Facility Space Planning

Facility Space Planning included the following tasks:

- Needs Assessment
- Operations Analysis
- Space Needs
- Layout

Needs Assessment

An administrator led the Project Steering Committee. The Department Task Group included the following members:

- Emergency Medical Director
- Emergency Department Director
- Nursing Shift Managers
- Project Operations Analyst, from AKA
- Project Architectural Planner, from AKA

Some members of the task group toured emergency departments of other facilities and developed a list of features that they liked and disliked. They had a strong desire for the new Emergency design to include certain patient amenities, such as private family waiting and more support space for the staff.

The objective of the Kick-Off Meeting with the task group was to identify issues with the current layout. The Emergency Department Director announced that an adjacent space to the Emergency Department would be vacated for expansion. However, the group was tasked with determining the space needed for the Emergency Department that would accommodate future growth of visits through ten years, even if it went beyond the allocated expansion area.
The Project Plan and proposed use of simulation analysis was presented to the task group. A simple simulation model of an Emergency Department was shown on a laptop computer (see Figure 2 — Simple Simulation Model), which generated mixed reactions.

A Town Meeting was held with at least one representative from each position in the department and from each shift. The first half of the meeting was spent identifying problem areas or issues in the current space. A Nominal Group Voting process was used to determine the priority of problem areas.

The second half of the meeting was used to develop a process flow for the simulation model. Activity times were estimated with an average, minimum, and maximum times by the attending representative of that role.

A review of the current layout for code and regulation violations was also conducted by AKA. Any violations were to be corrected in the renovation.

Operations Analysis
The volume of emergency visits was collected for several years. Figure 3 shows the Daily Average Emergency Visits. Although a couple years showed a decline, an overall trend of two percent growth emerged. This growth rate was consistent with national trends through 1999. The task group agreed to review future growth through ten years at a growth rate of two percent. However, the Medical Director was concerned about a drastic increase if all patients in Jackson County started going to Foote Hospital Emergency Department, which could happen if the other Jackson hospital downgraded or closed their emergency department.

Simulation analysis was used to determine the effects of these alternative processes.

Space Needs
Various methods are available to calculate beds and space needed without simulation analysis.

Space benchmarks have been used to determine bed needs for many years. The article “Data Benchmarks – How Does your Emergency Department Measure Up to These Benchmarks” was in the Cost Reengineering Report in December 1997. The report indicated about 1,100 visits per emergency bed and also suggested total departmental gross square feet to be 550 to 600 per bed.

AKA’s experience with 32 Emergency Department projects has led to the development of their own benchmarks. Their industry statistics
indicated an average of 2,000 visits per emergency bed for a community hospital and 1,600 visits per bed for a trauma center. AKA also suggested a range of 600 to 900 square feet per emergency bed for departmental gross space estimates. The larger space ratio would allow private rooms for patients and more support space.

An operational assessment was performed to determine the optimal number of beds for the facility space planning. The calculations require input data of patient visits by type on a peak day, length of stay by type, and bed utilization factor. This calculation is available in “Space Planner Toolkit, Hospital Edition”, by Frank Zilm, AIA and Kent Spreckelmeyer, AIA, 1995, American Society for Healthcare Engineering of the American Hospital Association.

Current peak daily visits were obtained from the nursing manager. Emergency visits were projected for future years based on established growth rate. Daily peak volumes in the future were based on current proportions. The average length of stay for discharge patients with routine treatment was 2.5 hours and admitted patients with extra holding time was 5.5 hours. The admission rate was 12 percent. The projected number of emergency beds and observation holding beds were then calculated. Table 1 shows the Average and Peak Daily Visits with Calculated Beds.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Year 1</th>
<th>Year 5</th>
<th>Year 10</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily #</td>
<td>142</td>
<td>156</td>
<td>172</td>
<td>184</td>
</tr>
<tr>
<td>Peak #</td>
<td>170</td>
<td>187</td>
<td>206</td>
<td>221</td>
</tr>
<tr>
<td>Beds</td>
<td>34</td>
<td>36</td>
<td>39</td>
<td>42</td>
</tr>
</tbody>
</table>

AKA’s architectural planner created a Gaming Board with colored squares of various sizes that corresponded with the size of rooms, such as 130 square feet for treatment room and 55 square feet for toilet. The task group tried to fit as many room pieces into the department space boundaries as possible based on functional adjacency and allowing for corridors and building fixtures.

Based on this exercise, it was established that the department space could accommodate the additional beds needed through the next five years. However, the desired support space would not fit in the current department space boundaries. Therefore, space needs were greater than the space allocation. The task group wanted to verify this conclusion and they anticipated that activity time improvements or alternative process flows would allow for greater patient volume through the space. Simulation analysis was used to support this case.

Simulation

Simulation Analysis was performed to evaluate how alternative processes would affect bed needs. Simulation included the following tasks:

- Data Collection
- Model Development
- Outcomes Analysis
- Bed Needs

Data Collection

A large variety of data was required for a simulation analysis, which was analyzed and reviewed by the task group. The task group assigned additional data collection where necessary.

Arrival rates were obtained from patient Log In Sheets. Figure 4 shows the Patient Arrival by Hour of Day. The trend of increasing arrival rates started at 8 AM.

These patients tended to be low acuity. This trend is earlier compared to national trends where arrival rates start to increase at 10 AM or 11 AM. Upon investigation, the majority of these patients did not have a primary physician and were going to the Emergency Department as a clinic.

Resource schedules were obtained from Assignment Sheets by day of week. The schedule tried to ramp up staff as patient census in beds was increasing and ramp down as census decreased after Midnight. The simulation module was not designed to designate all staff activity. Therefore, a certain percentage of busy time was randomly allocated to staff to make them unavailable. Physicians wanted
the schedule to reflect the last hour of their shift as busy on charting duties.

The development of the process flow began at the Town Meeting. The task group verified the finer details in the process for collection of activity times and decision points.

Emergency Department staff collected data for activity times from chart review, observation and self-recording. Activity times were needed for the following tasks:
- Triage by Nurse
- Registration by Clerk
- Patient Taken to Bed by Tech or Nurse
- Assessment by Nurse and Physician
- Order Written by Physician
- Order Entered by Clerk
- Specimen Collection by Tech
- Patient Taken to Radiology by Tech
- Other Procedure by Tech or Nurse
- Medication Administration by Nurse
- Wait Time for Results from Laboratory, Radiology, and Other Procedures
- Results Compiled in Chart by Clerk
- Disposition Decision by Physician
- Consulting Physician on Phone by Clerk
- Consult with ED Physician
- Discharge Tasks by Nurse and Physician
- Admission Tasks by Nurse, Physician and Clerk
- Transfer Tasks by Nurse, Physician and Clerk

The process flow identified a number of decision points at which patients were directed to various treatment options based on condition. Key data collected included the volume of patients (specific percentages of the total number of patients tracking through the Emergency Department) for each of the options listed below:
- Trauma or Triage
- Acuity Level
- Fast Track or Routine Treatment
- Lab Test
- Radiology Exam
- Other Procedure
- Medication
- Consultation Call
- Disposition Decision of Discharge, Admission or Transfer to Other Facility

The patient’s attribute of acuity level affected the route through the process flow and decision points.

- Low acuity patient could be assigned to the Fast Track, received fewest orders, and were all discharged.
- Moderate acuity patients went to treatment beds, had more orders, and had mostly discharge patients but some admissions.
- High acuity patients had some patients bypass Triage and go straight to Trauma while others went to Triage and Treatment beds. High acuity patients also had the highest rate of orders and admission. Some high acuity patients were transferred out to another facility.

**Model Development**

The simulation model was made using a flowchart based simulation language, Process Model™. The initial model was developed using current existing conditions. Not all conditions were inserted in the model, because real-life has too many variations.

The outcomes of the initial model gave patient length of stay values that were consistent with actual cases. Based on this verification, alternative models were designed to determine their effect on the following scenarios:
- Increase patient volume for anticipated growth rate and the elimination of a second local emergency department
- Faster process times from Radiology, Laboratory, and going to an inpatient bed
- Patient flow with alternative treatment areas: Emergency, Outpatient Clinic and Clinical Decision Unit

Models were run with a higher number of beds for increasing patient volumes. If the beds were not sufficient, some patients would encounter a bottleneck and not enter a bed within two hours of arrival. In real-life, patients would walk out if they did not get a bed within this period of time. Therefore, time into bed and overall length of stay were the primary measured outcomes for each scenario.

**Outcome Statistics**

Outcomes statistics were designed to provide measures for the task group to compare with real-life conditions, such as:
- Beds Filled by Hour of Day
- Patient Census by Hour of Day
- Overall Length of Stay by Acuity Level
- Times between strategic points of interest: Arrival, In ED bed, See physician, Enter orders, Disposition decision, and Leave ED
The outcome analysis for the different yearly volume and scenarios were based on the 90th percentile of beds filled, instead of the maximum or worst case of beds filled. This is a more economical approach for the design. Management intervention usually presents worst-case conditions that the model cannot replicate.

**Bed Needs**

The number of beds filled in the 90th percentile by year and scenario are presented as Emergency Beds Needed in Table 2. The bed needs are smaller than the original projections from the length of stay calculations.

The Fast Results scenario projects fewer beds needed than the No Change because length of stay is shorter. The scenario with three treatment areas (ED, CDU and Clinic) has slight improvement in Year 5. These results could be improved by encouraging a greater volume of low acuity patients to use the Clinic instead of Fast Track in the ED. Fast results in the ED with CDU and Clinic have similar bed needs as just the ED alone with Fast Results.

Table 2 – Emergency Beds Needed

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Year 1</th>
<th>Year 5</th>
<th>Year 10</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Change</td>
<td>29</td>
<td>32</td>
<td>35</td>
<td>39</td>
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<tr>
<td>Fast Results</td>
<td>27</td>
<td>28</td>
<td>32</td>
<td>35</td>
</tr>
<tr>
<td>ED, CDU &amp; Clinic</td>
<td>29</td>
<td>31</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Fast Results in ED, CDU &amp; Clinic</td>
<td>27</td>
<td>30</td>
<td>32</td>
<td>35</td>
</tr>
</tbody>
</table>

**Other Outcomes**

Although the simulation was not a full staffing study, it provided outcomes that were beneficial to staffing and scheduling.

- Staffing schedule of Emergency physicians was a bottleneck in patient throughput
- Utilization of physician assistants or nurse practitioner for ED Fast Track was too low for cost effectiveness at certain times of day

**Design**

Preliminary Design included the following tasks:

- Space Program
- Cost Estimate
- Alternative Designs
- Schedule

**Space Program**

A space program is a listing of all rooms by quantity and space allocation. The sum of space allocations is the net department gross square footage. A factor is added for building contingencies, such as walls, stairs, and hallways. The result is the total departmental gross square feet.

Space programs were developed for alternative designs.

**Alternative Designs**

Alternative designs were made of the Emergency Department.

- Scenario A was a Do Nothing alternative.
- Scenario B has more beds but not any additional support space. The renovation design is kept within the existing space boundaries of the Emergency Department and adjoining space for expansion.
- Scenario C has more beds and some of the additional support space. The design requires renovation of existing space and new construction beyond the boundaries.
- Scenario D has more beds and all of the desired additional support space. The design requires renovation of existing space and new construction beyond the boundaries.
- Scenario E has more beds and all of the desired additional support space. The design also has some support space placed on the second level, above Emergency.

**Cost Estimate**

The cost estimate was based on a standard cost per square foot for renovation or construction. Contingency, Permits, Architectural/Engineering Fees and Furniture/Furnishings/Equipment allocations were initially given as a percentage of renovation and construction cost. More accurate costs were collected as the project progressed and specific decisions were made.

**Schedule**

A time schedule was made with major decision points and tasks, which included:

- Approvals
- Pre-Design
- Schematic Drawing
- Design Development
- Construction Documents
- Bid and Award
- Construction
The project had two phases: renovation of existing space and new construction. The schedule was regularly reviewed to ascertain if the project was on time.

**Conclusion**

Phase One Emergency renovation is currently under construction, which increases beds to existing boundaries. The Foote Hospital Board has approved Phase Two Emergency renovation, which allows expansion of the building on first and second floors. Due to the closure of the other local hospital, management is closely monitoring emergency visit volume to determine how quickly additional beds will be needed.

The next step could be to perform another simulation analysis that focuses on staffing and scheduling. Outcomes analysis could evaluate staff utilization as it relates to the new design, patient volume, staff schedule and assignment by nursing station.

**Biographical Sketch**

Lillian Miller is a consultant at Albert Kahn Associates, Inc., in Detroit, Michigan. She has a bachelor of science in industrial engineering from Wayne State University, in Detroit and a master of science in industrial and systems engineering from The University of Michigan-Dearborn. She presently performs master facility space planning, simulation analysis and operations analysis for the Health Care Consulting Practice group. Prior to joining AKA four years ago, she worked for 18 years at various hospitals in metropolitan Detroit as a senior management engineer and operations analyst. She is a member of SHS/IIE, and Michigan Simulation Users Group. She has previously presented and published at HIMSS and at a simulation vendor users’ group.
Facility Space Planning
For Emergency Department
Using Simulation Analysis

SHS Conference
February 2004

Lillian Miller
Agenda

• Foote Hospital
• Emergency Department
• Facility Space Planning
• Simulation
• Design
Albert Kahn Associates, Inc.

- Architecture and Engineering firm
- 100+ Years Experience
- Quality Commitment
- Strategic Facility Planning
Foote Hospital

- Health System
- Jackson, Michigan
- 325 beds
- Major Services:
  - Behavioral Health
  - Cancer Center
  - Birthing Center
  - Heart and Lung Services
Emergency Department

- Two EDs in Area
- Level II Trauma
- Built in 1983
- 20 ED Beds
- 34,000 Visits
- Capacity
- 50,388 Visits in 2000
Facility Space Planning

- Needs Assessment
- Operations Analysis
- Space Needs
- Layout
Simulation

- Data Collection
- Model Development
- Outcomes Analysis
- Bed Needs
Design

- Space Program
- Cost Estimate
- Alternative Designs
- Future Design
- Schedule
Facility Space Planning

Needs Assessment

• Team Development
• ED Tours
• Available Space
• Town Meeting
• Codes and Regulations
Facility Space Planning
Operations Analysis

Facility Planning

Obtain market study

Interview key personnel

Tour facility

Gather data

Assessment

Determine current capacity

Determine space needs
Facility Space Planning

Space Needs

• Average and Peak Volume
• Key Rooms and Dept Space
• Trends and Benchmark
• Alternative Processes
Facility Space Planning
Layout

- Gaming Board
- Initial Layouts
- Beds
- Support Space
Simulation Analysis

1. Process Definition
2. Problem Identification
3. Model Development
4. Data Collection & Analysis
5. Model Validation & Verification
6. Scenario Development
7. Results Analysis
8. Presentation

Simulation Analysis Flowchart
Simulation Data Collection

- Arrival Rates
- Resource Schedule
- Patient Types
- Activity Times
- Decision Points
Simulation Outcomes Analysis

- Patients in ED
- Beds Filled
- Length of Stay
- Interim Times
- Bottlenecks
- Desired
Simulation
Bed Needs

- By Visit Growth
- By Process Scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Year 1</th>
<th>Year 5</th>
<th>Year 10</th>
<th>Far Future</th>
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<tbody>
<tr>
<td>Routine Process</td>
<td>29</td>
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<td>Faster Process</td>
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<tr>
<td>ED with CDU &amp; Clinic</td>
<td>29</td>
<td>31</td>
<td>35</td>
<td>40</td>
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</tbody>
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Design Space Program

- Room Types
- Room Quantity
- Room Area
- Listing
- Net Sq Ft
- Building Factor
- Dept Gross Sq Ft

<table>
<thead>
<tr>
<th>Room or Space</th>
<th>Qty.</th>
<th>Area</th>
<th>Total</th>
<th>Net Sq Ft</th>
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<td><strong>Category 1 (High Acuity Level)</strong></td>
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<tr>
<td>Exam/Treatment Room</td>
<td>4</td>
<td>230</td>
<td>920</td>
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<tr>
<td>Trauma Room</td>
<td>4</td>
<td>250</td>
<td>1,000</td>
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<tr>
<td>Isolation/Treatment Room</td>
<td>2</td>
<td>230</td>
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<tr>
<td>Isolation Ante Room</td>
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<td>Cardiac Room</td>
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<td>250</td>
<td>250</td>
<td></td>
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<tr>
<td>Nurse Station</td>
<td>1</td>
<td>400</td>
<td>400</td>
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<tr>
<td>Pyxis Machine Alcove</td>
<td>3</td>
<td>25</td>
<td>75</td>
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<tr>
<td>Patient Toilet</td>
<td>2</td>
<td>55</td>
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<td>Staff Toilet</td>
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<td>Pneumatic Tube Station Alcove</td>
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<tr>
<td>Stretcher Alcove</td>
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<td>Crash Cart Alcove</td>
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<td><strong>Subtotal:</strong></td>
<td></td>
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<td><strong>3,580</strong></td>
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Proposed
Design Cost Estimate

- Renovation
- New Construction
- Permits and Lab Testing Fees
- Furniture, Furnishings, and Equipment
- Architectural/Engineering Fees
- Contingencies
- Escalation
Design

Alternative Designs

A. Do Nothing
B. Minimal Renovation
C. Expand Horizontal
D. Further Expand Horizontal
E. Expand Horizontal and Vertical
Design
Future Design
Design Schedule

- Phases I and II
- Approvals
- Pre-design
- Schematic Drawing
- Design Development
- Construction Documents
- Bid & Award
- Construction
Project Status and Questions