;28(2)156–169.

construction risks and measures

FOCUS Outline

Construction Risks

- Dust and Fumes
- Mold
- Fungi
- Hazardous Materials
- Water Contaminants
- Noise and Vibration
- Emergency Procedures
- Utilities Disruption

Measures to Minimize Risks

- Isolate the Project
- Use Appropriate Work Methods
- Ensure an Effective HVAC System
- Use Negative Pressure Areas
- Set Up Clean and Dirty Anterooms
- Use Covered Containers for Waste Removal
- Use Low-Emitting Materials
- Carefully Plan Traffic Control
- Test Air and Water
- Monitor Immunocompromised Patients
- Provide PPE for Construction Workers
- Determine How Best to Use Barriers
- Clean the Work Area

TERM

personal protective equipment (PPE)

Construction in health care organizations poses many possible risks. This FOCUS feature explore some possible construction risks, as well as some actions organizations can take to minimize those risks.

Construction Risks

Each project presents a unique set of issues, which will vary depending on the type of project. Common risks include the following.

Dust and Fumes

Even in small-scale settings, dust and fumes can compromise patient safety. Dust can have severe effects on asthmatic patients. Volatile organic compounds (VOCs), which are chemicals typically contained in cleaners, paint, adhesives, and the off-gas of new carpeting and upholstered furniture, can cause a variety of adverse health effects.

Mold

It is not uncommon for mold to be discovered during demolition or construction. It often occurs on a construction site when materials get wet as well. This could be due to a burst pipe, a water leak, or rain intrusion. These scenarios are common to most projects. Mold can be hazardous to patients with compromised immune systems and others. The US Centers for Disease Control and Prevention (CDC) offers specific guidelines on how to handle materials that come in contact with moisture. Organizations must dry materials completely before use or remove them within 72 hours. Some organizations choose to use a conservative approach to mold prevention and ban the use of materials that have become wet during the course of the project.

Fungi

When renovating older buildings, construction teams often have to deal with fungi, such as *Aspergillus*. Sources of fungi include outdoor air; previous water damage to ceilings, plaster, or drywall; construction dust; excavation; wet areas in heating, ventilating, and air-conditioning (HVAC) system; living plants; and bird and bat droppings. Fungal spores can become airborne after being disturbed. To counteract this, handlers must take care to wet any affected material before its removal. The phases of construction that usually create the greatest fungi risk include demolition, window or wall removal, ventilation and utility outages, application of volatile chemicals, and placement of combustion engines.

Hazardous Materials

A renovation process can sometimes disturb existing materials, and some of these materials could be hazardous to patients' health. For example, asbestos and lead paint are still present in some facilities, and they have well-documented health risks across all populations. A common mistake is that facilities may look only at lead paint. In the United States, the Occupational Safety and Health Administration's standards for lead relate not only to lead paint but to all lead used in construction (see FOUNDATIONS: Standards and Regulation). Therefore, hospitals should look at all sources of lead, including roof flashings, plumbing, and most importantly, lead shielding in imaging departments. If not properly managed, the demolition and installation of lead shielding during health care construction can pose a significant health hazard to patients, visitors, and staff.

Mercury, commonly used in earlier decades for temperature gauges and switches, can still be found in some research laboratories and health care facilities. Fluorescent lamps also contain mercury. During construction, these instruments sometimes break, releasing the highly toxic substance into the surrounding environment.

Water Contaminants

During projects, bacteria can enter and contaminate the water system. Many existing water systems already contain contaminants such as *Legionella* in the biofilm. This does not pose a threat if left undisturbed. However, during construction, vibration can release *Legionella* into the water supply.

Noise and Vibration

Noise can have a detrimental effect on patient care, and vibration can affect delicate surgical procedures. Organizations should be aware of and work to minimize the negative effects of construction noise on patients and staff.

Emergency Procedures

Construction and renovation projects can dramatically affect an organization's emergency response procedures by moving entrances and exits, rerouting traffic, and disabling alarm systems. An organization must consider how it would respond to an emergency during construction, including how to defend in place during a fire and, if necessary, evacuate (see DESIGN FOCUS: Designing for Safety and Reliability).

Construction workers, for example, impact emergency procedures during the project. On a large-scale project, there may be thousands of additional people working within the facility on a daily basis. Some workers may be on site for only a few days, while others may be there for more than a year. It is important that the organization consider the type and extent of the impact these additional workers will have on emergency planning efforts.

The organization should also consider revising its hazard vulnerability analysis (HVA) to reflect the construction activities. For example, if a tower crane is being brought on site, does the HVA consider what would happen if this were to tip and block access to the facility or injure a large number of people in the area? It is important to train the construction workers in how to respond to an emergency such as this as well as to others (fire, earthquake, storm event). This is a critical part of emergency planning, and the organization needs to provide appropriate training when necessary.

Utilities Disruption

During the course of construction, an organization may be required to shut off the main power, heat, water, or air-conditioning. Organizations must consider the effect of these shutdowns on system and patient levels. For example, if the water must be shut off for two hours, how will patients, staff, and equipment be affected? When can the shutdown be scheduled so as to have the least effect?

Most hospitals do a good job with planned shutdowns of utilities, including having a plan in place in the event of an unexpected shutdown of a utility that gets damaged during construction. This is a critical part of any risk assessment

process. An organization should identify any utilities that are running through the space (water, medical gas), and then assess what would happen if during construction the contractor accidently were to break a water or oxygen line. What other parts of the hospital are served by these utilities? Has the contractor been properly instructed on what to do? This is a major risk point that sometimes goes unaddressed during the preconstruction risk assessment (see Chapter 3).

Measures to Minimize Risks

To address the many possible risks are many possible measures, including those described here.

Isolate the Project

Construction and renovation projects should be isolated from the rest of the facility. Large-scale projects, such as constructing a new wing or renovating an old one, might be easier to isolate than small-scale projects, such as painting a few rooms or repairing ceiling tiles. The National Fire Protection Association requires a two-hour separation from slab to slab to separate any construction areas from the rest of the building (see FOUNDATIONS: Standards and Regulations).

Use Appropriate Work Methods

Organizations should consider all work methods that could help reduce the likelihood of future patient safety problems. These methods may include using high-efficiency particulate air (HEPA)–filtered fan units, creating a negative air flow, employing the use of vacuums to minimize dust, working off-hours or on weekends to reduce the impact on patients and staff, wetting down materials with a fine spray to prevent the spread of dust and fungi, and other strategies to address risks.

Ensure an Effective HVAC System

Because virtually all buildings have some degree of recirculation in their ventilation systems, requiring both a supply and a return, careful proactive planning prevents buildingwide contamination during construction. This includes contamination from dust, fumes, or other airborne particles. To prevent contamination from the construction site, air must flow from clean to dirty. The facility's HVAC engineer must determine how to isolate the system. This may include sealing vents, adding additional filters, or using other means. Elevator shafts require special consideration because of their tendency to function like a chimney, drawing odors, dust, and fumes up through the shaft onto other floors.

Use Negative Pressure Areas

No matter how well an area is sealed with plastic sheeting or rigid barrier walls, air leaks can occur. Using negative pressure (see DESIGN FOCUS: Designing for Safety and Reliability) can prevent seepage into adjacent areas and draw air containing dust, fumes, and other particles back into the construction area. This prevents air recirculation. Exhaust from the construction area should be filtered and directed outside to a predetermined area. Negative air machines, capable of drawing in and filtering up to 2,000 cubic feet of air per minute, can be effective. In the past, these units were expensive, but their cost has dropped, and they work extremely well. HEPA–filtered units are capable of filtering out 99.97% of particulate matter. One downside to negative pressure machines is that they can be noisy. Organizations will need to address this noise during the risk assessment process (see Chapter 3). Organizations should also assess how much negative pressure will be needed at the construction site, where the exhaust will go, how the pressure will be monitored, and whether to use existing equipment.

Negative pressure can also be used with small-scale projects. For example, if workers need to run wires above a ceiling, they can contain just the area they are working in by building a plastic cube around the work space and putting the cube under negative pressure with a small negative-air unit or a HEPA–filtered vacuum cleaner. With proper exhausting outside the cube, dust and fumes can be prevented from migrating to occupied areas.

When vacuums and negative air units are exhausted inside the building, they should be part of a routine preventive maintenance program that includes periodic testing of the filtering efficiency. As this equipment ages and is moved around, damage and filter leakage may occur. Because this is common and undetectable by the eye, periodic testing using an aerosol challenge test or, at a minimum, a particle counter is recommended. This will help to ensure that this critical engineering control is functioning as designed.

Set Up Clean and Dirty Anterooms

Just outside the construction site, organizations may wish to set up clean and dirty rooms. This will help construction workers remove particles of dust, fungi, and bacteria from their persons before leaving the project area. This can minimize the transfer of such particles outside the construction zone.

By placing tacky mats at the entrance to and exit from the construction site as well, an organization can minimize the spread of dust and debris throughout the facility.

Use Covered Containers for Waste Removal

Use of covered containers for waste removal can prevent the spread of odors, dust, and other particles that can cause patient harm. It also reduces VOCs. Waste should be removed every day. In addition, containers of paints and adhesives should be kept closed when not in use. Doing so reduces the VOCs.

Use Low-Emitting Materials

By using low-emitting materials during construction, organizations can prevent off-gassing of VOCs and carcinogens into the air. This can preserve the environment as well as the safety of construction staff, health care staff, patients, and visitors.

Carefully Plan Traffic Control

Preconstruction planning defines how workers will enter and exit a building and the route they will take to the construction area. If possible, separation of patient, visitor, and staff traffic from construction traffic is highly desirable. Signs should direct patients, staff, and visitors away from the construction area. In larger buildings, it might be appropriate to designate freight elevators for construction traffic. These are designed for heavier use and are rarely used by patients. If this is not feasible, one or more elevators can be "keyed off," allowing only the construction staff to use them. Organizations should consider how to protect nonfreight elevators because they can be damaged quickly during construction. Placement of the construction office for large projects requires planning as well. An office trailer should not get in the way of patients, visitors, and staff entering or exiting the facility.

Test Air and Water

The CDC does not recommend routine sampling of air and water, but provides specific situations for performing sampling and sampling goals. Those are as follows:

- *Disease outbreaks:* To support an investigation of an outbreak of disease or infection when environmental reservoirs or fomites are implicated epidemiologically in disease transmission. This culturing should be supported by epidemiologic data, which should be conducted with a plan for interpreting and acting on findings.
- *Research studies:* To conduct well-controlled research studies
- *Risk management:* To monitor a potentially hazardous environmental condition, confirm the presence of a hazardous chemical or biological agent, and validate the successful abatement of the hazard
- *Infection control assessment:* To evaluate the effects of a change in infection control practice or to ensure that equipment or systems perform according to specifications and expected outcomes

This final situation is the most common one for sampling during a construction process for quality control. One common measurement is ongoing testing of air quality during construction. This is the one exception where conducting sampling for extended periods with no resulting adverse condition is applicable. The purpose is to determine breaks in environmental infection control measures. In addition, sampling is recommended during the commissioning of newly constructed space such as operating suites, immunosuppressed units, or other vulnerable populations (see Chapter 4).

Monitor Immunocompromised Patients

Careful monitoring of immunocompromised patients is particularly important during a construction or renovation project to detect any airborne contaminants as early as possible. The monitoring is not environmental sampling, but a close watch on any type of unexpected infection in patients. This is a requirement in the infection control chapters of accreditation manuals (see FOUNDATIONS: Standards and Regulations).

Provide PPE for Construction Workers

This may be a coverall, simple cover masks, varying degrees of respirators, eye shields, gloves, or other type of personal protective equipment (PPE). PPE is designed to minimize exposure to workplace injuries and illnesses.

Determine How Best to Use Barriers

Barriers can seal off the construction site. As part of a risk assessment, an organization should determine where to place barriers, what materials should be used to make barriers, and the life safety considerations associated with those barriers.

Clean the Work Area

This could include wiping down work surfaces with disinfectant, daily vacuuming with HEPA–filtered vacuums, and ensuring all trash is removed from the construction site on a regular basis.

CHAPTER

the commissioning phase

Chapter Outline

TERMS

clinical operations commissioning (COC)
commissioning authority
commissioning plan
facility commissioning (FC)
issue resolution system
owner's project requirements (OPR)
process alignment
punch list
simulations

Because a construction or renovation project is never purely linear, the first steps of the commissioning phase begin during the earlier planning, design, and construction phases. Two types of commissioning are necessary. Facility commissioning (FC) (or systems commissioning) is a systematic process that involves documenting and verifying that all building systems and features are present and perform interactively, according to the intent of the design and the organization's needs. Clinical operations commissioning (COC) focuses on the human activity in the health care facility by examining work flow processes. Training and monitoring are part of both types of commissioning. Other aspects of commissioning are applicable to the process as a whole as well.

The Commissioning Process

The commissioning process can vary by project. It should ideally begin in the planning phase and may continue a year or more after construction is completed. Different aspects of the process are stressed during different parts of the overall project process:

- ***During the planning phase:*** The organization should establish the owner's project requirements (OPR) during the predesign phase that begins during the planning phase. These can be used to provide baselines during later stages of commissioning. These requirements are similar to the guiding principles in the Design Outcome Plan™ (DOP), although usually more technical (see PLANNING FOCUS: Design Outcome Plan™).
- ***During the design phase:*** During design, the following issues related to commissioning should be outlined:
  - System and work flow design intent
  - Systems to be installed; work flow processes to be applied
  - Documentation requirements for each party involved in the commissioning process (may include contractor performance language in systems-provider contracts)
- ***During the construction phase:*** During this phase the organization should work with staff to develop and transition new work flow processes that will align with the final design of the facility (see page 116). This is also the time to create and begin applying the commissioning plan (see page 113).
- ***During the commissioning phase:*** As commissioning activities begun in earlier phases continue, new ones are added, each expressing one of the following key elements of commissioning:
  - Documenting system and work flow design intent, operating sequences, and testing/monitoring procedures
  - Verifying system and staff performance based on extensive operational testing and measurement
  - Training building operations staff on system operation and maintenance procedures and orienting staff to the new spaces and processes
  - Monitoring system and staff performance on an ongoing basis

Once the facility opens, it can begin to measure the outcomes of the goals set in a DOP and evaluate the performance of systems and processes identified during commissioning and any other quality measures established for the organization. Some processes may have fluctuating measures, as the processes tend to stabilize during the first few months of operations.

Allowing Time for Commissioning

Clearly, effective commissioning cannot be done overnight. Operational components of the building, such as equipment, boilers, piping system, and heating, ventilating, and air-conditioning (HVAC) equipment, can be tested while construction is under way and, in fact, often are commissioned at the original equipment manufacturers' factories. If a component will not change before the building

is occupied, it can be commissioned early. For example, after radiology or laboratory equipment has been installed, the individuals in charge of commissioning can verify the presence of the equipment and ensure that it works. Similarly, for COC, staff and department leaders can work with mock-ups during the design phase to perform preliminary tests of work flow processes (see Chapter 2). Starting the commissioning process early and allowing plenty of time for it can reduce the stress involved and prevent those in charge of commissioning from becoming overwhelmed.

The Commissioning Team

Commissioning is complex process, so early in the planning phase, an organization should consider developing an interdisciplinary team to help guide it. The commissioning team is one of the multiple subteams for any project.

Sample Commissioning Team

- Health care organization representative
- Safety officer
  - Design professionals involved in construction drawings
  - Infection prevention and control specialist
  - Facilities engineers and representatives from the maintenance team
- Staff representative(s) from the area(s) under construction

Commissioning Authority

Depending on the type and scope of a project, as well as the organization's preferences, a person deemed the commissioning authority could be appointed responsible for managing, coordinating, executing, and documenting the commissioning process. A facility director or the executive team project leader may be an appropriate choice for the role of commissioning authority. Those involved in the building commissioning field generally believe the commissioning authority should work for the health care organization and represent its interests. However, numerous options exist: The commissioning authority might be an independent third party or someone working under contract with the construction manager. This works well when the construction manager is independent of the contractor's team. Some architectural and engineering firms include commissioning as part of their services to ensure that they deliver high-quality buildings to their clients. When deciding who should commission a building, an organization should keep in mind the needs of the organization, the nature of the project, the budget for the project, and the time allowed for commissioning.

Standards and Regulations for Commissioning

Throughout the process of commissioning, health care facilities must keep in mind the standards and regulations that apply. Because today's new health care technologies give rise to increased safety issues (a situation that makes commissioning critical to ensuring safety for patients, staff, and visitors), the Facility Guidelines Institute (FGI) *Guidelines* and the American Society for Healthcare Engineering (ASHE) call for commissioning activities above and beyond those that have occurred in the past. Although not requirements, the guidelines in ASHE's *Health Facility Commissioning Handbook* provide facilities with perhaps the most comprehensive guide to commissioning activities available for health care's complex construction needs.[1] US health care organizations should refer to these documents in addition to Joint Commission standards for compliance with all requirements (see FOUNDATIONS: Standards and Regulations).

JCI and Commissioning

While Joint Commission International (JCI) has no specific set of requirements for commissioning, the "Facility Management and Safety" (FMS) chapter in the JCI manual includes a requirement that organizations manage risks within the environment in which patients are treated and staff works. Although not explicitly stated, this requirement also applies to the commissioning process.

Facility Commissioning

Facility commissioning, as defined earlier, is about the physical structures, components, and systems. The commissioning plan, intended for FC, is typically completed at the beginning of the construction phase and updated throughout

construction as equipment is installed and tested. Project schedules are reviewed along with contractor documents and operation and maintenance manuals.

FC: Performance Tests

Detailed performance test plans should be part of the commissioning plan. These should be written for each system and piece of equipment involved in the commissioning process. Any construction details that might affect equipment and system performance or operation should be noted. The person or team responsible for commissioning should coordinate with the various contractors to perform the prefunctional performance tests during construction. Key systems tested in the commissioning plan should include the following:

- Building envelope
- Life safety
- Heating, ventilation, and air-conditioning (HVAC) systems
- Controls
- Plumbing systems
- Medical gas and other specialty gas systems
- Electrical system
- Fire alarm system
- Information technology
- Fire protection system
- Interior and exterior lighting
- Refrigeration
- Vertical transport
- Materials and pharmaceutical handling

FC: Punch List

Another document designed for FC is the punch list, which the design team, in conjunction with the organization's representative, should create as an organization goes through the commissioning process. The punch list verifies that the building is functioning and finished as designed. It is a list of all the deficiencies and malfunctions that need to be addressed prior to full occupancy. Issues on the punch list may be equipment that does not function correctly, an incorrect wall finish in the surgical suites, inappropriate door handles in isolation rooms, and so on. The contractor is required to correct all issues on a punch list before the organization accepts the building and final payment is released.

Items should be added to the punch list throughout construction and addressed as soon as possible. Many deficiencies can be caught early so they are not concealed in the construction or duplicated unnecessarily. Incorrect or improperly installed items should be noted during field observations by architects, engineers, organization representatives, or commissioning agents throughout the construction process.

The contractor should always complete his or her own punch list as well and correct any deficiencies found. This ensures that the contractor presents the most complete work for review. Regular meetings to review and synchronize the lists are helpful for efficient project management. The punch list is not intended to provide a quality control method for the contract; rather, it is intended to verify the completion of the project as it was designed.

The final punch list is created just prior to building acceptance. This timing is key to determine who is responsible for bearing any costs associated with items on the punch list, which will help avoid issues at final payout to contractors. This punch list is developed during the final walk-through of the building and should contain relatively minor issues that need attention.

FC: Process Management with Checklists

Some organizations use a checklist to manage the FC process and ensure that all aspects of building design, construction, and content (systems, controls, building automation, coordination with existing building systems) are verified. Organizations may want to use the material and building system specification divisions developed by the Construction Specifications Institute (see Chapter 2) as a framework for the checklist. An organization should customize the checklist for the particular project and include information from construction documents and any changes made during construction.

Creating this checklist will take time, but it can help manage the commissioning process. An organization that starts creating the checklist when construction documents are finalized can ensure that all aspects of the project are included in the checklist.

FC: Process Documentation

To prevent duplication of efforts or omission of important aspects of the building during FC, an organization should document not just items discovered and put on the punch list, but the entire FC process. This may include creating a database that stores information on areas of acceptance as well as items

for the punch list. Project staff—or the commissioning team—may want to review this database periodically during commissioning to keep abreast of punch list issues and their resolution.

Before the building is accepted, the individual or individuals in charge of commissioning should observe and verify the proper operation of equipment, systems, and controls per contract documents. Any corrective actions must be verified, and complete operation and maintenance manuals should be present. The various contractors typically carry out the performance testing. When all performance tests are complete, the individual or team in charge of commissioning should issue a final report, including all documentation.

FC: Required Documentation

In addition to the commissioning documents, US organizations will need to develop (or modify for renovations) the required Centers for Medicare & Medicaid Services (CMS) utility systems management plan, and complete an inventory of equipment and utilities, as required by Joint Commission standards. JCI–accredited facilities will also have to develop or update a written utility plan.

Statement of Conditions™ or Facility Improvement Plan

Health care buildings are in a constant state of change in terms of construction, renovations, or demolition. The use of space in an organization changes frequently—for example, services expand to meet patient needs, or various pieces of equipment make it necessary to reconfigure patient care areas. All these changes mean newly constructed, newly renovated, or existing health care buildings may not be fully compliant with required codes at any given moment.

For US organizations accredited by The Joint Commission, construction, renovation, or demolition will also require an update of its Statement of Conditions™ (SOC) discussed in Chapter 3. As part of total building commissioning, an organization should complete the SOC process.

Internationally, JCI–accredited facilities can complete a facility improvement plan (FIP), based on a facility inspection report (FIR) that addresses facility issues and a plan for remediation. At the time of this writing, however, there is no electronic format for submitting an FIP, as there is for the SOC.

Facility Orientation

Once the building is ready to be handed over, staff can be oriented to the new spaces. Organizations need to plan on extensive orientation for staff using the new facility. This orientation must be documented individually for each staff member involved and include all employees as well as credentialed and/or contracted staff in the facility. Engineering staff should know about the new equipment and monitors, including where all the shutoff valves are located. Security staff must be able to reach all the areas quickly. Often support staff are left out of this training—perhaps because such basic duties as cleaning do not change all that much. However, locations for supplies, access to water, and other items could be very different in the new space. Also, new types of finishes may require very different cleaning regimens than in the past.

Checklists of all the new equipment, systems, and processes need to be complete and documented prior to orientation. As suggested above, these lists can be formulated as decisions on equipment and supplies are made throughout the design process. They are then updated as decisions are finalized or changed to allow training in the facility to begin at the time of facility turnover from contractors.

The postoccupancy evaluation (see page 119) requires that staff orientation and training records be available. These records must show complete documentation of the training process, including content and dates of completion. In addition to intradepartmental training, it is important for all staff users of the new facility to learn the location, transport pathways, and access methods to all the departments in the facility. The staff users will be assisting patients and visitors with wayfinding, and they should be able to do so in a confident and knowledgeable way (see DESIGN FOCUS: Designing for Safety and Reliability).

Simulations

In the last decade, scenario simulations have been used as part of the final preparation of staff for new facilities. Simulation differs from facility orientation in significant ways:

- Simulation places the staff member in a real-world situation of using the new facility, its equipment, and supplies, along with the newly designed processes.
- Simulation occurs after facility orientation, so staff should already be familiar with equipment and accessing supplies for use.

- Scenarios are created based on routine processes as well as high-risk or high-volume, nonroutine processes. They are meant to test situations that the staff is likely to encounter, as well as situations that have a high-risk component. One example would be a failure in the medical gas line with subsequent shutoff and ancillary service procurement.
- Multiple interdepartmental scenarios are practiced simultaneously to test all systems.
- Volunteers can act as patients, family members, and the press to create a real-world atmosphere similar to that of mock disaster drills.
- Scenarios should incorporate as many of the new processes and related equipment as possible. Training checklists should be developed to help identify the processes and equipment.
- Observers should be used to evaluate the simulation activities and identify issues that may need to be addressed prior to occupancy. Those involved in performing the simulation may be unable to critique themselves.
- Issues identified during the simulations should be categorized as to their potential for creating harm or as nonfunctioning processes. If the observation is a major concern, a failure mode effects and analysis (FMEA) should be performed to identify all the issues and to assist in developing solutions that can be incorporated prior to occupancy.

Staff Training and Simulations

Simulations take place shortly before the scheduled opening of the facility. As explained above, FC should be completed and staff should have been trained and spent time in the facility. Planning staff training prior to simulation can be a challenge. For a new facility trying to save on costs, staff may not even be hired until a month prior to opening. For new or renovated spaces at an existing facility, staff will be caring for patients and will have limited time for training. However, to obtain an accurate assessment of the facility's operations readiness, staff *must* be trained before a simulation takes place.

SCORE™

Joint Commission Resources (JCR), The Joint Commission's consulting, education, and publishing affiliate, has developed a method called Safe Clinical Operations Readiness Evaluation (SCORE™), which helps organizations develop the simulations, run them, and determine possible points of failure in the systems. FMEA can then be used for areas that demonstrate problems, and those issues can be resolved before patients enter the new facility.

Clinical Operations Commissioning

The FC process checks the physical aspects of the new environment to make sure they are functioning properly. COC checks to make sure work flow processes are ready as well, primarily through simulation. Currently, there are no Joint Commission standards that require organizations to perform COC. However, given its potential for identifying safety issues prior to occupancy, JCR developed SCORE™ for conducting COC simulations that test processes related to the seven medical flows.

Seven Medical Flows

The following seven types of medical flows comprise the majority of routine and clinical work flow processes in a health care facility; therefore, they are a natural focus for COC simulation:

- Patients
- Providers
- Visitors and Families
- Supplies
- Equipment
- Medication
- Information

Five Steps for COC Simulations

There are five steps in developing and conducting COC work flow process simulations that focus on the medical flows mentioned above:

- ***Step 1—Identify major day-to-day processes:*** These should be things the staff does regularly that involve new processes, equipment, and/or supplies.
- ***Step 2—Develop real-world scenarios to test each work flow process:*** These should test how the processes will work in the new setting.
- ***Step 3—Aggregate processes for simultaneous scenarios:*** These will test processes that occur throughout the facility at the same time and will therefore test the entire system in a way that matches as closely as possible to the way it will operate at full functionality.
- ***Step 4—Test at various staffing levels:*** By testing at various staffing levels, differences in processes based on such variables as time of day and weekday versus weekends can come to light.
- ***Step 5—Identify and resolve risks:*** Simulations should reveal failure points in the processes. Some points of failure may be easy, quick fixes. For more complex points of failure, FMEA is a valuable tool.

Effect of Work Flow Processes on Medical Flows

Each of the health care work flows/processes that will occur in the new or renovated facility should be tested via the simulations and evaluated for its effect on the medical flows. Following are some factors to keep in mind for each medical flow during this evaluation[2]:

Patients

The overarching theme regarding patients as a medical flow is whether the patient will have the desired experience throughout the spectrum of care at the facility. It is important to pay attention to such issues as wayfinding, access, privacy, confidentiality, and safety from the patient's perspective.

Providers

During COC simulations, several key issues to test are providers' familiarity with communications systems (equipment alarms, nurse call systems, telephones) and new equipment as well as their ability to know how to navigate the facility for emergencies. When scheduling simulations, remember that it can be difficult for providers to fit training into their schedules. To maximize participation, it can help to run short, intense drills or to plan several sessions at different times. Conducting simulations on several shifts can identify gaps or potential risks that would be missed if only daytime support-level simulations are used.

Visitors and Families

This third flow is often overlooked when considering a facility's readiness to open. Issues to consider include wayfinding, waiting rooms, and management of family members during normal and stressful situations. Simulations may involve use of mock visitors who act angry, frightened, or bothersome in various situations. Simulations should also test how staff meet visitor and family needs.

Supplies

The flow of supplies goes beyond merely learning where things are stored. During a simulation, attention should focus on accessing and using supplies appropriately, proper management of various waste from supplies (such as biohazard waste from chemotherapy), quantity and type of supplies available, and accurate accounting for supply usage.

Equipment

Simulations should assess how competent the staff is at using the equipment throughout the various clinical operational areas, such as the operating rooms and obstetrical areas, as well any new technologies, such as communication systems, alarm systems, or electronic medical records. Portable equipment should also be tested for its ability to be used in the areas intended, such as a portable radiology unit in patient rooms or cubicles. Though particular attention should be paid to equipment that is new or otherwise unfamiliar, standard features should be assessed too, including fire alarms and shutoff valves for medical gas.

Medication

From its arrival on the loading dock through the pharmacy storage, ordering, and dispensing, and then administration in patient rooms, medication flows through many separate, often unrelated areas of a facility. A simulation should check for appropriate processes in each area independently, as well as test the system integration for accuracy and cohesiveness—with particular attention to electronic interfaces, storage, dispensing, and administration.

Information

Simulations should make sure information, such as patient records, diagnostic orders, and reports, as well as required documentation, flows accurately and efficiently throughout the planned system. Also important to assess is the ability of staff to access equipment for data entry and whether privacy or security of data is at risk either during entry, relay, or storage. Downtime procedures are especially critical to test during simulations because often new facilities have new system technologies and processes.

Using FMEA

If a simulation identifies a process failure, the goal is to have time to correct the failure before the facility opens. For a problematic process identified during the simulation, an FMEA is useful to diagnose the problem and create potential solutions.* The suggested solutions should then be simulated as well, to see which can most effectively and efficiently correct the situation. When an appropriate solution is found, relevant policies regarding process and procedures should be updated to reflect the changes.

* This proactive risk reduction model is described in detail in the Joint Commission Resources publication *Failure Mode and Effects Analysis in Health Care: Proactive Risk Reduction*, now in its third edition. It is available at http://www.jcrinc.com/failure-mode-and-effects-analysis-in-health-care-proactive-risk-reduction-third-edition/.

Move-In

Deciding when and how to open the facility to patients depends to a great extent on the legacy of the organization. If it is a new facility with no existing services offered, decisions must be made regarding which services to open and when. For an existing organization, the issue is more when and how to move its services. This is a complicated planning effort and should commence months before the actual event. Once again, an interdisciplinary team needs to be gathered to consider all the issues that may arise during the move. One such move in Chicago saw more than 500 patients transported from an inpatient facility. On stretchers and wheelchairs, patients were conveyed through five blocks of city streets to the new facility—all within eight hours.

Regardless of whether the facility is new or existing, a useful safeguard is to establish an incident command center during this time, similar to those used for disasters. This allows staff to have clear lines of communication for resolution of issues that may arise during the first hours or days of occupation by patients in the facility. It may also serve as a building evacuation exercise. See COMMISSIONING FOCUS: Moving Day.

Issue Resolution System

An issue resolution system needs to be designed and used for the first six months of occupancy of a new facility. This system is nicknamed the "shakedown cruise" period. It should be easy for the staff to use. One simple method is to make sticky notes and a pen available in key areas for staff to instantly capture concerns with processes, procedures, or the facility. It should also allow for prioritizing issues, which will permit those issues identified by staff as critical to be addressed appropriately. In addition, it should establish communication and reporting mechanisms for each priority level.

STANDARDS SIDELIGHT

Medication Management

Medication errors occur daily in health care settings, resulting in thousands of injuries and deaths and millions of dollars in additional expenditures. For payers, this problem represents a huge generator of unnecessary and wasteful spending of scarce health care dollars. To the organizations where errors occur, errors represent a public relations problem, lost revenue, and even legal exposure problems. For health care providers, this and the underlying problem raise deep concern and discomfort. And to consumers of health care—the most important stakeholders here—the problem and its magnitude are frightening. So when constructing and moving into a new or renovated structure, medication management processes are some of the most important to focus on for simulations and systems testing. Medication management processes include procurement/ordering, storage, prescribing, repackaging, transcription, preparation, dispensing, administration, monitoring, and disposal.

MM and MMU

The Joint Commission's National Patient Safety Goals (NPSGs), Joint Commission International's (JCI) International Patient Safety Goals (IPSGs), the Joint Commission Medication Management (MM) standards, and the JCI Medication Management and Use (MMU) standards all address the importance of organizational culture, effective communication, and meticulous medication management systems. (Also see FOUNDATIONS: Standards and Regulations.)

It is important to review and communicate to the staff the established mechanism for how and when concerns will be prioritized and acted upon (or not), and outcomes relayed. These systems usually provide for immediate response to any issues that may pose a threat to life or property, identify needed procedural changes, and pinpoint any areas that may be resistant to change. Whatever the reason behind the issue being reported, management needs to provide reciprocal communication as to each concern's status and resolution. Building transparency into the process shows management's commitment to listening and taking action.

Postoccupancy Evaluation

Once the issue resolution system has become stabilized and few new issues are being identified, it is time to begin the postoccupancy evaluation phase of the facility. This is when the DOP performance metrics are measured and documented on the plan to see how the design is fulfilling the expected performance. During the commissioning process, the organization should have also identified the OPR and begun to test whether or not the designed and installed systems are performing as expected and if rebalancing or calibrating is necessary. Most performance metrics for the facility need to be measured for at least a year to determine cycles that can be related to weather, occupancy levels, and other factors. This allows for the fine-tuning of processes or calibration of equipment to obtain the most effective and efficient performance possible.

Dissemination of Evaluation Findings

Information from facility projects' performance is critical for future projects. Whether a true research project is developed and executed, or anecdotal information is collected, it is valuable to share experiences and outcomes with colleagues worldwide. There are many opportunities to disseminate new knowledge, including presenting at professional conferences, writing articles for publication, and encouraging a health care magazine to interview project leaders. It is important that the field learn what built environment elements truly contribute to increased effectiveness and efficiencies in the provision of health care.

Commissioning Budget

Commissioning not only involves a monetary cost (hiring a third-party commissioner or paying the contractor for commissioning efforts), but it also involves a time cost. If an organization chooses to have organization representatives perform the commissioning, those representatives must be allowed time in their schedules to carry out commissioning tasks effectively. This may require temporarily reassigning their regular job duties to others. Organizations should therefore consider the timing as well as the monetary aspects of commissioning in the project budget so costs do not come as a surprise at the end of the construction process.

Benefits of Commissioning

The benefits of commissioning are greater efficiency and safety, as well as bottom-line savings from avoiding downtime, retrofitting, process redesign, unwanted occurrences, and reduction in operations costs over time. Commissioning may seem costly up front, sometimes exceeding $2 per square foot for new construction.[3] Yet a study for the July 2009 Lawrence Berkeley National Laboratory showed that commissioning can identify and resolve more than 10,000 energy-related problems, which can result in average energy savings of 16% for renovation projects and 13% in new construction.[3] In one case, a newly constructed medical center spent approximately $600,000 on a commissioning fee, but the organization saw savings of more than $1 million a year. Another hospital's commissioning resulted in cutting the facility's energy consumption by more than 10%, with a financial savings of $1.2 million annually.[4] The value equation for commissioning is value = benefit/cost.

Survey Considerations

If an organization is in the middle of a construction or renovation project at the time of its triennial survey, The Joint Commission and JCI do not want the organization to cease work because of the survey. (Note: At the time of publication, The Joint Commission conducts almost exclusively unannounced on-site surveys; all of JCI's triennial on-site surveys are announced.) In fact, The Joint Commission expects any construction or renovation work will continue throughout the survey process. Functions related to construction and renovations that surveyors may examine during the on-site survey include the following:

- General safety issues

Overarching Issue

Process Alignment

The lengthy project process provides the perfect opportunity for those in operations to review and finalize facility processes that will need to change based on the new design. Change management activities are extremely important during such process alignment. Research has shown that for effective change management, more time should be allocated for staff to accept the process changes provided by the design.[1] The Joint Commission's process improvement method, Robust Process Improvement® (RPI), has a dual focus on the process and the people, making it ideal for use during process alignment (see PLANNING FOCUS: RPI and Change Management).

Transition specialists are often contracted to assist with the process alignment. Postoccupancy research participants said this actually needs to start during design. This should not be left to finalize a few months before opening of the facility. Transition planning can incorporate change management activities during process alignment. This allows staff members to have some control over new processes, which hopefully reduces resistance to changes.

If mock-ups have been used during design, they can prove useful in testing new processes (see Chapter 2).

Note that any user group involvement in process alignment activities should be interdisciplinary (see Chapter 1). Often departments revise procedures and processes without understanding the full impact of those decisions on all patients or providers. Having an interdisciplinary group involved in the revision can highlight shared concerns and lead to desired outcomes. The process alignment leader should be one who has the skills and abilities to use the organization's process improvement system. The Joint Commission does not require a specific system for this purpose, but it does require that some system be chosen and used effectively and consistently.

It is imperative that each of the process alignment plans or changes be documented completely, as there are often staff and leadership changes during projects. Documentation provides the rationale for decisions, as well as the decisions themselves.

- Interim life safety measures (ILSMs)—includes the assessment of *Life Safety Code*®* compliance and implementation of ILSMs (United States only) (see Chapter 3)
- Proactive risk assessment—includes how the assessment is done, the scope of the assessment (including infection control risk assessments [ICRAs]), and the continuity with the ILSM assessment (United States only) (see Chapter 3)
- Cleanliness of the construction site
- Appropriate behavior of construction workers
- Adequate knowledge among construction workers
- Perspective of staff—surveyors may ask staff members in nearby units how long the construction will last and how they are affected by construction efforts

Extension Surveys

The Joint Commission may need to conduct an extension survey of an organization if the organization has done the following:

- Instituted a new service or program for which The Joint Commission has standards
- Changed ownership, with a significant number of changes in management and clinical staff or operating policies and procedures
- Offered its services at a new location or in a significantly altered physical plant
- Expanded its capacity to provide services by 50% or more, as measured by patient volume, pieces of equipment, or other relevant measures

* *Life Safety Code*® is a registered trademark of the National Fire Protection Association, Quincy, MA.

- Provided a more intensive level of service
- Merged with, consolidated with, or acquired an unaccredited site, service, or program for which there are applicable Joint Commission standards

JCI will perform an extension survey if required by any of the following construction- or renovation-related factors:

- Limitation or closure of patient care services
- Alteration in use of patient care buildings, construction of new or expanded patient care buildings, or the occupation of buildings in new locations in the community that expand the type and volume of patient care services by 25% or more
- Expansion of capacity without new, renovated, or expanded facilities to increase services by 25% or more, as measured by patient volume, scope of services, or other relevant measures
- Addition or deletion of one or more types of health care services
- An organization has merged with, consolidated with, or acquired an unaccredited site, service, or program for which there are applicable JCI standards

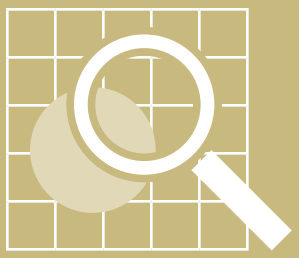
An extension survey is conducted at an accredited organization or a site owned and operated by the organization if the accredited organization's current accreditation is not due to expire for at least nine months and when at least one of the conditions above is met. The results of an extension survey may affect the organization's accreditation decision.

Exit Note

Even the most deliberately planned, thoughtfully designed, and carefully constructed health care facility needs to be checked before the first patient walks through the door. This chapter has explained that commissioning the physical features via FC ensures that all equipment and utilities are working as they should, while COC tests how people use processes in the new space. Safety continues to be the goal through move-in, and it should be assessed regularly postoccupancy to maintain a high quality of patient safety and care.

References

1. American Society of Healthcare Engineers (ASHE). *Health Facility Commissioning Handbook: Optimizing Building System Performance in New and Existing Health Care Facilities*. Chicago: ASHE, 2012.
2. Healthcare Design. Reno K, Grazman D. Operations Commissioning: Putting New Healthcare Buildings to the Test. Apr 8, 2014. Accessed Jul 6, 2015. http://www.healthcaredesignmagazine.com/print/article/operations-commissioning-putting-new-healthcare-buildings-test.
3. Shinneman C. Starting out right: Weighing the benefits of health facility commissioning. *Health Facil Manage*. Jan 3, 2011. Accessed Jul 6, 2015. http://www.hfmmagazine.com/display/HFM-news-article.dhtml?dcrPath=/templatedata/HF_Common/NewsArticle/data/HFM/WebExclusives/2011/StartingOutRight.
4. Martin D. Aligning hospital designs with outcomes: ASHE Perspective. *Health Facil Manage*. Dec 1, 2011. Accessed Jul 6, 2015. http://www.hfmmagazine.com/display/HFM-news-article.dhtml?dcrPath=/templatedata/HF_Common/NewsArticle/data/HFM/Magazine/2011/Dec/1211HFM_DEPT_ASHE_letter.
5. Reno K, et al. Lessons learned: Clinicians' post-occupancy perspective of facility design management. *HERD*. 2014;7(2):127–139.



commissioning focus

moving day

FOCUS Outline

Major Move-In Considerations

- Patient Safety
- Roles and Responsibilities for Staff Members
- Activation of a Command Center
- Communication to Patients and Family Members
- Move Routes
- Mock Move
- Planning for Equipment
- Planning for Communication

Best Practices for Moving Day

Moving day at any health care facility can be both a very exciting and very anxious time. Anxieties are high as departments rush to complete the last-minute details before the first patient enters through the door. Appropriate planning and communication can help ensure a safe and successful patient and department move. For most staff, a move such as this will be unlike any other day in their career.

Moving day requires an interdisciplinary team to develop a comprehensive organizationwide plan for the days leading up to and including moving. Regardless of facility size, the coordination of moving patients and departments requires a very well-defined, well-documented, and well-communicated plan. Each department is responsible to develop and communicate a plan outlining its tasks and responsibilities during the patient and department moves.

Major Move-In Considerations

Whether an organization is moving across corridors to a new tower or across town to a new facility, major considerations during the patient move include those described here.

Patient Safety

To ensure a safe move, it is important know the needs of each patient. A patient roster can help to track the census on each unit days before the move. This roster also includes vital information such as code status, isolation precautions, equipment needs (intravenous pumps, ventilators, and so on), and bariatric needs. Updates are made to the roster daily before the patient move as well as on the morning of the move.

Roles and Responsibilities for Staff Members

The roles and responsibilities of all staff members during the move should be identified, documented, and clearly communicated. For example, lab collection and x-ray times may be adjusted on move day, rounding and discharge procedures may change, and staff may be traveling with their patients and need to be aware of what their responsibilities are.

Activation of a Command Center

A moving day command center should include senior leadership, information technology personnel, operations personnel, a clinical liaison administrative assistant, and an ambulance liaison (if applicable). These will be the people to make decisions in the event that the move does not go as planned.

Communication to Patients and Family Members

Prior to the move, patients and their families should be told what to expect on moving day. In addition, having a place for the family members to wait, with refreshments, assists with potential interruptions to the patients' moving.

Move Routes

Organizations should create well-defined and documented move routes for patients, ambulances, and equipment to travel. Keep in mind that these may not be traditional paths of travel for patients. For example, the front lobby may be the most expedited path for ambulances to line up and patients to exit the building. While not typical, this may be the safest way for patients to exit.

Mock Move

It is very helpful to conduct a mock move to identify and mitigate potential issues concerning patient safety and infection control. It also provides critical timing to be built into the sequencing of patients during the move.

Planning for Equipment

It is important to be sure adequate equipment is already on the new unit when patients arrive. This is particularly vital when equipment is being reused or transported with a patient.

Planning for Communication

There must be a detailed communication plan throughout the move (open conference lines, cell phones, walkie-talkies, and so forth). Communication to the command center is an important step to ensure that all patients are accounted for, and to monitor the speed and flow of the patients moving, which is critical to patient safety upon arrival to the new unit.

Best Practices for Moving Day

Prior to and during moving day, best practices indicate that organizations should do the following:

- Conduct the patient move on a weekend. This allows for a natural decrease in census due to end-of-the-week discharges and decreased operating room usage on the weekend.
- Implement a realistic ramp-down plan to decrease the census prior to moving day.
- Conduct a "purge campaign" in the months leading up to moving day to decrease the amount of department materials and equipment to be moved.
- Schedule provider rounds the day before, and write pending orders to expedite rounding and discharges on moving day.
- Infection control needs to be tightly maintained during the patient move. Personal protective equipment and infection control supplies should be available at all patient exit and entry points to ensure that infection precautions are maintained.
- Conduct staff training sessions (including bedside staff, transport, and ambulance personnel) prior to moving day to alleviate anxieties and allow for a smooth patient transfer.
- Have the emergency room placed on divert for the hours prior to and during the patient move, to decrease possible emergencies or admissions.
- Use volunteers to assist with family members and visitors.
- Create unit- and patient-readiness checklists for bedside staff to be completed prior to the patients moving. This will help to expedite patient preparation and ensure that all safety measures are completed.

The intricacies of the organization moving day require detailed planning by the moving day team. It is important for the organization to recognize the scope of work involved with regard to staff, resource commitment, and financial implications. With adequate time, interdisciplinary collaboration, and clear communication, an organization can execute a safe and successful move.

Contributed by: Erin Clark, RN, MS, Project Manager, Transition and Activation Planning, HTS, Inc.

index

C

D

E

G

H

M

N

O

P

R

S

T

U

V

W