SURGICAL SUITES: EMERGING APPROACHES TO PLANNING AND DESIGN

TODD ACCARDI, AIA & JULIE DUMSER, RN
Doing more with less is a running theme in today’s healthcare industry. The surgical environment is no exception.

Sq2 predicts that inpatient surgical volumes will grow by about 3% over the next 10 years, while outpatient surgical volumes will grow by 23%, demanding increased capacity from hospitals and health systems. At the same time, according to the Association of American Medical Colleges (AAMC), physician shortages are predicted across the industry due to many different variables (age of retirement, changes in payment and delivery, etc.) and surgical positions will be some of the hardest hit. By 2025, AAMC has modeled the surgical physician shortage to be anywhere from 23,100 to 31,600. Additionally, the number of states experiencing a nursing shortage across the industry is expected to increase from five in 2009 to thirty in 2025.

Exacerbating these issues is the inefficient use of time and resources that many health systems struggle with on a day-to-day basis, as demonstrated by the rising costs of healthcare which are estimated to reach $4.8 trillion by 2021. The most expensive real estate in the hospital, the Operating Room (OR), is one of the first places to think about reducing costs. Studies estimate that hospitals charge an average $62 a minute for OR time (not including cost of the physician), making every minute the OR is in use extremely valuable. However, operational inefficiencies often result in ORs that sit empty for long periods of time. Similarly, surgeon’s time is typically worth more than $500 an hour when they are operating, so creating efficiencies for their work has major cost implications.

These are just some of the reasons that a significant shift has taken place in the operating room environment in recent years. Traditional surgical models, while always placing the patient at the center, located surgical and minimally-invasive interventional procedures in their respective departments. For instance, the cardiac catheterization lab, the electrophysiology lab, interventional radiology, and the OR all had their own departmental space in the hospital and were completely separated from the radiology department. Gradual movement towards co-locating these service lines began to take place. Newer models are continuing on this trajectory; placing the patient at the center of care, but taking more of a clinician-centric approach in support of operational optimization and more efficient use of space and resources.

Today’s surgical environment is rapidly evolving. Strategies for developing sophisticated solutions that support collaboration between service lines and medical professionals as well as the information-rich technology that is increasingly a significant aspect of the surgical environment are needed.

**ISSUE**

Today’s surgical environment is rapidly evolving. Strategies for developing sophisticated solutions that support collaboration between service lines and medical professionals as well as the information-rich technology that is increasingly a significant aspect of the surgical environment are needed.

**DRIVERS**

- Physicians shortages coupled with the rising costs of healthcare are making operationally efficient use of the surgical platform more important than ever before.
- Newer surgical platforms are taking a clinician-centric approach in support of operational optimization and more efficient use of space and resources.

**SOLUTIONS**

- A robust planning process that includes key stakeholders will help assure the surgical suite solutions are rooted in a fully integrated future vision.
- Consensus-building activities such as planning studies, simulation modeling, and physical mock-ups can help garner buy-in from key stakeholders.
- Design solutions that increase flexibility and anticipate changes in equipment and technology will help “future-proof” the surgical platform.
- The “Universal OR” has faced barriers to adoption, but it still considered the future of the surgical platform.
Intelligent Planning for the Evolving Surgical Platform

This changing environment requires that surgical platforms be planned and designed to optimize clinical operations and adapt as possible to constantly advancing technologies. As shared resources, technological considerations, and critical adjacencies become more and more important, it is no longer appropriate to develop a program and design a surgical platform based on templates or a single point of view. Today, planning and design processes must take into consideration the unique conditions a given health system or hospital is facing. A truly integrated solution that is intrinsically tied to both the health system’s strategic vision and operational opportunities needs to be informed by many different factors including projected volumes and utilization, clinical and patient flow, performance expectations, models of care, integrated technology strategies, and considerations for future design flexibility (FIGURE 1).

Fostering Involvement of Critical Stakeholders

While the surgeon and operating room remain at the heart of the surgical platform, collaborating in the deluge of activities that take place around them is critically important. However, increasingly there are more and more important adjacencies that need to be considered as part of the planning process; this, in turn, is increasing the number of key clinical stakeholders that need to be involved in the design process (FIGURE 2). Creating a structure that gives all key stakeholders a voice, but also puts forth a clear path for decision-making helps foster buy-in and ownership of the process. FIGURE 3 provides an example of what groups may need to be involved and the roles and responsibilities that they might have in the overall decision-making structure. When creating these designated groups, it is important that members are aware of why the groups have been formed and understand what decisions are expected to be made as well as what decisions are being made by other groups. This helps to avoid major conflict or changes down the road (SURGICAL SCENARIOS: PLANNING FOR A HYBRID OR).

Surgical Scenarios*
Planning for a Hybrid OR

In this scenario, the planning is for a hybrid interventional OR; however the staff, physicians and other key stakeholders from the cath lab were not involved at any point. Several issues could have been avoided if this group of stakeholders had been engaged earlier in the process including:

- Realizing upon the room opening that the OR and the cath lab used two different types of electronic charting
- Monitors had to be relocated because placement that is optimal for a surgeon is not optimal for cardiac interventionalists
- Ceiling height was too low for necessary equipment; necessitating drilling into the floor to gain additional space

*Surgical Scenarios are based on the authors’ previous observations and are not reflective of the CannonDesign portfolio.
The Integrated Surgical and Interventional Design Team

<table>
<thead>
<tr>
<th>The Integrated Surgical and Interventional Design Team</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steering Team</strong></td>
<td>Key leadership from OR, Cath, Interventional, and Support Services. Responsible for project oversight, decision mediation, maintaining construction schedule and budget expectations.</td>
</tr>
<tr>
<td><strong>Physician Steering Team</strong></td>
<td>Physician representatives from perioperative, cath, interventional, and radiology. Physician-focused input to project development.</td>
</tr>
<tr>
<td><strong>IT Committee</strong></td>
<td>Sub-committee comprised of operations, clinical and IT/informatics representatives. Integration of IT systems and processes.</td>
</tr>
<tr>
<td><strong>Support Services Team</strong></td>
<td>Support services including EVS, SPD, biomed, lab, and pharmacy.</td>
</tr>
<tr>
<td><strong>Working Team</strong></td>
<td>Representatives of OR, Cath, Interventional and various supporting functions. Convene for procedure viewings, scheduled work sessions, and all-staff presentations.</td>
</tr>
</tbody>
</table>

FIGURE 3 Example of how hospital stakeholders can be incorporated into an integrated platform design team.

**Anticipating the Impact of Different Solutions**

While traditional design processes may find teams starting to draw solutions as soon as they have received some initial information, there are certain steps that will support a deeper understanding of the impact of proposed solutions. While solutions should ideally always be adaptable and flexible to the future state, decisions to build expensive multi-purpose operating rooms or hybrid spaces should not be made without a business case that includes predicted market share, payor mix, equipment costs, staffing requirements, space needs, and stakeholder commitment.

**Current State Assessment**

A current state assessment of all the procedural spaces that are involved will provide a clear, unbiased and unambiguous understanding of the current state operations of the area under study. Activities that help define the current state can include stakeholder interviews, facility tours, data acquisition and analysis, current state process mapping, clinical shadowing and procedure viewing. Data and resources that will support a more robust current state assessment include high-level department reports (e.g., type and volume of procedures, total room time per procedure, room utilization by surgeon/proceduralist), detailed patient-level data, and previously conducted assessments.

**Future State Visioning**

Outlining transformational principles that will guide the project process can be accomplished with future state visioning. This can include a range of different activities such as future state process mapping, workshops to identify measurable performance goals and outcomes based on current state and industry benchmarks, and market forecasts and projections. Future state process mapping is particularly relevant as an aide to uncovering differences in care delivery between the operating room, cardiac cath lab, and interventional radiology staffs. It is often during this phase that significant design and equipment challenges manifest themselves; such as choice of the operative table and the fixed or mobile imaging technology. Once the future state vision has been established, revisiting these goals as necessary throughout the project will help support decision-making.

**Procedure Viewing**

Both the operating room and the minimally invasive lab experience several transformations throughout the life of a single case. The way a room is set up before the case can be very different than how it looks during the case and changed again for close. Design teams should observe the actual orchestration of physicians, nurses, and support staff in the operating room environment. This will aid in the development of solutions that will optimize, as opposed to conflict with, current or future operational processes. For example equipment, tables and carts have different parking spots depending on the phase of the operation, the type of case, specific patient needs and even surgeon preferences. The process of efficient room turnover must also be understood as this is critical to platform throughput and financial performance.
Planning Studies
Once test-fits have been conducted to ensure that all necessary program elements will fit within a given space, the design team typically develops different arrangements and adjacencies among critical program elements. Getting feedback on how different layouts will impact operations and efficiencies for the different departments is a critical step to fostering buy-in among key stakeholders. The most favorable layouts can then be further developed with more detailed space planning and understanding of support spaces (SURGICAL SCENARIOS: LAST-MINUTE PLANNING DECISIONS).

Simulation Modeling
Once the team has identified several layouts that might work, they can be tested via simulation modeling. Simulation modeling allows stakeholders to see how operational processes might play out in a three dimensional environment (FIGURE 4). First, the model is tested against the current state to assure accuracy. Then, variables such as staff functions, costs of staff functions, travel distances, and types of cases are all inputted into the model and can be used to help determine the best scheme. In a clinical environment where physicians and administrators alike are used to backing-up their decisions with data, simulation modeling can be a powerful tool to support capital investment decisions.

Physical Mock-ups
Similarly physical mock-ups – whether made of foam core or actual materials – can also help staff and clinicians make decisions that they would have a hard time making from simply reading two-dimensional floor plans or elevations (FIGURE 5). Mock-ups allow them to play with booms, lights, and the operating table, simulating procedures and transport to determine whether the space will or will not support optimized movements and processes.

Surgical Scenarios*
Last-Minute Planning Decisions
In this scenario, the third floor of a major academic medical center (AMC) is dedicated to the neurosurgery and neuro-interventional service lines. While it makes good sense to have these two service lines on the same floor, at the last minute, your team makes a hasty decision to add IMRIS to the platform. Because this decision was not assessed for the impact on facilities and operations, the AMC ended up with an under-utilized, very expensive piece of real estate in the middle of the floor. There are a couple of reasons for this:

• Being located in the middle of the neurology floor, the MR is not available for diagnostic imaging which can help balance out the capital expenditure.
• Since the IMRIS sits in a garage and is connected to two ORs, those ORs required specialized equipment designed with non-ferrous materials. As a result, surgeons do not like using them because they are different from the rest of the ORs.

*Surgical Scenarios are based on the authors' previous experience and observations and are not reflective of the CannonDesign portfolio.
Designing Flexibility for the Future

Personal technology has been rapidly evolving over the past couple of decades. Today it is not unusual for a person to have a smart phone that they use to obtain and send on-demand information while wearing a bio-feedback device that gives them updates on their physical activity and health. The healthcare industry is beginning to expect this level of technological integration in the clinical environment as well. Future healthcare environments are likely to not only be information rich with on-demand historical data from electronic medical records, but they will also support the use of 3D holographic simulations of the patient body that can be used to visualize incisions and procedures before the surgery even begins in a fully lit room. Technological advancements like these, along with new advances in molecular and cellular surgeries, are putting new, rapidly evolving demands on clinical environments like the operating room, which now must provide the infrastructure for data access, data capture, RTLS, and voice recognition, while also supporting both patient safety and staff efficiency.

Digital Cockpits

While it is certain that the coming years will include many technological advancements, how those will play out for a given healthcare organization can be difficult to anticipate. One way to “future-proof” the design of operating rooms is to include a digital cockpit that can be used for a variety of different purposes. For several years, digital cockpits have been included in image-guided labs to serve as a control center. However, the same concept can apply to operating rooms. While the specific use for these spaces may not be determined at the time of construction, there are more than enough appropriate uses for it including:

- Pre-Op Warm-ups
- Imaging / Robotics Garages
- Patient Intelligence Modeling
- Bio-printing
- Relaxation / Decompression Space
- Teaming, Teaching and Observation Galleries

Simulation Labs

In order to really understand what might be possible and how care can be improved in the operating room environment, ongoing research and innovation is needed. Simulation labs are increasingly being used to research care innovations. For example, under a partnership with the U.S. Department of Defense, Cedars-Sinai is using the OR 360° to explore how to improve outcomes in trauma patients during the “golden hour” – the first hour of emergency medical treatment, when swift care is most critical to survival (FIGURE 6). The operating room functions like a theater where doctors and military professionals can set the stage for whatever scenario they needed to test. These types of spaces offer an additional way to investigate how procedures and operations will play out in real-time.

FIGURE 6 The OR 360°, funded via a partnership between Cedars-Sinai and the U.S Department of Defense, is designed to be endlessly reconfigurable. A gridded trolley system on the ceiling allows the surgical lights, equipment booms and the glass walls to be repositioned or removed altogether.
Sterile Operating Zone
A dedicated sterile operating zone surrounding the operating table, identified by the markings on the floor and laminar flow diffusers above, supports all necessary safety and infection control protocols. Fixed horizontal surfaces have been eliminated and replaced by articulating equipment on the ceiling and mobile workstations and storage components.

Surgical Modalities Available
Laparoscopic, endoscopic, robotic, and/or other surgical modalities are available within the room as a fixed feature, or more flexibly can be wheeled in on a mobile cart as needed. Connections to power, data, video, and medical gases can come from the ceiling via booms and smaller articulating arms to eliminate tripping hazards and the need to tether equipment to infrastructure historically located on the walls.

Fixed or Mobile Imaging Available
Angiography, intraoperative CT, intraoperative MR, fluoroscopy, optical and electromagnetic surgical navigation systems, and focused guided ultrasound provide highly specialized imaging used by multiple surgical modalities. Ceiling hung monitors at the midpoints of the four sides of the surgical field can be positioned to accommodate virtually any surgical setup. Audio/video integration allows for the combination of live and historical radiology images to be routed to any of the ceiling hung monitors in the field or one of the wall hung PACS screens.

Universal Infrastructure
The minimum room size and proportion can accommodate the amount of equipment and personnel needed across multiple types of operations and procedures. Designated functional zones are arranged in a consistent and logical manner so people and equipment can flow without conflict. This includes (1) consistent and dedicated entry points for the patient and surgical supplies, (2) a circulating nurse control station with convenient access to the room entry points and clear visualization of the surgical field, (3) multiple dedicated, unobstructed surgical zones that accommodate various table orientations, (4) an anesthesiologist zone near the room entry at the patient’s head for induction, (5) a circulation zone surrounding the surgical field and (6) both clean and sterile equipment storage zones on the outer perimeter.

Universal ORs as the Way Forward
Given the constant technological advancements and many unknowns related to the operating room environment, emerging solutions need to be rapidly adaptable and flexible in order to remain relevant. Although not always feasible, healthcare organizations should be targeting universal solutions that will accommodate interventional procedures for multiple specialties, encourage collaboration between specialties, eliminate the limitations and inefficiencies associated with using an operating room solely for one service line or procedure type, and provide flexibility to future clinical innovation. Primary considerations for the Universal OR model are listed (Figure 7).

The shift towards Universal ORs has been slow and not without its barriers. If planned correctly, the Universal model offers a solution to space constraints while achieving an ability to perform complex surgical and minimally invasive procedures. It is ultimately the goal that healthcare organizations across the country need to be moving toward.

FIGURE 7 Primary considerations for the Universal OR model
Conclusion

There are no cookie-cutter solutions for designing the ideal surgical suite. Creating environments that improve operational efficiency while supporting clinical excellence requires an in-depth understanding of the current state, leadership and buy-in from the many important stakeholders that will occupy the space, and a vision for the future that moves patients, staff, and organizational leadership beyond the status quo. The most proactive organizations will find themselves headed in the direction of rapid flexibility and adaptability - moving closer to an integrated environment within the universal operating room.

References


About the Authors

With over 15 years of healthcare experience, Todd Accardi has worked on a variety of institutional and large-scale healthcare projects throughout the world. He focuses on the operational analysis of clinical teams and the physical analysis of their facilities to create planning solutions that reflect their vision. He is skilled at working closely with key stakeholders to translate program elements and optimized clinical workflows into a cohesive design that responds to patient, staff and organizational needs to create healing environments that provide the highest quality care.

With a career that spans 30+ years as a perioperative nurse in the healthcare profession, Julie Dumser has a wealth of experience that includes direct patient care, healthcare operations, nursing administration and executive leadership within inpatient and ambulatory settings. As a certified LEAN and Six Sigma professional, Julie promotes the use of process improvement tools to develop clinically efficient environments.

About CannonDesign

CannonDesign is an integrated, global design firm that unites a dynamic team of strategists, futurists, researchers, architects, engineers and industry specialists, driven by a singular goal — to help solve our client’s and society’s greatest challenges.

Contact Information

For more information please visit cannondesign.com.