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A SPECIAL MODERN MATERIALS HANDLING SUPPLEMENT

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Planning Guidelines for Manufacturing, Warehousing and Distribution

Materials handling STUDENT DESIGN COMPETITION

An exclusive look at the top five winning designs of 2001-2002

- INTERVIEWS
- FACILITY LAYOUTS
- DESIGN TRADE-OFFS
- EQUIPMENT

CONDUCTED BY: MODERN Materials Handling — PRODUCTIVITY SOLUTIONS FOR MANUFACTURING, WAREHOUSING & DISTRIBUTION

CICMHE COLLEGE-INDUSTRY COUNCIL ON MATERIAL HANDLING EDUCATION

A SPECIAL MODERN MATERIALS HANDLING SUPPLEMENT

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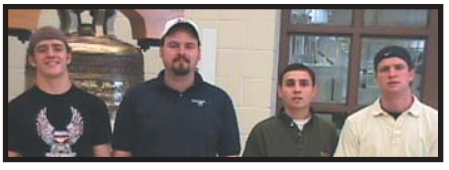
Planning Guidelines for Manufacturing, Warehousing and Distribution

NOVEMBER 2002

What's inside

First Place Winner:
VIRGINIA TECH



Second Place Winner:
PENN STATE UNIVERSITY

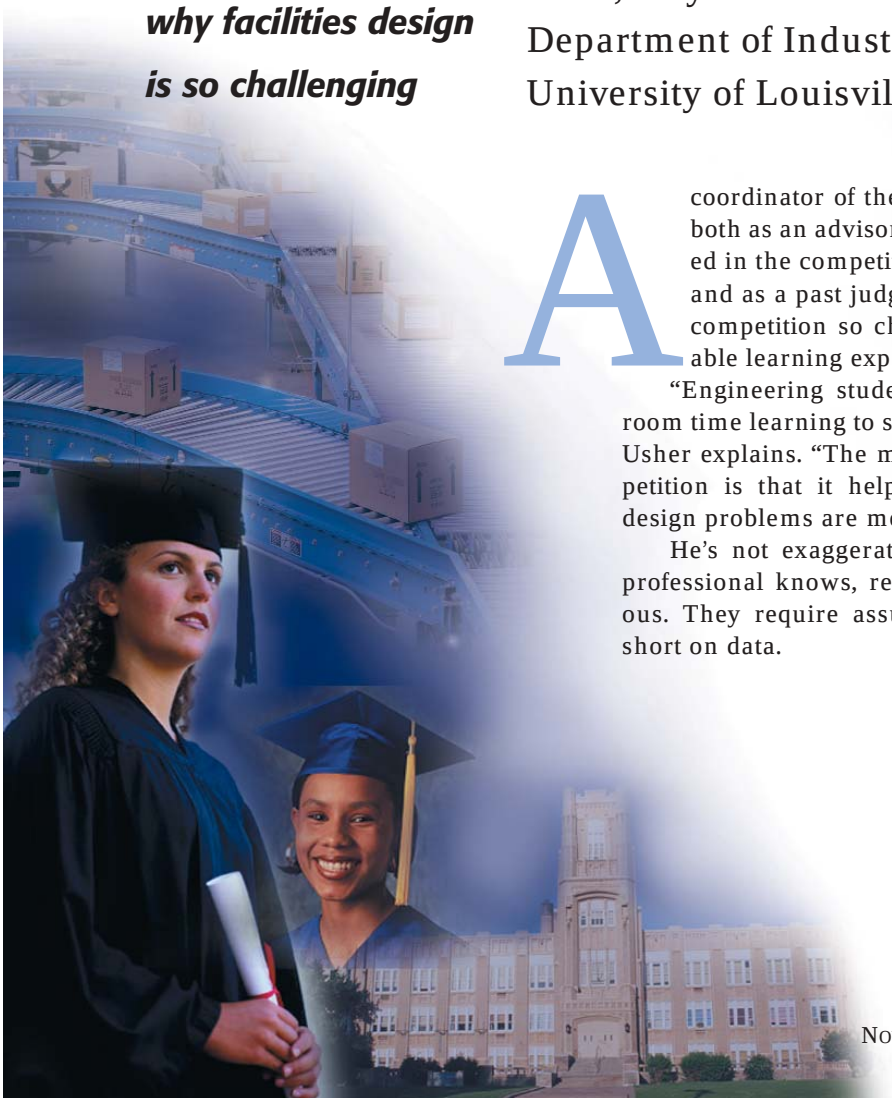
Third Place Winner:
UNIVERSITY OF FLORIDA

ONE PROBLEM, FIVE WAYS TO SOLVE IT: Asked to design a new facility for Sneaky Sneakers, an athletic shoe retailer experiencing rapid growth and a change in business, competing student teams from around the country take five completely different approaches to success.

Today's Engineering Students, *Tomorrow's* FACILITY designers

Diverse in their approach, the five winning entries of this year's Materials Handling Student Design Competition reveal just exactly why facilities design is so challenging

"One of the most challenging aspects of the Materials Handling Student Design Competition is that there is never an optimal design out there," says Professor John Usher, of the Department of Industrial Engineering at the University of Louisville. "Trade-offs abound."



A coordinator of the contest this year, Usher speaks both as an advisor to students who have participated in the competition (including a team this year), and as a past judge. Yet precisely what makes this competition so challenging also makes it a valuable learning experience for students.

"Engineering students spend much of their classroom time learning to solve problems out of a textbook," Usher explains. "The most powerful aspect of this competition is that it helps them realize that real-world design problems are messy."

He's not exaggerating. As any materials handling professional knows, real world problems are ambiguous. They require assumptions. And they are always short on data.

THE winners

A total of eleven teams submitted entries for the 2001-2002 Material Handling Student Design Competition. Here are the award winners:

First place: Virginia Tech
Second place: Penn State University
Third place: University of Florida
Honorable mention: Ohio University
Honorable mention: New Mexico University

THE sponsors

This year's Student Design Competition was made possible through the generous support of the following sponsors:

- **Modern Materials Handling DP&I Partners**
  Interlake Material Handling
  Nissan Forklift Corp.
  LINPAC Materials Handling
- **CIC/MHE – College-Industry Council on Material Handling Education**

THE judges

The following people—all with extensive experience in materials handling systems design—served as judges in this year's competition. Given the number of outstanding entries, they say choosing the winning designs was not an easy task.

Richard Lindeke, Professor
Department of Industrial Engineering
University of Minnesota

Mike Ogle
Director of Technical & Engineering Services
Material Handling Industry of America

Dale Atkins
Georgia Tech

Bryan Norman
University of Pittsburgh

John Yacka
Gross & Associates

Michael Romano
Abel Integrated Handling Solutions

Helping students gain some close to real-world experience is precisely the goal of the Materials Handling Student Design Competition, which was started by the College-Industry Council on Material Handling Education (CIC/MHE) in 1994. Since then, nearly 100 design teams have participated in the competition, coming up against such diverse challenges as improving the efficiency at a non-profit recycling center to developing a plan for fast food chains to handle an array of packaged flour products.

That real-world experience is invaluable, given that a fair percentage of participants in the competition go on to pursue careers designing distribution centers. Usher, for example, says that some 50% of the students in his program go to work for UPS.

This year, eleven teams from engineering schools across the country designed a new distribution center and devised a strategy for shoe retailer Sneaky Sneakers. They were assigned a case that resembles the kind of issues many real-world companies are experiencing today: An expected increase in business due to a plan to begin selling product to consumers directly over an Internet site (see the design challenge, below, for a detailed description).

Virginia Tech's Dr. Russell Meller, who was an advisor to the team who took home first prize this year, used the case as part of the curriculum for a facilities design and materials handling course he teaches. "It's a great experience for the students," he says. "It is also fascinating for me to see the thought process evolve. Although I must admit it's sometimes a struggle to not put in my two cents!"

As far as the actual judging, the criteria seem straightforward. Students are told that they will be judged on the effectiveness of product flow, equipment and space utilization, the operational plan, and overall integration. But determining what is number one out of five good entries is diabolically difficult, says Usher, who uses the cases himself in an undergraduate-level industrial engineering course.

"What I look for first and foremost is, 'If I were the person buying the system, did they sell me on their concept and do sufficient analysis to back it up?"

The winning entries this year all did just that. In the pages that follow, we take a look at the five top award winners—diverse in their approach to equipment selection, facility design, equipment investment, and operating costs. To put things into perspective, the capital equipment outlay ranged from under $1M to $8.5M—and that's just for starters!

The design challenge

SNEAKY SNEAKERS is a retailer that sells athletic shoes in its own stores. It currently operates retail 500 stores located primarily in shopping malls. Sneaky has recently launched a website and is now selling shoes direct to consumers. The company has outgrown its current facility and needs to design a new facility that will be able to handle both its retail and Internet businesses. (For a detailed description of the case, including design constraints and operational details, go to **http://contentconvergence.com/contest/home.htm.)**

Virginia Tech Student Design Team

Customer services rules at this winning facility design, with features like same-day delivery and attention to damage control

Kevin Ferguson, Rachel Luken, Rachel McGuire, Craig Morin

THE DETAILS...

- U-shaped flow of material is maintained with few exceptions throughout the facility, minimizing handling and length of travel path
- Pallet flow racks allow for faster picking times and quicker flow through for high-moving SKUs
- Separate picking areas for extremely fast-moving SKUs help expedite order fulfillment
- Internet catalog orders are handled in a parallel system, circumventing the sortation system for direct truck loading
- Pop-up skatewheel diverts on the sortation system ensure gentle handling of merchandise
- Automated dock levelers improve efficiency at the dock

"One of our main objectives was to provide the customer with the highest quality of service," says Student Rachel Anne McGuire. She points out that a major problem with the existing Sneaky Sneakers facility is the high level of merchandise damage that occurred during manual processing. "In fact, we determined that the longer the product stays in the warehouse, the more likely it is to sustain damage," McGuire emphasizes. The team opted for a semi-automated system, which they say strikes the appropriate balance between the need for quick handling and need to maintain product integrity.

The Material Flow

Incoming merchandise is palletized and transported to either static rack and pallet flow racks, or directly to forward picking depending on priority. Internet-catalog orders are picked from a forward picking location adjacent to the shipping dock. Picked orders for retail stores are placed on a sortation conveyor and sorted by order and location. Returned merchandise that passes quality inspection is sent directly to the forward picking area for repicking.

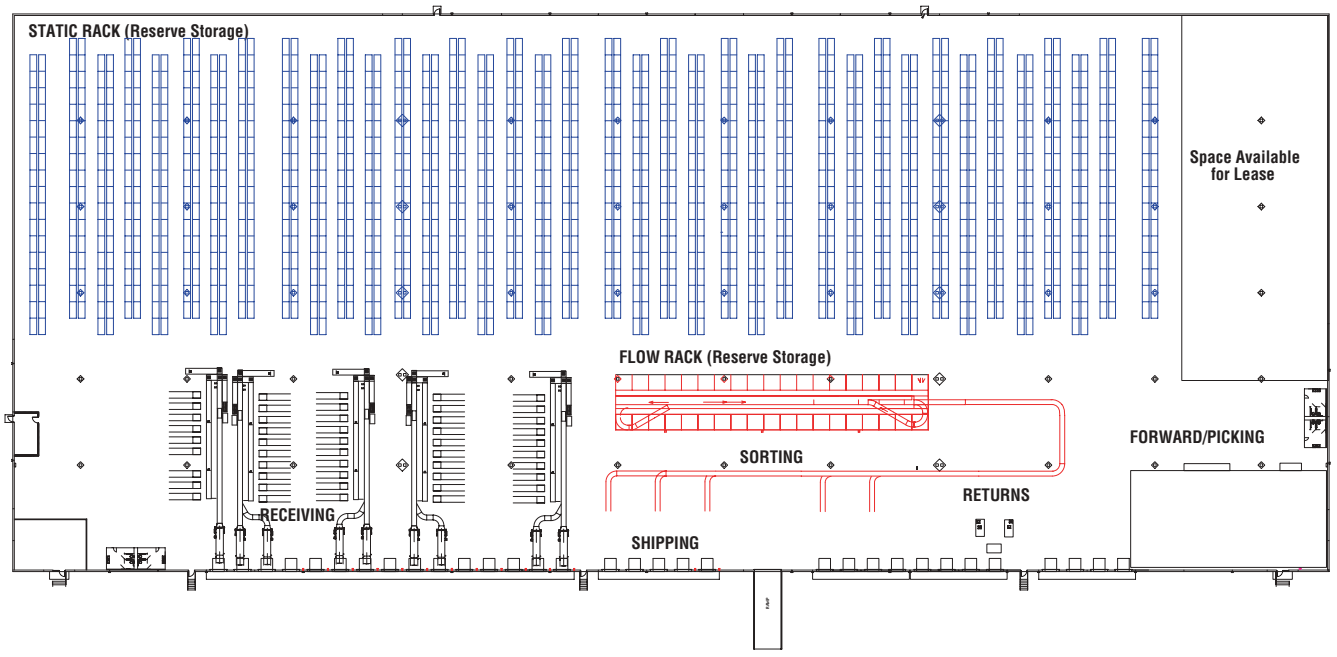
THE FACILITY STATS

Facility size (sq ft): 179,724
Capital investment cost: $2.4M
Annual facility operating cost: $5.4M
Number of employees: 81
Equipment employed: Automated sortation system with pop-up skatewheels, automated dock levelers, industrial trucks, static and flow racks, conveyor, bar code scanners
Noteworthy features: Same-day delivery, parallel flow for Internet catalog orders

THE TEAM

1st place

Kevin Ferguson
Rachel Luken
Rachel McGuire
Craig Morin
Student advisor: Dr. Russell Meller



FIRST PLACE WINNER

NISSAN FORKLIFT

NISSAN FORKLIFT CORPORATION, NORTH AMERICA

THE NISSAN INDUSTRIAL EQUIPMENT DIVISION of Nissan Motor Company Limited began manufacturing forklifts in Japan in 1957, and has been selling forklifts in the United States since 1965. In 1988, Nissan Industrial Equipment purchased Barrett Industrial Trucks, a manufacturer of industrial equipment in the Chicago, Illinois area since 1914. This purchase made Nissan the first Japanese company in North America to manufacture and distribute all five classes of industrial trucks. The first Nissan forklifts were assembled in Marengo, Illinois in May of 1988. From that small beginning thirteen years ago, Nissan has seen sales and production grow to over 15 times that first year's production number. In 1993, the consolidation of operations was completed in Marengo and a new corporation was formed, Nissan Forklift Corporation, North America, manufacturing the Nissan Forklift and Barrett Industrial Truck brands for distribution to the North American market, and export to other global markets.

Nissan Forklift Corporation employs 530 full time employees in their 400,000 sq. ft. facility. The Nissan facility in Marengo is the largest of three Nissan forklift production facilities in the world. Nissan's forklift operations have consistently posted operating profit for the company. Its Industrial Machinery Division employs 1,730 people in Japan, Europe, and the United States, and approximately 30,000 units were sold last year in more than 60 countries worldwide.

Nissan Forklift Corporation, North America is a full line supplier of engine powered forklifts, electric sit-down and stand-up riders, narrow aisle reach trucks, electric pallet trucks, electric tow tractors, electric walkie stackers, and manual pallet trucks in the Nissan and Barrett Industrial Truck brands. Both products are sold and serviced through a North American dealer network with more than 140 locations.

Contact us at (815) 568-0061 or visit us on the Web at www.nissanforklift.com

Penn State University Student Design Team

A powerful warehouse management system and judicious use of automation lend this winning facility both efficiency and flexibility

Trever Murcko, John Rudy, Jarrod Sharpe, Chris Turnbill

THE DETAILS...

- Cross-docking expedites shipping and reduces the amount of storage space and equipment required
- Rack-mounted light displays in the forward picking area help expedite the picking process and minimize picking errors
- Elevated sortation system accommodates extra space required by conveyor pushers and frees up floorspace below
- Mezzanine-based picking system takes advantage of overhead space and accommodates additional pick faces
- Automated sortation system facilitates the replenishment of case flow racks for easy, localized order picking
- Light displays in pallet building area alert driver when a sufficient quantity of merchandise is ready to be palletized

"The large manual warehousing system that the current facility employs will not support the five-year increase in volume without large increases in manpower and space," says the Penn State Student Design Team. "In addition, tracking and sortation are run in a confusing manner that results in larger cycle times and low turnover." The team's proposed design is governed by a high-complexity WMS, which makes use of scanning and automatic sortation to route the expected increase volume of product efficiently and eliminates the need for an overflow warehouse.

The Material Flow

Incoming merchandise travels by conveyor directly from trucks to a forward picking or reserve storage area, or is cross-docked directly to an order-building area. High-volume pallet-loads are assigned to a dedicated location in pallet flow racks, all other SKUs are stored randomly in pallet racks. Cases travel by conveyor to flow racks in a mezzanined picking system. Picked items are placed on the sortation conveyor and diverted to the appropriate pallet building location, where orders are consolidated and palletized for shipment.

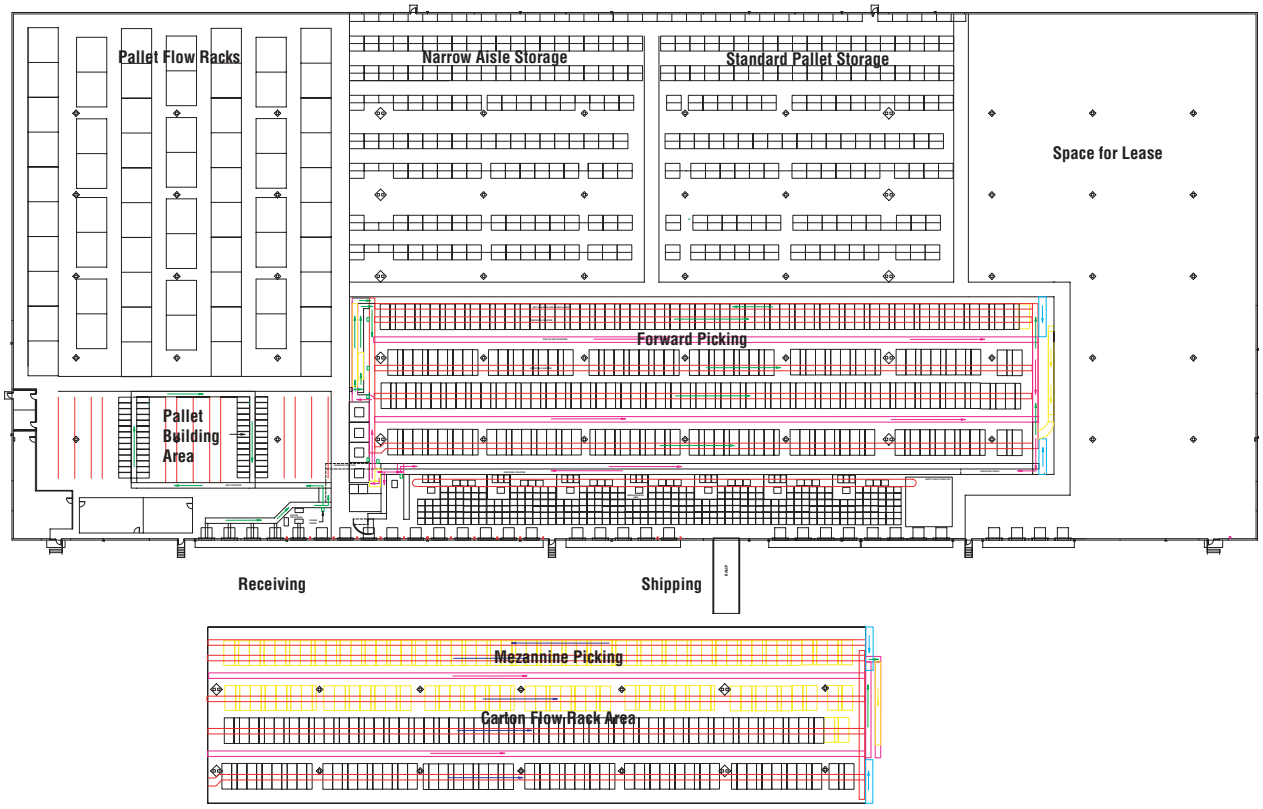
THE FACILITY STATS

Facility size (sq ft): 162,000
Capital investment cost: $8.6M
Annual facility operating cost: $4.8M
Number of employees: 66
Equipment employed: Conveyors, pallet and flow racks, industrial trucks, mechanical dock levelers, WMS
Noteworthy features: In-truck conveyor system at receiving dock, pick-to-light system in forward picking, use of FactoryPlan software for layout and design work

THE TEAM

2nd place

Trever Murcko
John Rudy
Jarrod Sharpe
Chris Turnbill
Student advisor: Dr. D.J. Medeiros



SECOND PLACE WINNER

LINPAC Materials Handling

ROPAK EXTENDED LENGTH CONTAINER WITH FOUR DROP DOORS HAS BEEN TESTED AND MEETS AIAG RC-9 PERFORMANCE STANDARDS

LINPAC Materials Handling's strong, durable ROPAK™ 64.5" Extended Length four drop door model has joined other ROPAK containers by being tested and meeting the Automotive Industry Action Group's (AIAG) RC-9 Returnable Container Performance Test Guidelines for bulk containers.

The testing, carried out by a certified third-party testing agency, validated the 64.5" x 48" container's ability to withstand the rigors of transportation and handling and meet AIAG's demanding qualifications.

The battery of tests, conducted over four days, included testing the container's strength against side impact, drop impact, vibration, compression and deflection of components when filled to capacity.

The AIAG, a globally recognized organization formed in 1982, continuously improves business processes and practices involving trading partners throughout the supply chain. Its container and packaging systems committee works to achieve consensus on common automotive industry rules for containers, including sizes, quality and testing procedures.

Designed with added strength and rigidity to accommodate long and hard-to-fit parts, such as automotive bumper reinforcements, plastic trim and air ducts, the long-lasting, durable ROPAK Extended Length containers protect and transport parts and products safely. The four drop door model has a latchless design and when opened, the lightweight doors lie flat against the outside of the container.

ROPAK Extended Length containers stack high, either upright or collapsed, to conserve floor space; withstand years of repeated wear and handling, and are easily recyclable at the end of their useful lives.

Contact us at (800) 442-4892 or visit our Web site at www.LinpacMH.com

Go to #169 at mmh.com/info

University of Florida Student Design Team

A hybrid design incorporating both traditional and automated materials handling equipment is key to this award winner's high accuracy and efficiency

Ashley Benedict, Robert Lunn, Shanna Goodson

THE DETAILS...

- Bi-directional horizontal carousels improve picking efficiency and increase order accuracy to more than 99%
- Creating pods consisting of multiple carousels eliminates operator wait time, improves picking throughput
- Use of narrow-aisle (seven high) pallet rack maximizes use of vertical space
- Single-deep pallet rack provides easy access to pick faces for inventory requiring only moderate depth
- Segregating stock by SKU activity level and order type optimizes picking efficiency and facilitates flow of orders through the facility
- WMS maintains tight control over inventory, order management, and physical flow of inventory

"To be able to manage future growth, Sneaky Sneakers needs a system that can handle a variety of SKUs and order types," says Student Ashley Benedict. "Our team looked at many materials handling techniques. The hybrid layout that we ultimately selected delivers the best trade-off in terms of cost versus benefits. Although the upfront cost is higher than a purely traditional system, it drastically reduces the number of employees required to process an order, and thereby reduces the chance of human error."

The Material Flow

Incoming merchandise is taken either to pallet racks (85% of stock) or directly to a forward picking area consisting of horizontal carousels. Inventory is segregated by activity level and by type of order—retail vs. Internet. Picked cases from carousels are placed onto live roller conveyor and transported to a queuing area for order consolidation and palletizing. Internet orders and low-quantity SKU picks are processed at workstations. Bar codes and a WMS are used to control all warehouse activities.

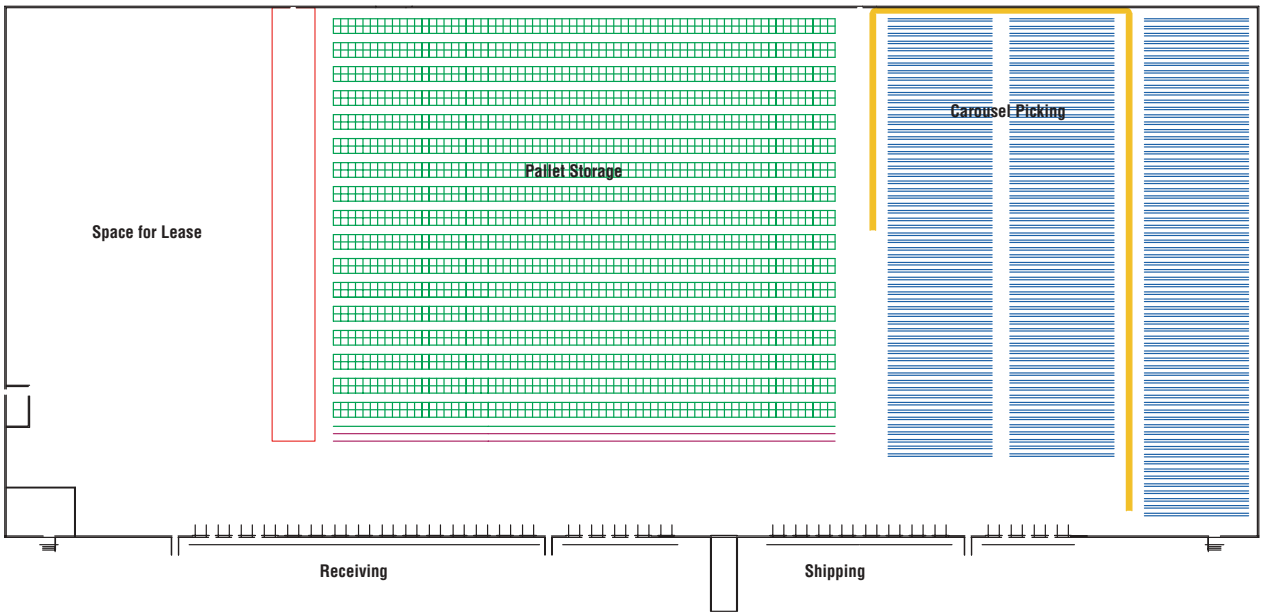
THE FACILITY STATS

Facility size (sq ft): 153,010
Capital investment cost: $5.5M
Annual facility operating cost: $2.4M (includes equipment payments)
Number of employees: 73
Equipment employed: Carousels, bar-code scanners, conveyors, industrial trucks, reusable bins, pallet rack
Noteworthy features: Use of horizontal carousels, narrow-aisle storage,

THE TEAM

3rd place

Ashley Benedict
Shanna Goodson
Robert Lunn
Student advisor: Hulya Emir



THIRD PLACE WINNER

Ohio University Student Design Team

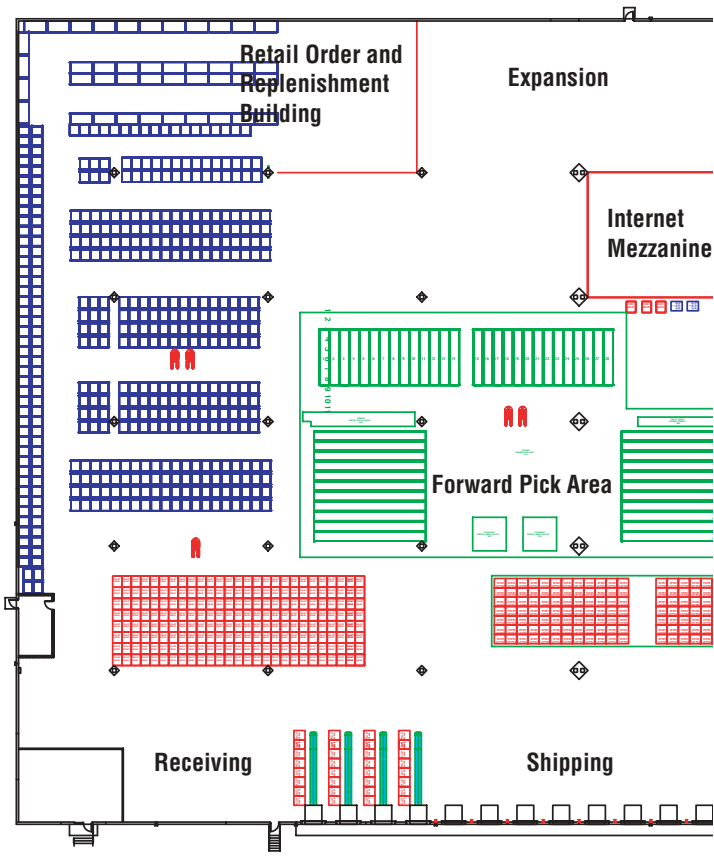
A space-saving design and reliance on proven materials handling equipment and techniques deliver a winning facility

THE TEAM

Rick Bornhorst
Mohamed Elhag
Brad Hollingsworth
Christina Snyder
Student advisor: Dr. Dale T. Masel

THE DETAILS...

- U-shaped flow of material is maintained with few exceptions throughout the facility, minimizing handling and length of travel path
- Flow rack is sized to accommodate depth of inventory required for a particular SKU, providing good access to inventory
- Pallet racks are arranged in a U-shaped configuration to minimize travel distance and maximize picks
- Reserve storage replenishment and putaway occurs on the outside of the pallet flow rack to avoid any interruption to picking
- Dedicating one lane to partial pallets awaiting completion frees up floorspace
- An additional bay and a half is reserved for expansion of the forward pick area to accommodate any increase in volume
- A WMS maintains tight control over inventory and material flow throughout the facility



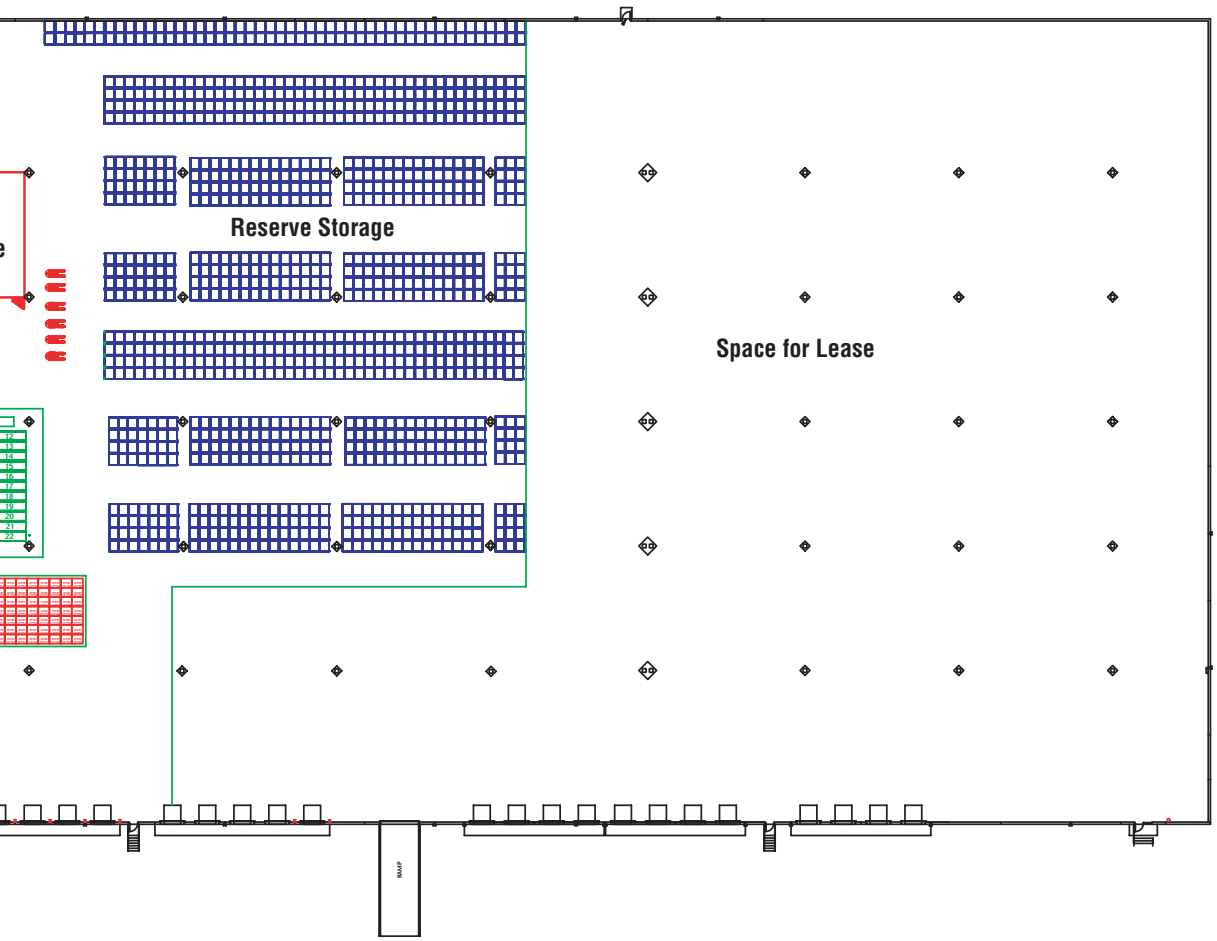
The Ohio University team came up with a successful design by focusing on the old 80/20 rule. "A small percentage of the SKUs accounted for approximately 75% of the order picking," explains Student Brad Hollingsworth. "By utilizing a forward/reserve system for storage and picking, we were able to consolidate those more popular SKUs into a small cubic area. This allowed for a higher throughput rate for filling orders, without the need for a high degree of automation."

The Material Flow

Cartons are unloaded using skatewheel conveyors and palletized. Pallets are transported to reserve storage, where they are assigned a storage location in either single or double deep pallet rack, depending on SKU activity level. The forward pick area consists of pallet flow rack for high-activity inventory–the 219 SKUs that make up 76.4% of the volume. Pickers palletize as they go. Internet orders and returns (estimated to make up only a small fraction of the business) are segregated in a parallel operation.

THE FACILITY STATS

Facility size (sq ft): 115,000
Capital investment cost: Approximately $384K plus WMS
Annual facility operating cost: $1.2M
Number of employees: 31
Equipment employed: Skatewheel conveyor, pallet rack, flow rack, storage shelving, industrial trucks, WMS
Noteworthy features: A focus on simplicity, proven handling techniques



HONORABLE MENTION

New Mexico State University Student Design Team

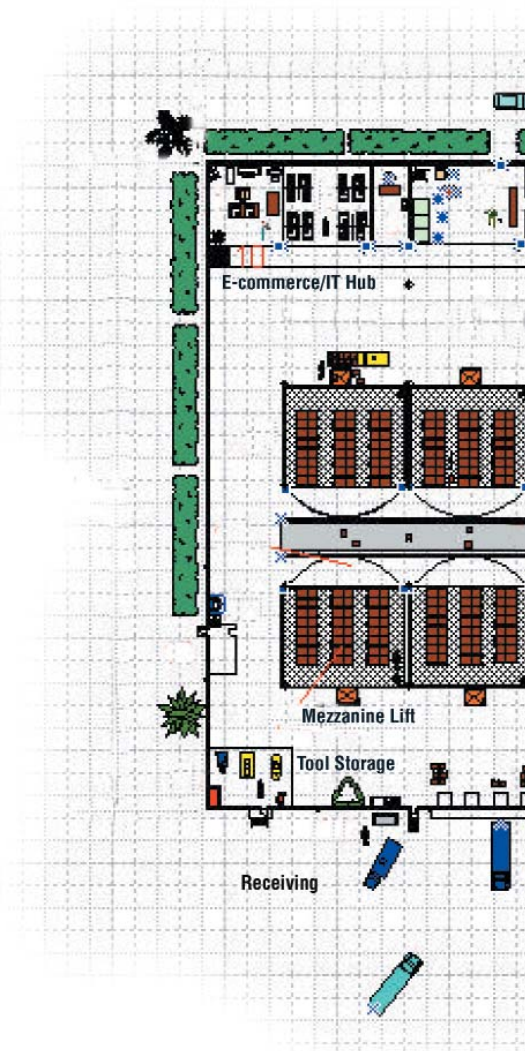
Skimping on space, this winning design relies on a multiple-level mezzanine and proven equipment to serve an industry in transition

THE TEAM

David Blacklock
David Embry
Victor Sanchez
Jorge Valadez
Student advisor: Dr. Linda Riley

THE DETAILS...

- The existing layout of the building was retained in order to minimize startup costs
- Large mezzanine employs existing columns as supports and effectively uses vertical air space
- Burden carriers, which transport cases to the two-level mezzanine center, have lower overall operational costs than conventional gas or propane utility vehicles
- SKUs are segregated by activity level to minimize travel distance, as well as bending and reaching motions
- "Case only" operation eliminates handling steps and need for different types of storage media
- Extensive use of bar codes helps maintain good control over operations, track orders and cases, and perform sortation



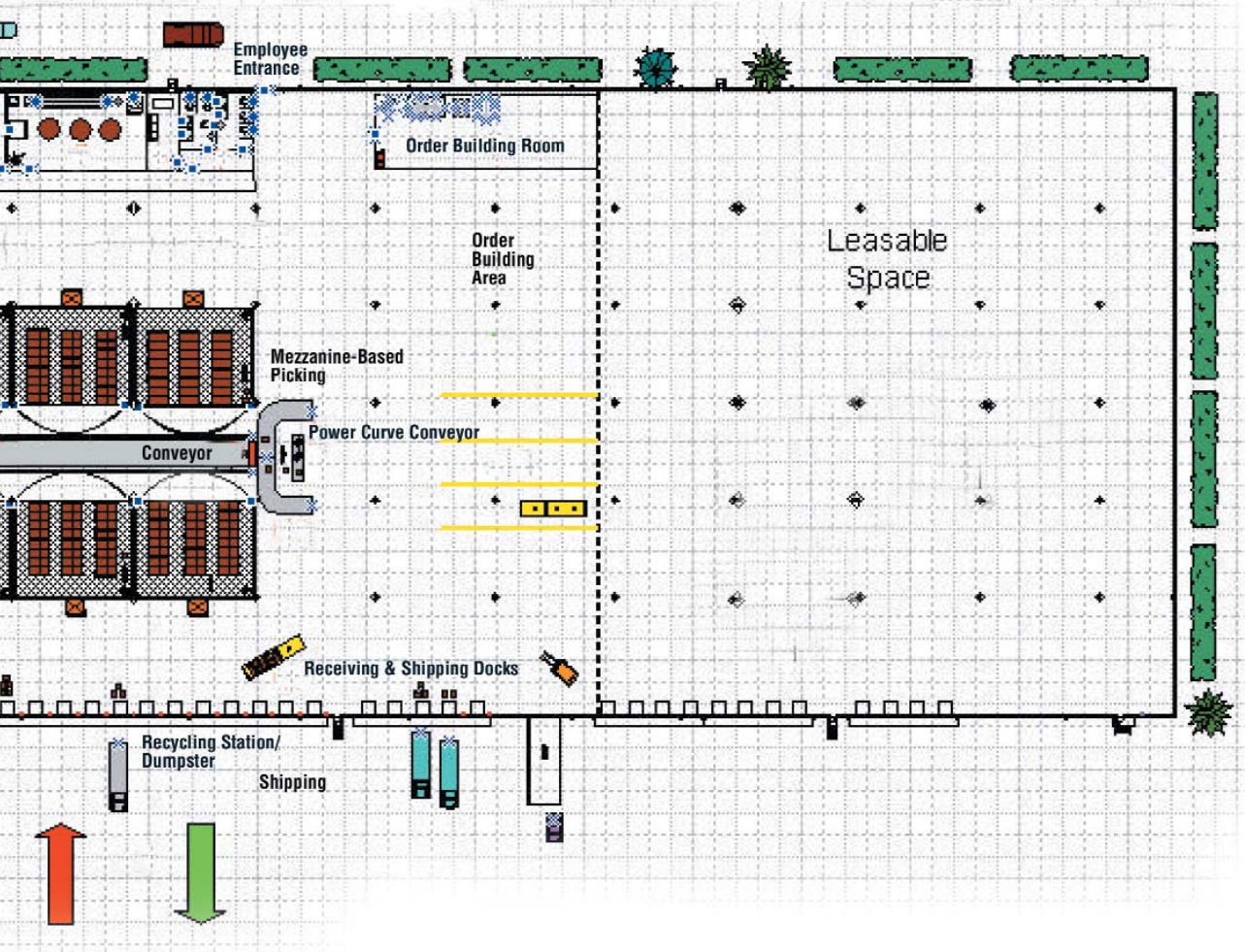
"For a number of years, the shoe industry has been experiencing reduced margins due to competition. These market dynamics were a key factor in our decision to minimize the amount of capital investment for the operation," says Student Victor Sanchez. The team's main objective was to develop a system that takes advantage of traditional equipment with a heavy reliance on information systems and technology. Since Sneaky has the option to lease out unused space, Sanchez says considerable effort was made to minimize the amount of floorspace utilized and collect rent on the rest.

THE FACILITY STATS

Facility size (sq ft): 121,256
Capital investment cost: $2.2M
Annual facility operating cost: $2.1M
Number of employees: 13 FT/22 PT
Equipment employed: Bar code scanners, computers, light displays, conveyor, mezzanine, carton flow rack, industrial trucks
Noteworthy features: Pallet-less handling, moderate floorspace requirements, use of Design Workshop 3D modeling tools

The Material Flow

Incoming merchandise is transported from the receiving dock via burden vehicles directly to the mezzanine picking center, where it is unloaded and placed onto carts. Cases are scanned and automatically assigned a storage location based on priority. Workers pick cases from racks onto carts, then transfer them to a conveyor belt that transports cases to a staging area. From here, cases are sorted off the conveyor onto a burden carrier and transported to the appropriate truck dock.



HONORABLE MENTION

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