AIA INDIANA HEALTHCARE DESIGN AWARDS

COLUMBUS REGIONAL HEALTH
AT NEXUSPARK

The Application of Discrete Event Simulation (DES) to Enhance Wait Times and Space Utilization

In response to the evolving healthcare landscape and the growing need for high-quality, cost-effective outpatient services, this project used Discrete Event Simulation (DES) to evaluate and optimize the design of a multi-department outpatient clinic. This simulation-driven, evidence-based approach enabled project stakeholders to make informed architectural and operational decisions, ensuring improved patient flow, space utilization, and staff efficiency.

The project centered on the adaptive reuse of a 400,000-square-foot mall into a wellness and ambulatory care campus in Columbus, Indiana. With 120,000 square feet dedicated to a consolidated multi-specialty outpatient clinic, the facility aimed to integrate 12 departments—ranging from primary care and pediatrics to audiology, neurology, OB-GYN, physical therapy, and laboratory services—into a patient-centered, efficient healthcare delivery model. A crucial component of the planning process involved evaluating design strategies and staffing models through a DES platform to answer four critical questions:

1. Does the proposed design and staffing support future patient volumes?
2. How does centralized registration and kiosk check-in impact staff utilization?
3. Can underutilized rooms be repurposed without disrupting operations?
4. Which departments require additional providers during peak periods?

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Applying DES to a Complex, Multi-Department Environment

Given the complexity of outpatient clinic operations—variable patient flows, staffing levels, space needs, and appointment types—DES was identified as a powerful tool. The team utilized FlexSIM 2021 software to model the clinic's operational dynamics using over 176,000 data points from Electronic Medical Records (EMRs), covering patient appointments, arrival and departure times, provider interaction, and room usage.

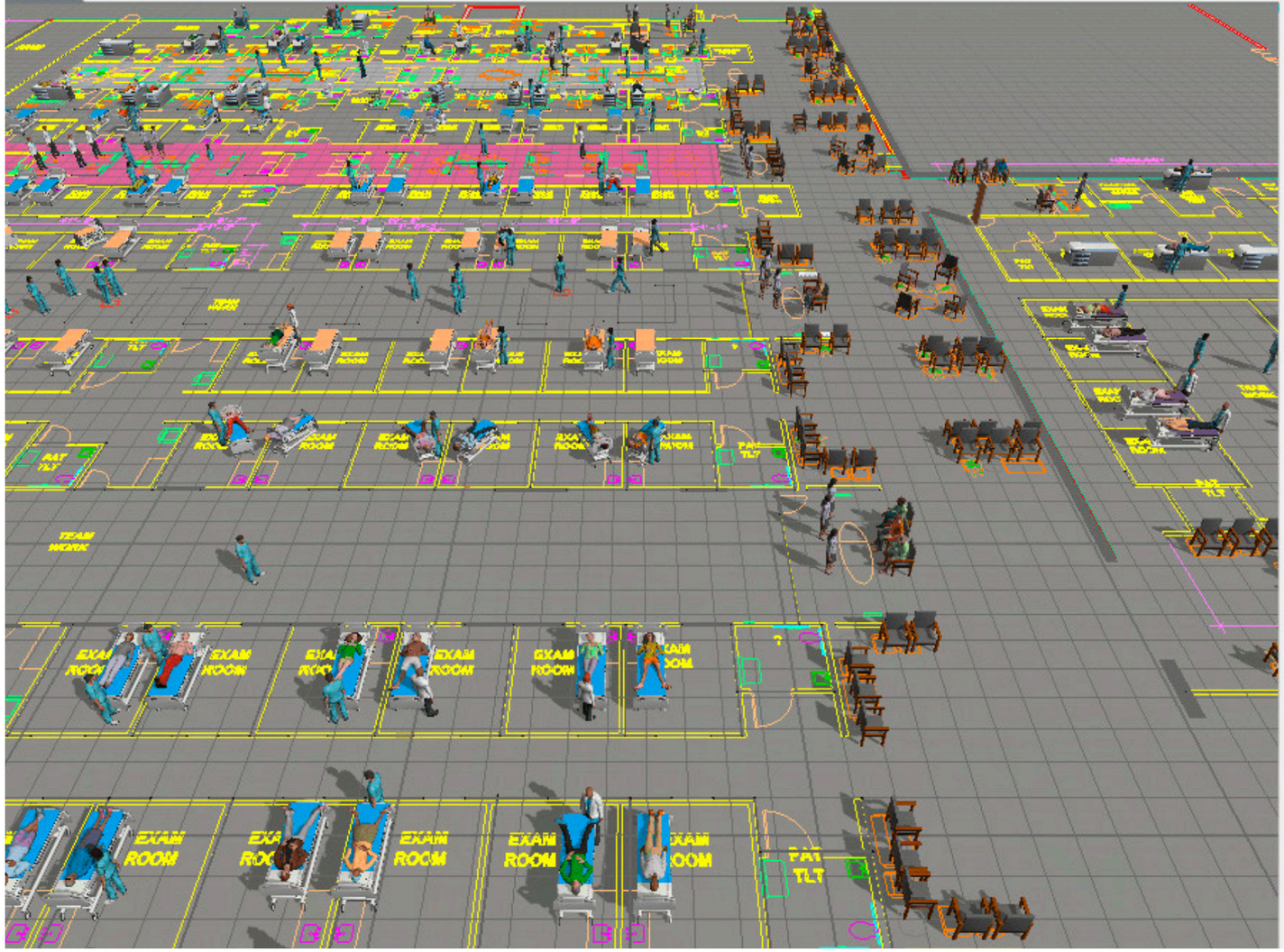
Each clinic module was individually analyzed, with special focus on primary care (PC) and pediatrics departments. Variations in patient volume, staffing patterns, and appointment types were modeled, and assumptions were based on realistic clinical operations derived from historical data and validated through stakeholder interviews. The models included multiple user groups to verify assumptions and adjust logic according to department-specific workflows.

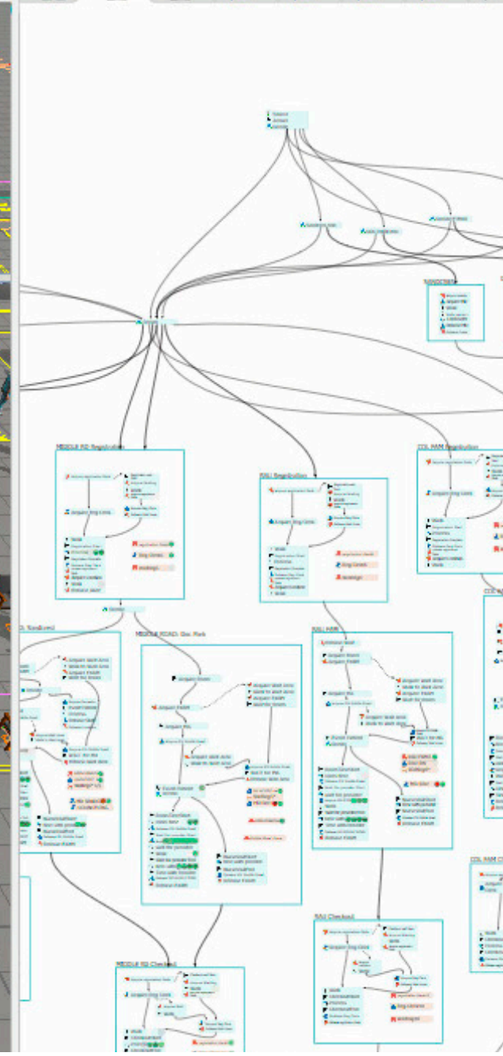
Key Design Strategies and Simulation Outcomes

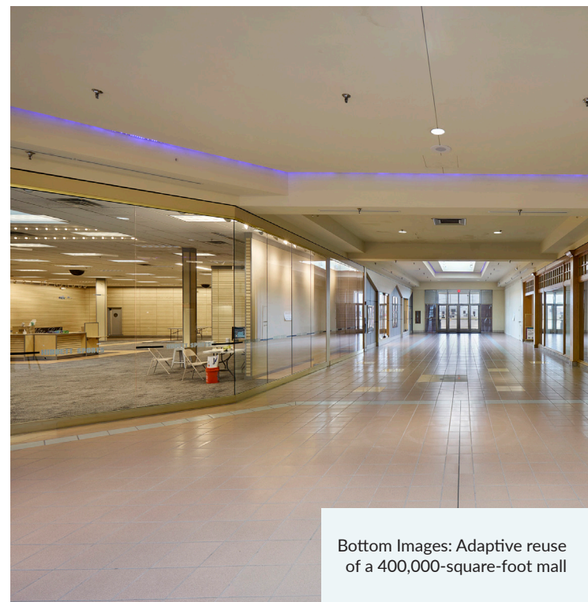
1. Assessing Baseline Capacity

The simulation first assessed the existing (current-state) design and staffing against anticipated patient loads. Results indicated that three of the six primary care clinics experienced bottlenecks in room and provider availability during peak hours. Specifically, PC2 and PC4 exhibited high provider utilization rates (83% and 86%, respectively), which correlated with longer patient wait times.

Conversely, pediatric exam rooms were underutilized, with an average utilization rate of just 24%. These disparities pointed to inefficiencies in the spatial distribution of resources and laid the foundation for design interventions.







Bottom Images: Adaptive reuse of a 400,000-square-foot mall

2. Centralized Registration and Kiosk Integration

To streamline operations and reduce underutilization of front-desk staff, the project proposed consolidating registration desks for primary care departments into centralized zones and introducing eight self-check-in kiosks. The simulation assumed 20% of patients would use kiosks for check-in or check-out.

This intervention improved staff efficiency, increasing registration staff utilization from 31.8% to 49.4%. An Independent Samples T-Test confirmed the statistical significance of this improvement. Departments with more specialized patient needs were excluded from centralization to preserve patient care quality.

The study highlighted how kiosks not only reduced staff workload but also improved patient throughput. The literature supports these findings, citing reduced check-in times and increased patient satisfaction with kiosk use—benefits that could be further explored with real-time POE data.

3. Repurposing Underutilized Spaces

To enhance spatial efficiency, the team explored converting low-use exam rooms into other functions. Four pediatric exam rooms were transformed into dedicated pediatric waiting spaces and telehealth rooms. Three exam rooms from primary care departments were also reassigned for telehealth use.

The simulation showed that these changes did not negatively impact patient flow. Pediatric room utilization increased modestly (from 24% to 29%), and there was a measurable decrease in wait times for rooms in PC5, validating that flexible space reallocation could improve operational efficiency without increasing construction costs or compromising care.

Additionally, a consult room in PC4 was converted into a flex exam-consult room to accommodate peak-hour demand, substantially reducing wait times for that department.

4. Adding Providers During Peak Hours

Recognizing that wait times for providers were disproportionately high in PC2 and PC4, the DES tested the impact of adding one provider to each department during peak hours. The result was a significant reduction in patient wait time for providers:

- PC2: Median wait time dropped from 38.78 minutes to 12.15 minutes.
- PC4: Median wait time decreased from 67.50 minutes to just 2.52 minutes.

This dramatic improvement underscores the value of using simulation to test the operational impact of staffing changes before committing to long-term resource allocation.

Broader Impact and Design Implications

This study offers an in-depth look at how DES can support the planning, design, and operation of complex outpatient environments. By incorporating stakeholders, testing design options, and analyzing data through simulation, the project exemplifies a shift toward performance-driven design.

The project aligned with national healthcare trends, including the rise of telemedicine and the push for more efficient outpatient care. Dedicated telehealth rooms were intentionally designed to meet technological, privacy, and ergonomic requirements, supporting future growth in virtual care.

Importantly, the project promoted flexibility, a key concept in resilient healthcare design. By converting standard rooms into flexible-use spaces, the design supported changing patient volumes and service needs—an essential feature for post-pandemic facilities. Pediatric waiting spaces, for example, were reimagined to support family-centered care, incorporating playful, secure, and socially engaging environments.

Stakeholder Engagement and Model Validation

A major strength of the project was the active involvement of stakeholders throughout the simulation process. Multiple rounds of feedback ensured the model accurately reflected departmental workflows and culture. The visual animation of patient flows and resource use helped communicate complex findings in an accessible way, improving decision-making and model buy-in.

Model validation included both qualitative interviews and statistical comparisons between simulated and historical data. No significant differences were found in milestone comparisons, confirming the accuracy and credibility of the model outputs.

Lessons Learned and Future Opportunities

While the DES proved to be a valuable tool, the study also revealed that early integration into the design phase is essential for maximizing impact. In this case, DES was introduced midway through the planning process, limiting the opportunity for real-time implementation. Nevertheless, the findings influenced design discussions and supported broader organizational planning.

The study also highlighted the need for reliable, complete EMR data to inform simulations. Inconsistent data entry by clinical staff required extensive data cleaning and validation, pointing to the importance of staff training in digital documentation.

Finally, the project suggests a promising future for integrating DES with Post Occupancy Evaluations (POE), patient surveys, and other qualitative tools to assess behavioral and cultural impacts of design decisions—especially as it relates to kiosk acceptance and flexible space usage.

Through simulation, stakeholder collaboration, and forward-thinking design, the team reimagined a healthcare environment that not only meets today's outpatient demands but is poised to adapt to tomorrow's healthcare innovations.