



The Simulation Games

by Monica Elliott

ENGINEERS ARE USING SIMULATION MODELING TO PLAN VENUES, ENSURE
SECURITY, AND INCREASE EFFICIENCY FOR THE 2002 WINTER OLYMPICS
AND PARALYMPICS IN SALT LAKE CITY

Industrial engineers are people of many talents.

But a hazard of their profession is that for their many titles and achievements, their identity as industrial engineers often remains unrecognized. Consequently, the realm of their influence often remains unrecognized, too.

But even though industrial engineers are often hidden from public view, their work offers opportunities and variety that few professions enjoy.

Addressing material handling concerns, relieving the chaos of logistical jungles, and increasing the economic efficiency of processes are all in a day's work for many IEs. And the 2002 Winter Olympics and Paralympics in Salt Lake City in February and March are providing the very challenges that IEs are trained to conquer.

Wherever there's a process, there are industrial engineers hard at work making that process better. The Salt Lake Organizing Committee (SLOC) is using one of industrial engineering's signature tools to tackle venue planning and development for the Games: simulation software.

Value of simulation

Simulation is about seeing before being — a tool that paints a picture of a process or problem showing the consequences of a number of possibilities. Such technology seems naturally invaluable to planning such a massive undertaking as the Olympics, so it is somewhat surprising that SLOC is the first Olympic organizing committee to make use of it.

SLOC used simulation software to model everything from spectator flows to security measures to transportation concerns. So suited is that tool to the Olympic planning process that it was used to plot the movement of spectators as they parked their cars at park-and-ride stations, boarded shuttle buses that would take them to a venue, departed the buses at the venue, walked to the venue, passed through metal detectors and security searches, and found their assigned seats.

Grant Thomas is SLOC's senior vice president for venues. He is responsible for venue development, transportation, environment, and material/logistics. He recognized early in the process that the magnitude and complexity of such a project called for some sophisticated planning. Of the 20 major Olympic venues, there are 10 competition arenas, all of which have to be filled and emptied in the safest and timeliest manner. SLOC hired Promodel Corp., a provider of simulation software and consulting, to model seven of the ten competition venues as well as security and downtown Salt Lake City.

The simulation work began in the summer of 2000. Jeff Leavy, a Promodel consultant who was instrumental in managing the project, asserts, "For each event and each venue, [SLOC] basically set out a goal that they wanted to achieve for maximum waiting time in the [security] queues or lines and the maximum time for them to empty the venue after the event."

SLOC had to know how much time is required to empty an arena in order to give the next round of spectators enough time to fill the arena for the next event. According to Leavy, SLOC could ask, "If there is a competition from 10 a.m. to 12 p.m. at the Snowbasin venue, and there is another competition at 2 p.m., what do we have to do as far as bus service, number of bus stalls, queuing people in the lines, etc., in order to empty and fill that venue in two hours?" And simulation would provide the answer.



A COMPETITOR SKATES AT THE WORLD SINGLE DISTANCE SPEED SKATING CHAMPIONSHIPS IN THE UTAH OLYMPIC OVAL LAST MARCH.

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Protecting the masses

Due to the historical and international significance of the Olympic Games, it is a foregone conclusion that security is the highest priority for the organizing committee. The current war on terrorism has brought a heightened sense of awareness of security needs at the 2002 Games. But as evidenced by the tragic bombing at the 1996 Summer Olympics in Atlanta, terrorism is a threat regardless of the current state of international relations. Simulation modeling has enabled SLOC to see how security can be maintained without slowing spectator movement to a crawl.

Industrial engineers have been involved with Olympic emergency and security upgrades since the Sept. 11 attacks on America. They have been able to apply new contingencies and scenarios to the simulation models that had already been developed for the Games. "A lot of that work was done independent of and well before the incident at the World Trade Center. So basically for us, we've had all the information to be able to make evaluations on adjustments and changes we might make," says Thomas.

Despite the fact that the park-and-ride lots are located some distance from the venues and few vehicles other than the shuttle buses will be allowed near the venues, vehicle checks will be commonplace during the Games. According to Thomas, even though the Utah Olympic Public Safety Command is responsible for screening accredited and permitted vehicles to make sure there are no prohibited items on board, simulation enters the picture because the security screening process cannot be allowed to inhibit transportation flow. He says modeling has been taking place to gauge

spectator throughputs under various security processes.

Although the number of vehicles near the venues is small, the distance between the park-and-ride lots and the venues does present a potential security problem. Case in point: the Snowbasin venue, site of the women's and men's downhill events. "Snowbasin ... was particularly of interest to SLOC because not only was it a high-profile event where they're going to get quite a few people, but the distance from the park-and-ride to the venue in one case was over 20 miles," says Leavy.

A chief concern was where to locate security for the event. Once shuttles arrived at Snowbasin, people who had not yet gone through security screening would be fairly close to the grandstand, under the original plan. So the whole scenario was re-modeled with security stations at the remote park-and-ride lots, about 27 miles from the Snowbasin venue.

The primary line of defense at the security stations is what's known as the "mag and bag check," named for the magnetometers that scan every spectator for metal objects and the manual bag checks. It's very much like the security process in American airports. "We were able to make the model flexible enough so that they could change the staffing configurations and test out different configurations for their metal detection," said Leavy.

As a baseline requirement for each magnetometer, SLOC assigned one line marshal (who guides people into lines), and one pacer (who keeps the lines moving steadily through the magnetometers). Also stationed at the venue entrance are bag checkers, magnetometer operators, and a person known as a wanderer, who uses

a remote metal detection wand on spectators who fail the magnetometer. People who fail the magnetometer are taken to a nearby area to be scanned with the wand.

With the baseline staffing configuration in place, SLOC staffers can alter any number of variables — get rid of a line marshall, increase the security, increase the number of bag checkers — to determine the effect it will have on the timeliness of spectator flows. "One of the beauties of the modeling is that you can go in and change the parameters and run it as many times and as many different ways as you want to, and we've been able to do that. If loading time changes, input capacities at the mags change — all of those elements are in the model — we simply change the parameters and run it again and see what it tells us," says Thomas.

Bodies in motion

SLOC developed a general transportation plan with federal, state, and local authorities for traffic throughout the venues, the University of Utah campus, and the city of Salt Lake and surrounding areas. The group had to account for the transportation needs of approximately 3,500 athletes; 9,000 media representatives; 7,500 sponsors; 20,000 staff and volunteers; and 1.7 million spectators.

Thomas explains, "We've done a number of transportation models for roadways and highways. We've gone through and used simulation modeling to model all the traffic on the main corridors and highways that will serve the Olympics. And as we get additional information from our ticket holders and spectators, we continually update and adjust those models."

In addition to being able to anticipate traffic concerns on the highways, SLOC had to consider how to transport pedestrians throughout the Olympic theatre to minimize congestion. As any city planner can tell you, the easiest way to reduce traffic is to reduce the number of cars.

The park-and-ride lots serve this purpose, allowing spectators to park their cars a sufficient distance away from the competition venues and ride shuttle buses to the events. This plays into the industrial engineering mantra of promoting efficiency through material (or in this case people) handling — getting the most people to the venue in the least amount of time and expending the fewest resources.

On a visit to the Utah Olympic Park venue in the fall of 2000, Leavy and his staff walked the path spectators would use to get to the venue. It was a long, arduous trek — all uphill. It took a minimum of 25 minutes, and that was from the shortest origin point and with a clear path. Perish the thought

Olympic

COMPETITION VENUES

Deer Valley Resort

Park City, Utah

- Freestyle aerials
- Freestyle moguls
- Slalom

E Center

West Valley City, Utah

- Ice hockey

Ice Sheet at Ogden

Ogden, Utah

- Curling

Park City Mountain Resort

Park City, Utah

- Snowboarding parallel
- Snowboarding halfpipe
- Giant slalom

The Peaks Ice Arena

Provo, Utah

- Ice hockey

Rice-Eccles Olympic Stadium

University of Utah, Salt Lake City

- Opening and closing ceremonies

Salt Lake Ice Center

Salt Lake City, Utah

- Figure skating
- Short-track speed skating



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The Olympic Village, located on the University of Utah's campus, will house athletes, coaches, and officials of the 2002 Games.

Snowbasin Ski Area

Wasatch-Cache

National Forest, Utah

- Downhill skiing
- Combined downhill/slalom skiing
- Super-G

Soldier Hollow

Soldier Hollow, Utah

- Biathlon
- Cross-country skiing
- Nordic combined

Utah Olympic Oval

Kearns, Utah

- Speed skating

Utah Olympic Park

Park City, Utah

- Bobsleigh
- Luge, skeleton
- Ski jumping
- Nordic combined



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University

PROVIDES A COMPETING HOME

What is a university to do when it learns a massive undertaking such as the Olympic Games will be sweeping through its campus for more than a month? Engage in one of the biggest facilities planning projects it has ever tackled. The University of Utah in Salt Lake City will house athletes, coaches, and officials in the Olympic Village, a large project that entailed both renovating standing facilities and constructing 21 new buildings. The University's Rice-Eccles Stadium will serve as the site of the opening and closing ceremonies for the Games.

Other than the computer-aided design software used by architects constructing and renovating buildings for the housing project, no software was used by the facilities planning team, which was headed by the University's director of facilities planning, M. Anne Racer. The team addressed its material handling, transportation, parking, and budgeting issues with value engineering and a lot of common sense.

Competing home away from home

Where do you place nearly 3,500 athletes when they are not practicing or competing? Start with the obvious and build the rest. The university has

spent two years restoring its student-housing complex, Heritage Commons, which is located on historic Fort Douglas, a 138-year-old U.S. military installation. For their efforts, the university was honored with a 2001 National Trust Preservation Award. In addition to that landmark renovation, 21 new low-rise apartment and suite-style units were built for student housing and Olympic athlete use on the campus.

The university's housing preparations have been predicated on its own student housing needs, not on the fact that the Olympics were coming, points out Racer. There are approximately 2,500 student beds and 3,500 Olympic athlete beds available in the complex. The students have been living in the facilities for a year.

One material handling issue facing the school is moving student furniture out of the rooms and bringing in furniture for the athletes, which will be accomplished with labeled, standardized boxes and a staff of 45 movers. Another was how to feed all those athletes. A new dining facility was constructed with a loading dock on the first floor and the kitchen on the second floor. Dan Adams, assistant vice president of student affairs, explains that it requires just-in-time management to get the food from the loading dock to the kitchen and put away. The cafeteria is designed in the marché-style — like an open market — as a time saving and quality measure. Common throughout Canada and Europe, this style of food service provides fresh food, prepared to order directly in front of the customer, in a short amount of time.

The accommodations at Heritage Commons were designed to accommodate Paralympic athletes, which was not a problem because the buildings had to meet the Americans with Disabilities Act requirements.

"We designed the entire site to be ADA-friendly, and that's already had payoffs for us as a university because of the kind of students we're now able to attract. As far as the building, they all have elevators, which has really facilitated movement throughout the complex. There isn't a pathway in that roughly 80 acres that you have to use a stair," according to John Huish, director of campus design and construction.

A pedestrian-only suspension bridge connects Heritage Commons to the main campus of the University, crossing over a six-lane highway. "If we have a six-lane highway that separates Heritage Commons from main campus, it's absolutely crit-

ical to have this pedestrian bridge, not only for convenience and safety, but to truly integrate the two sides of the campus together as one," says Racer.

Getting around

Parking and transportation concerns abound at the university, but Racer and her staff have worked with university officials and transportation services as well as the Utah Transit Authority to ensure smooth flows. In fact, says Racer, the amount of traffic the university sees will be lower than usual for a number of reasons.

The university has had a shuttle system in place for many years for students, and it has established

The team addressed its material handling, transportation, parking, and budgeting issues with value engineering and a lot of common sense.

various alternatives to single drivers trying to get around in their cars, including a light rail system that runs through the campus on a north/south line. The university is currently constructing additional lines that will run throughout the campus.

"Our availability of parking is becoming more and more challenging," Racer notes. "The shuttle system has been an absolute salvation in the past 12 to 15 years it's been used. The integration of our shuttle system, bicycles, major pathways, carpooling, the use of the buses, and now light rail — we're doing just about everything that we possibly can to encourage people to use alternative transportation to really coordinate all of the transportation on campus."

A primary reason for the decrease in traffic is that the University rescheduled its spring break to three weeks in February instead of the traditional break in March. About 12,000 university staff members will remain on campus during that time, instead of the usual 38,000 to 39,000 population of staff and students.

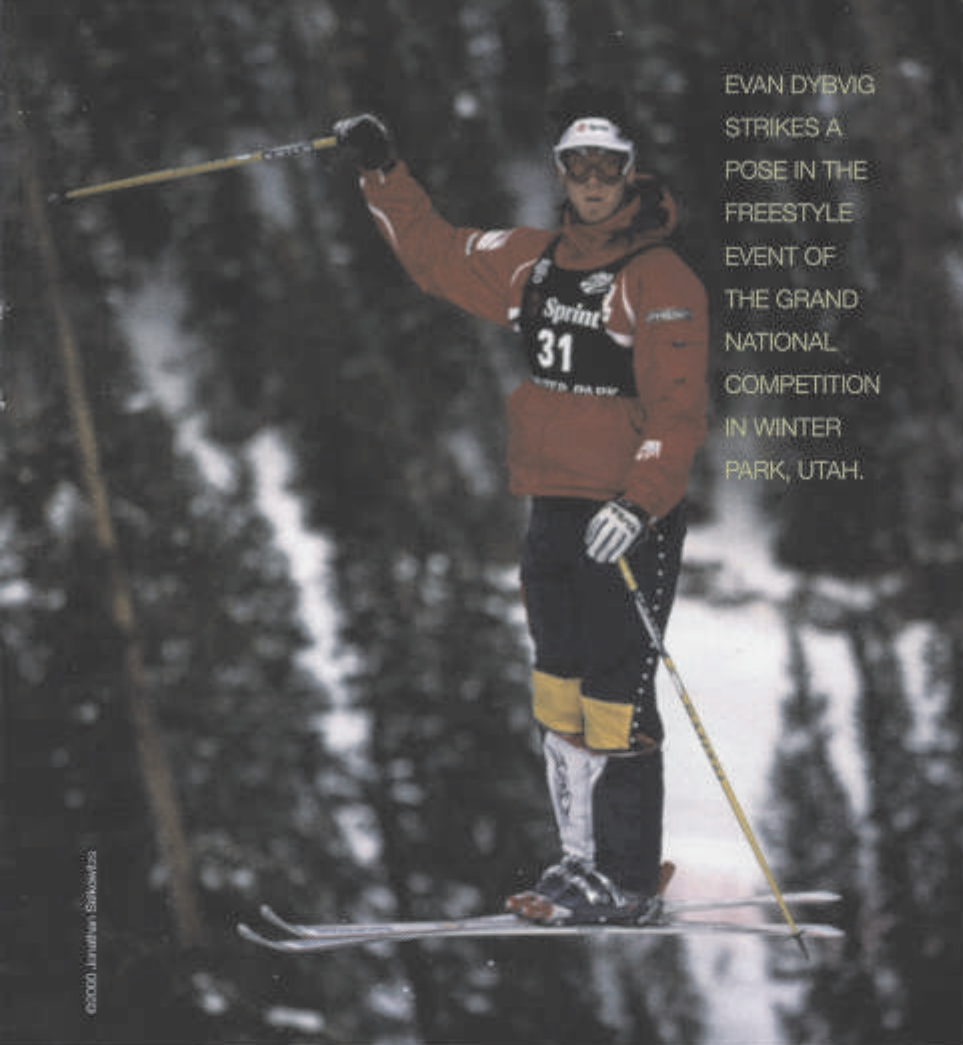
Baseball bats to the budget

Huish notes that the budget for this massive under-



Photo courtesy University of Utah

An easy way to get from Heritage Commons, part of the Olympic Village, to the main campus of the University of Utah is by taking this stylish, pedestrian-only bridge. It certainly beats trying to cross the six-lane highway that runs beneath it.



EVAN DYBVIK
STRIKES A
POSE IN THE
FREESTYLE
EVENT OF
THE GRAND
NATIONAL
COMPETITION
IN WINTER
PARK, UTAH.

©2000 Jonathan Siskowitz

taking was tackled with value engineering on one end of the spectrum and a baseball bat on the other. Though it's clear he is joking, it's also clear he may have needed that baseball bat at times. "At the different stages of development of the project — schematic and design development stages — we hold value engineering sessions dividing into teams for peer review of the design team's work. Cost cutting isn't necessarily so much our issue at the university, though. We're really after quality issues and particularly sustainable and maintainable construction," Huish says.

For Adams, value engineering consisted of things like making sure the right kinds of windows were used so the cranks on them worked and the paint didn't crack. The maintenance staff had standards for the design elements of the buildings. To facilitate this, Huish's office prepared a design guide for consultants.

"Of course, we insist on good budget presentations in those value management sessions, and if it's apparent that there are budget problems, then the university as well as the 'cold team' reviewers — the peer reviewers — will go to work on that budget and do some actual value engineering cost cutting in propos-

ing alternatives for design teams to use to get the project down in cost," Huish explains.

Racer adds that the costs of the project were the sole responsibility of the university. "There is a misconception that is accepted broadly — incorrectly — that the Olympics are paying for these facilities. It's a \$120 million project for the new facilities only. The renovation of the historic buildings is all being done through private funding. The \$120 million for the new construction is being paid from university funds, not state funds. SLOC is contributing \$28 million within a lease agreement to use the facilities for the period of time they need," Racer explains. SLOC is also leasing the Rice-Eccles Stadium for \$8 million for the period of the games.

There was a budget for each of the building sites, which included five neighborhoods plus guest homes. "It was really a collaborative effort. There were days when we didn't like one another, but we also understood the ultimate goal of what we were trying to accomplish and that was to build the most dynamic facility that we could come up with under the budget constraints that we had facing us," says Huish.

of severe winter weather conditions.

Leavy says he and his team collected data ("You know, the industrial engineering time studies kind of thing") and after studying the problem, they convinced SLOC to provide some additional shuttle buses for spectators who would find the walk too challenging — people of ill health or advanced age. The simulation team did further studies to determine the number of shuttle buses needed given a certain percentage of spectators who would request the service. After reviewing all the data, SLOC decided to provide shuttle buses for all spectators, eliminating the walk. A contributing factor in the decision was the pre-existence of a shuttle bus loop with a drop-off point near the venue.

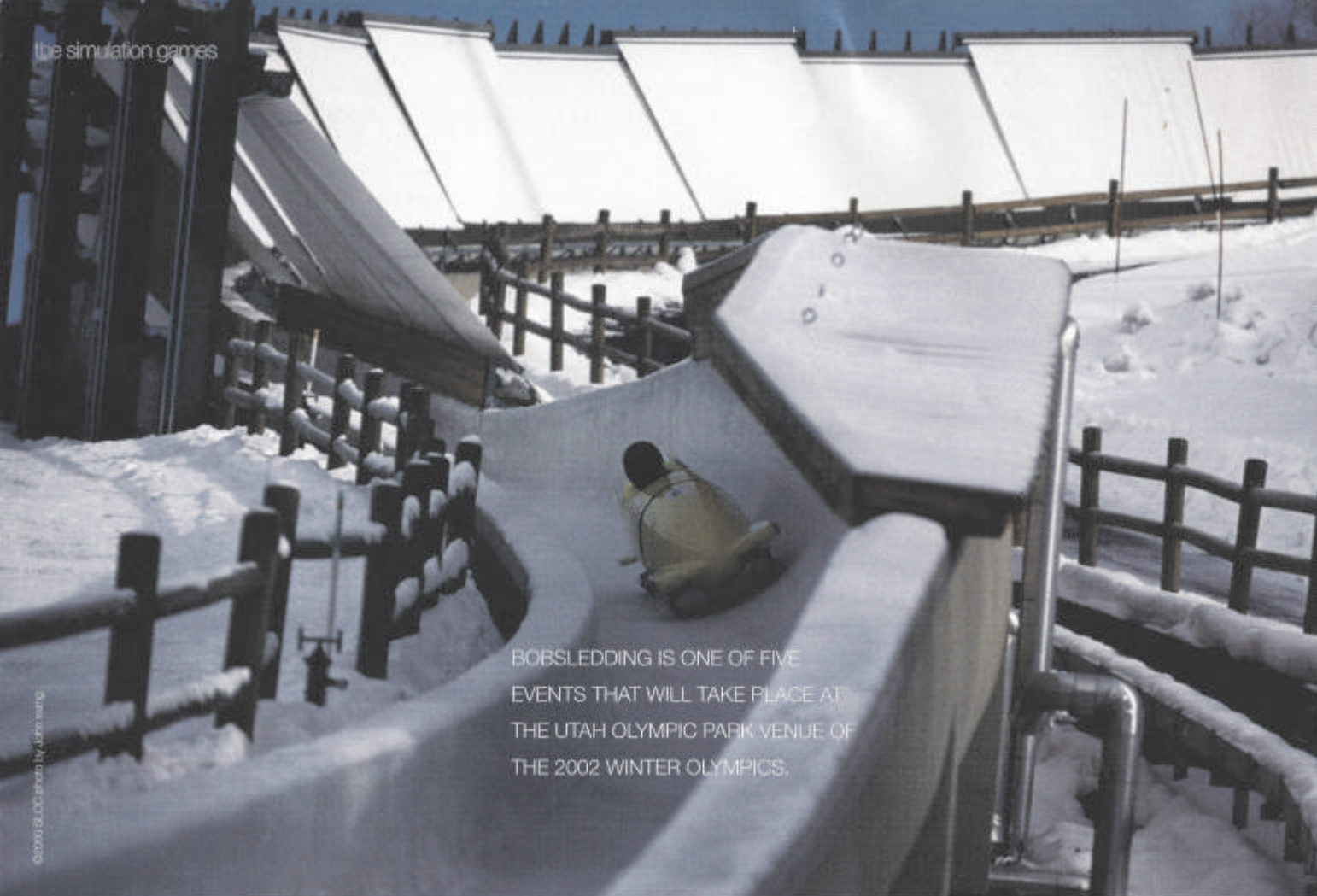
Let it snow

Although simulation software cannot predict the weather, it can help people prepare for it. The simulation team put weather factors into the Snowbasin venue model to determine how inclement weather would affect the more than 20-mile run from the park-and-ride lot to the venue.

"Before the simulation was run, we'd have them [SLOC] choose and set different parameters, one of which was the weather factor," explains Leavy. "They could pick it as good weather, bad weather, blizzard, or whatever. And that would affect the average travel time between the park-and-rides and the venue, which would affect the loading of the venues."

If it would take an hour and a half to transport all the spectators in good weather, perhaps it would take an hour longer in bad weather. Having this information in advance enables SLOC to issue advisories to the general public about when they should arrive at a venue and what to wear.

This is not only critical for the winter games, but for the summer games as well. In the 1904 Olympics, having only one water station 12 miles into the racing competition caused one American athlete to collapse from a stomach hemorrhage in the brutal heat of St. Louis. Another athlete dropped out nine miles into the race from exhaustion. A hallmark of industrial engineering training is common sense, a valuable tool for anyone.



BOBSLEDDING IS ONE OF FIVE EVENTS THAT WILL TAKE PLACE AT THE UTAH OLYMPIC PARK VENUE OF THE 2002 WINTER OLYMPICS.

©2002 SLOC photo by John Wang

Money always an object

Saving money is sometimes the goal of industrial engineering, but more often it is the consequence of making processes more efficient. The latter was the case when simulationists examined various ways to load the shuttle buses. Instead of having bus stalls that were lined up behind one another at a curb, the simulation team determined that a double stall or two rows of buses would be faster. According to Leavy, they also determined that the buses should move together at the same time — as a train with many

cars — to make the process more efficient. As any industrial engineer or lean management guru knows, you don't have to increase capacity to enhance throughput.

"What we determined was that in some cases they didn't need to increase the number of buses in order to get the people there on time and unloaded on time. What they needed to do is have good traffic control. So that'll help them in planning and having people guide the buses at the venue — kind of like the people that guide airplanes into their gates," notes Leavy.

The economics of pulling off the Olympics are astounding. Thomas tallies the design and construction bill alone at \$500 million for the 20 major venues, including temporary and permanent facilities, and the roads, highways, park-and-rides, and operational projects. Anything that could reduce the amount of new construction in favor of implementing hidden efficiencies was a welcomed idea.

The quiet winter wonderland known as Salt Lake City will soon be inundated with athletes, coaches, and spectators — most of whom know little or nothing about industrial engineering. But having applied some tools of industrial engineering, SLOC is ready to impress all visitors with its production of the Olympic Games. Perhaps more importantly, it is equipped to handle any number of contingencies relating to security, material handling, and spectator flow. And what makes them think they're so prepared? The fact that they have seen it all before — through simulation.

Monica Elliott is staff writer for *IIE Solutions* and *Industrial Management* magazines.

Enormous PROPORTIONS

Attending the 2002 Winter Olympics and Paralympics:

- 3,500 athletes
- 9,000 media representatives
- 7,500 sponsors
- 20,000 staff and volunteers
- 1.7 million spectators

Source: Salt Lake Organizing Committee



Sean Becker is a member of the New Zealand Curling Team that will compete at the 2002 Games.

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