Proceedings of the 2004 Winter Simulation Conference
R .G. Ingalls, M. D. Rossetti, J. S. Smith, and B. A. Peters, eds.

ANALYZING INCENTIVES AND SCHEDULING IN A MAJOR METROPOLITAN HOSPITAL OPERATING ROOM THROUGH SIMULATION

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ABSTRACT

This paper discusses the application of simulation to analyze the value proposition and construction of an incentive program in an Operating Room (OR) environment. The model was further used to evaluate operational changes including scheduling processes within the OR and utilization rates in areas such as Post Anesthesia Care Unit (PACU) and the Ambulatory Surgery Department (ASD). Lessons learned are presented on developing multiple simulation models from one application as well as issues regarding model transition to a client.

1 CLIENT OVERVIEW AND BUSINESS CHALLENGE

St. Vincent's Hospital, the oldest hospital in Birmingham, Alabama is a not-for-profit hospital that has been dedicated to the betterment of health in Birmingham for more than a century. Founded by the Daughters of Charity of St. Vincent's DePaul in 1898, this Catholic health care facility is a member of Ascension Health Corporation.

Incentive systems in hospitals have gone through cyclical periods of embracement. Another hospital in St. Vincent's local market had recently included incentives in its compensation program. Although embraced by its employees, the "other" hospital reportedly paid out nearly $1,000,000 in incentives while receiving very little benefit in its operating structures. St. Vincent's Hospital, while desiring to evaluate the application of incentives, did not want to suffer the same fate of minimal returns.

The client did desire further understanding of the benefits and full value proposition associated with the incentive application. It was unclear to the client how incentives would be used in this environment or what level of improvement could be achieved. The capability of the system needed to be better understood and proposals developed for administration. Once gathered, this information would be utilized in deciding not only the basic question of "should the OR have an incentive system" but also the deeper question of "if an incentive system is valuable, how valuable is it?" Also, a number of questions relating to operational issues in the OR were unresolved. Moreover, the complexity of the questions proved to be overwhelming in light of traditional analytical processes. Consequently, valid and trusted solutions were hard for management to provide.

2 THE TEAM

The project team was comprised of individuals from numerous backgrounds within the OR and other support areas. The OR Director headed the analysis team supported in that effort by the Chief Nursing Officer (CNO) of the facility. In the first stage of the development process a number of individuals assisted in gathering sufficient information for the model design and further data for the designed conceptual model. The main individuals from St. Vincent's Hospital included Pat Booher (OR Special Projects Coordinator), and Mike Neuendorf (Director of Internal Consulting).

The model building team included Marty Miller and David Ferrin both of Business Prototyping Inc. Many of the same individuals performing data collection and model design also participated in the validation phase of the project. The analysis team using the model to determine the value proposition included Sherry Wininger (OR Director-St. Vincent's Hospital), Michael Neuendorf, Pat Booher, Martin Miller and David Ferrin.

3 THE APPROACH/METHODOLOGY

The team project approach was a combination of BPI methodologies, industry best practices, and program leadership experience. Discrete-dynamic process simulation was a key technique utilized in this initiative. Computer simulation has existed for almost 40 years and has been used in every industry to study systems where there are resources at locations acting upon people or products [Nance and Sargent. 2002]. A few examples of simulated systems are manufacturing plants, banks, airports, health care organization or business organizations [Ferrin, Miller, and Giron. 2000].

The project approach, detailed in the project work plan, included five major phases of work:

- Develop the conceptual model
- Code the simulation
- Experiment with business scenarios
- Report simulation results
- Train client-based users

4 RESULTS

Incentives relating to three areas were evaluated:

- Case Cart completion,
- Pre Admission Testing (PAT), and
- Room Turnaround Time, Setup and Cleanup time.

Case cart completion in the OR had recently improved to 85%. The model showed that improving case cart completion rate to 100% provided a 3% improvement in the time from when the patient was ready in the Ambulatory Surgery Department (ASD or Same Day Surgery) until the patient was in the Operating Room. A 100% completion rate also provided a 12% improvement in the ASD room utilization. While helpful operationally, this improvement was not significant enough for the incentive application.

The PAT incentive looked at taking PAT from approximately 75% to a theoretical 100% completion, realizing that 100% PAT is difficult if not impossible to attain. Results of this scenario showed 6% improvement in OR on-time starts. Although helpful, this result was not significant enough for the incentive program.

Improving the room turnaround process 20% did yield a 4% OR case volume improvement and a 5% improvement in the ASD room utilization. The OR case volume improvement meant the capability of adding a handful of cases a week to the OR schedule without the addition of other labor resources. In other words, more volume with the same cost structures. Consequently, the additional revenue for this scenario was quite significant and proved to have a substantial return for the incentive program.

Administration had numerous other questions relating to the number of ASD rooms needed to process patients. The hospital wanted to reconfigure one of two ASD units into Medical/Surgical rooms with the goal of improving patient throughput. The model showed that a number of ASD rooms could be reconfigured.

After evaluating the number of rooms needed with current volumes for the ASD, the model showed the following conclusions.

- The number of ASD rooms could be reduced from the current amount of beds (baseline),
- OR hours (and costs) would increase to compensate for the ASD capacity reductions,
- As patient waiting times increased, patient and staff satisfaction would likely decrease and
- To close one of two full ASD units would “break” the system in numerous ways causing considerable operational problems in the OR itself.

The main recommendation was not to reduce the number of ASD units from two to one. If implementation of a program to decrease the number of ASD rooms were instituted, caution was recommended. Specifically, an incremental reduction of ASD beds through a defined Rapid Cycle Testing (RCT) methodology was recommended. Process measures needed to be instituted before decreasing ASD rooms and continuously monitored during the Rapid Cycle Tests. These measures would indicate the success or failure of each cycle tested warning management of imminent system failure in the OR. It was recommended that each RCT decrease no more than two rooms for a period of at least 1-2 weeks. If volumes during that time proved not to be consistent with expectations, the current cycle with its associated closed rooms should be repeated before more rooms were reduced. Measures for the RCTs would be:

- OR and PACU employee overtime costs including,
- Cycle time from “Call to ASD” to “OR Ready”
- Cycle time from “PACU complete” to “ASD Discharge”
- ASD room utilization percent and
- Average patient waiting time for an ASD room.

The model showed that the system “broke” around the reduction of nine ASD beds. One unanswered question was how quickly the OR overtime costs would outpace the value of ASD savings and associated improvement in the hospital-wide patient care throughput. Hence if implementation of ASD bed reductions were undertaken, the two beds per RCT approach was greatly warranted. The following charts support the conclusions presented.

Figure 1 showed that compared to the current number of ASD beds (baseline) and Operating Rooms (OR), as the number of ASD rooms decrease, the hours the OR is open increase. The pink line indicates the number of ORs that increased two hours or more in their time to end their day whereas the blue line shows the rooms that had a 1-2 hour increase. Overtime is not shown here, only the time the room closed for the day.

The blue line in Figure 2 shows the time (hours) from when the OR requests the patient (Call to ASD) until the OR is actually ready for the patient (OR Ready). The pink line indicates time from when a patient leaves the Post Anesthesia Care Unit (PACU Complete) until they leave the ASD (Discharge). A substantial increase is seen beginning around the -5 bed level for these statistics.

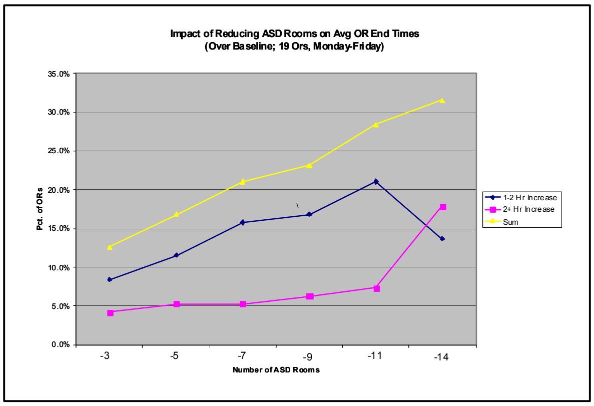

Figure 1

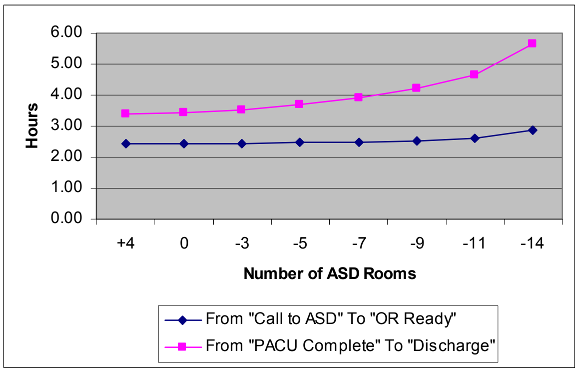

Figure 2

Figure 3 shows the room utilization of the ASD and PACU. It is important to note that this utilization is based upon 24 hours. The current hours of ASD operation is about 12 hours. Consequently, ASD bed utilization is quite high and the associated hours of operation increased dramatically.

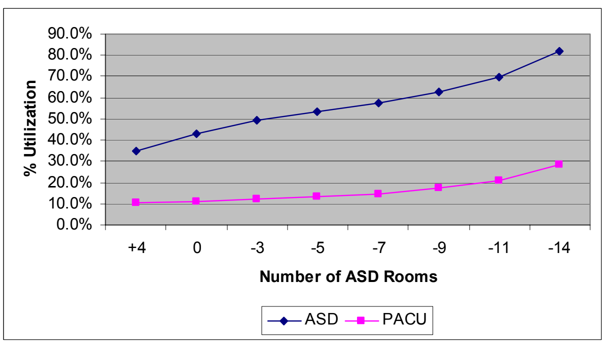

Figure 3

Figures 4 and 5 are the average time patients wait and the average number of patients waiting for ASD rooms. Both charts show a significant increase after a nine bed reduction clearly indicating that the system will "break" beyond that level.

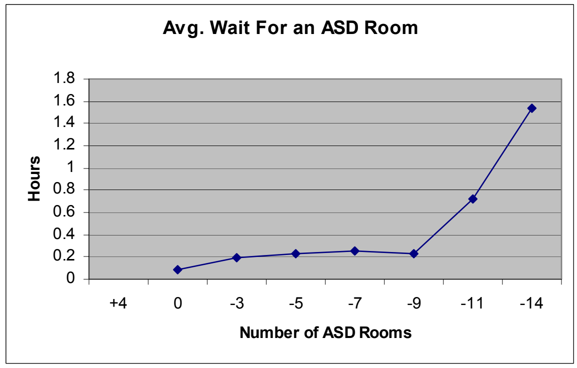

Figure 4

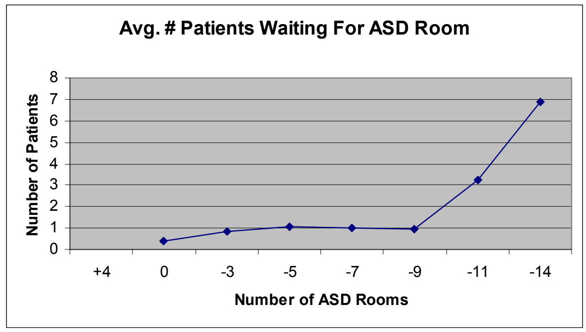

Figure 5

5 CONCLUSIONS

The model did an excellent job directing administration and OR management in the incentives and initiatives that were cost beneficial. Moreover, the model informed administration in what to do as well as what not to do saving financial and political capital for the things that matter most.

Modeling and simulation enabled better understanding of the customer experience, process performances and staffing inter-relationships. The team brought clarity to difficult internal debates and helped develop a model which can be utilized repetitively to aid the decision making process as the system changes.

Generally, results showed the balance between costs, staff utilization, and process performance. Other scenarios that have been evaluated with this model include:

- determining the number of Operating Rooms needed
- the number of pre-op holding bays needed
- the number of beds needed in the Post Anesthesia Care Unit
- changes in the physician blocks for schedules
- changes to improve the on-time performance of the first case of the day.

A Graphic User Interface (GUI) was made to assist the client in using the model. This "Control Panel" proved very helpful for the client and is shown in Figure 6.

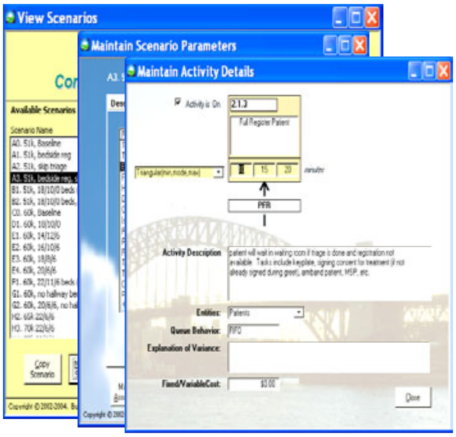

Figure 6: Control Panel

A few screen shots of the model are shown in the following figures.

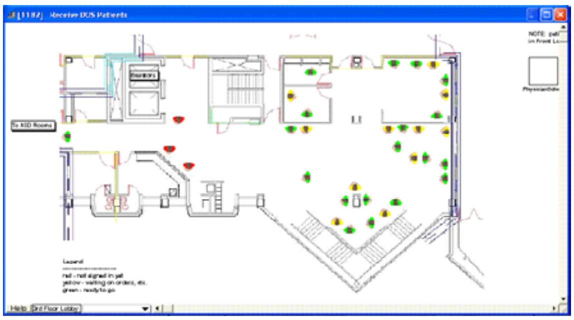

Figure 7: Admitting Lobby

Figure 8: The Main OR

6 LESSONS LEARNED

Making changes to the model late in project lifecycle, including modeling changes and parameters, can cause wasted time and effort. Investing more time getting the model right and at the right level of detail, then getting buy-in earlier, will save time later with coding and experimentation. Also,

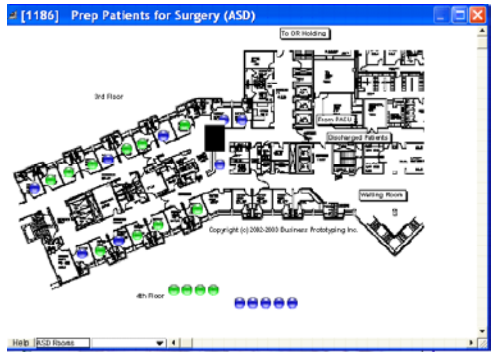

Figure 9: The Ambulatory Surgery Department (ASD)

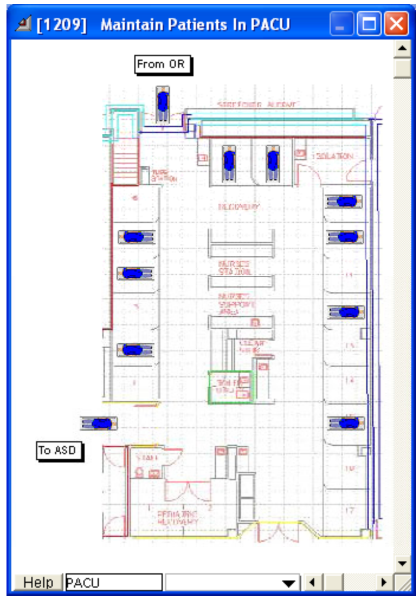

Figure 10: Post Anesthesia Care Unit (PACU)

successful project outcomes can be achieved with a demanding client if you effectively manage their expectations and project scope.

When simulation is used to aid in the decision making process of the system, the scope and complexity of the simulation model are easily lost. This can create a more complex and sophisticated model which adds little or no value to the output of the simulation model. Therefore, it is necessary to work constantly with the design team/ decision makers to manage their expectations and agree on solutions which satisfy all needs and expectations.

Problems exist in numerous well-respected simulation support software systems that perform distribution fitting type functions. Primarily, parameters when "translated" into the simulation software by the distribution fitting software reversed specific parameters incorrectly [Law and Kelton, 1991]. For example:

- Weibull

- LogLogistic
- Pearson type 5

These distributions were incorrect in that parameters were reversed thus giving incorrect distributions for the model. Consequently, modelers should never abdicate control to the automated software distribution vendor. Checking the model for correct distributions should be in all modelers vernacular. Of course, other distributions were translated correctly by vendor software. This issue has been noted in the past and has not been addressed properly by the distribution fitting software vendors.

Once the initial efforts were completed, the client decided to use the model at least twice quarterly. This ensures that the model does not go "stale." In addition, they will continue to receive added value through using the model on new topics. Consequently, it is necessary to update the model's data on an annual basis. With this model, that is a significant commitment since the data needed for the model is rather substantial.

Another lesson learned was in regards to working on the client site. It is important to take the team off site at certain points allowing the entire team to focus solely on the client needs. It's become apparent over numerous projects that when the team works entirely at the client site, the client can overly influence the focus and progress of the team. Being off site mitigates this opportunity allowing the team to focus on the deliverables and analysis. It's important that the data leads the team down the analysis path, not the client leading the team down a predetermined path with their individual outcomes in mind.

Flexibility in the project plan is another lesson learned. Project plans that do not account for "hiccups" in analysis, coding or other parts of the project can hurt teams in the end. Many modelers for instance only allow a few days for validation and verification or only a few more for analysis and experimentation. Allowing sufficient time for the team to follow the data and allow for adequate discovery does not allow the model to tell its story. Too often we just want to get the answer(s) and move on. The model, like a fine wine must be allowed to breathe and reveal its secrets to the team. This only happens when we give it adequate attention and explore all avenues. Models take considerable effort to build. Shortening analysis and experimentation is to be avoided at all costs.

While flexibility is good in many aspects of a project, building too much flexibility in the pre-processor can be hazardous to a model's health. Pre-processors (control panels) must be vigorously tested so that all possible outcomes are well understood by the designers. Designers have a responsibility to ensure clients that their analysis will not lead them down a "primrose path" to unsubstantiated results. It is better to limit pre-processor flexibility to known topics. On occasion it is even better to not even leave a model in the hands of a novice client without sufficient training or experience.

Transitioning a model to a client is a complex process at best. Only robust, well-proven models should be transitioned. Clients must be screened and have sufficient analytical experience to make this process a success. Allowing sufficient time for the training is also important.

Different client types require different types of preprocessors. For example, a model to be used by a sales force is of a much higher level (and less flexibility) than a model to be used by an analysis team of engineers or experienced modelers. Each pre-processor must be custom fit to its particular clientele.

One lesson learned is to prepare the client for data/information gathering in advance of the on-site simulation team. This can be accomplished in numerous manners. One way is to prepare a data collection inventory listing all data needs, the responsible party and current status. Another mitigation strategy is to give the client a generic flow process chart for their review and comparison. All this information can be reviewed during conference calls before the first site visit.

REFERENCES

Law, A.M. and W.D. Kelton, *Simulation Modeling and Analysis*, McGraw-Hill, New York, NY, 1991.

Nance, R.E and R.G. Sargent. 2002. Perspectives on the Evolution of Simulation. *Operations Research*, Vol. 50, No. 1, pp 161-172.

Ferrin, D., M. Miller, and G. Giron. 2000. Electronic Workflow For Transaction-Based Work Cells In A Financial Services Firm. In *Proceedings of the 2000 Winter Simulation Conference*, ed J.A. Joines, R.R. Barton, K. Kang, P.A. Fishwick.

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