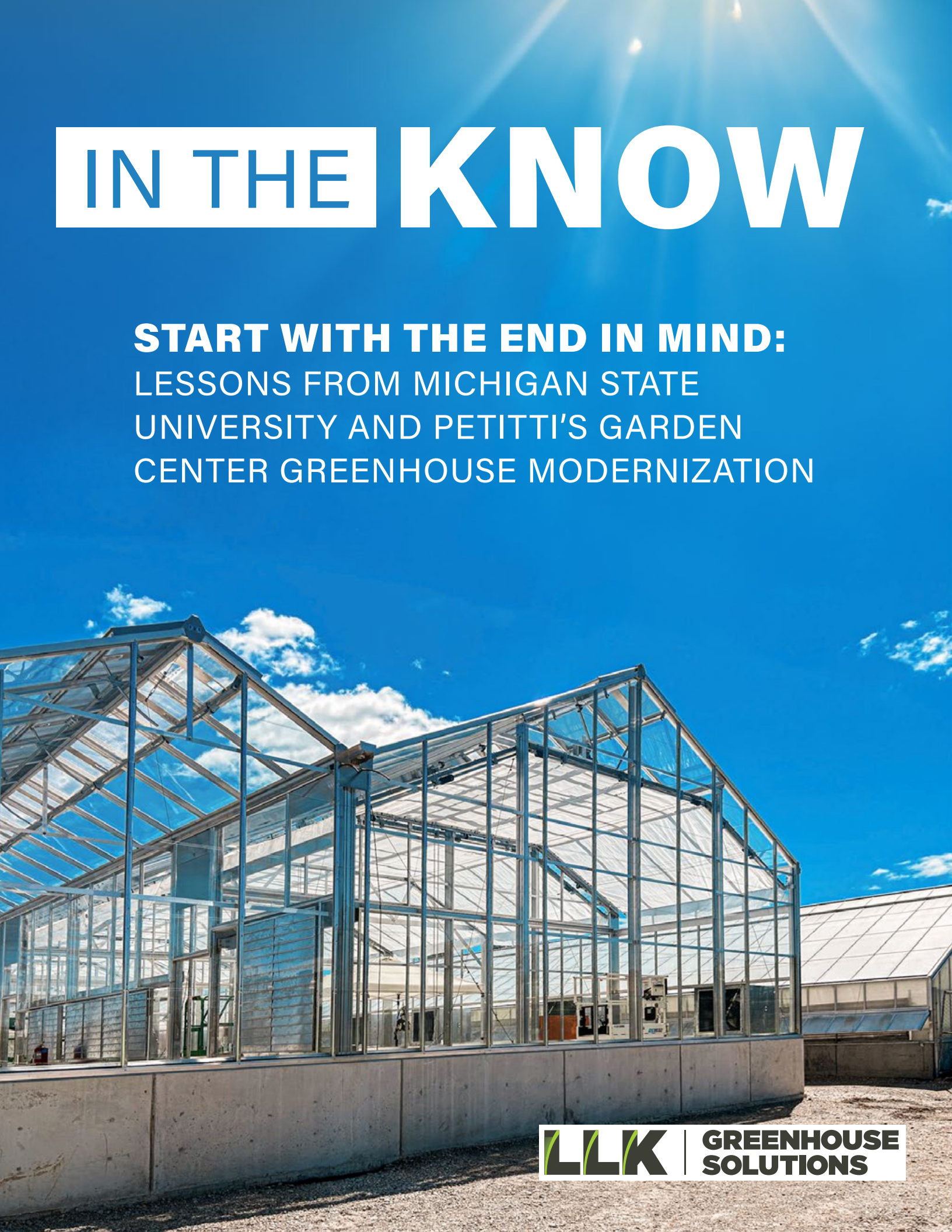
IN THE KNOW

START WITH THE END IN MIND:
LESSONS FROM MICHIGAN STATE UNIVERSITY AND PETITTI'S GARDEN CENTER GREENHOUSE MODERNIZATION



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90+ Years

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A MESSAGE FROM LLK GREENHOUSE SOLUTIONS

DESIGN WITH THE END IN MIND

Welcome—and thanks for your time. Whether you have met us at a Industry Tradeshow/event or are reading this on your own time, we're glad you found us. At LLK Greenhouse Solutions, we specialize in what happens long after the design and construction of your greenhouse. From commissioning and training to maintaining and long term renovation, our team stands ready to support your operation..

Greenhouse design is changing fast. Technology is smarter, regulatory demands are tighter, and expectations from researchers, growers, and investors have never been higher. But one thing hasn't changed: short-sighted planning still sinks good projects.

That's where we come in.

LLK is a design and infrastructure partner built for the long haul. We work with institutions, CEA innovators, and commercial growers to design and build greenhouses that adapt to what's next—not just what's now. Whether it's helping a land-grant university modernize a legacy research facility or guiding a commercial grower through long-term greenhouse strategy, our goal is the same: Our Customer's Success.

Our team is continuing to focus on solving critical Industry questions such as:

- How do we meet the project budget, while achieving end user requirements?
- How do we retrofit older systems with modern equipment/technology that compliments operations while providing ROI?
- How do we assess our current greenhouse operations while planning for future expansions?

You'll see those ideas in action in this edition's cover story, which dives into our work with Michigan State University—a multi-year, multi-phase greenhouse renovation and build project that's redefining what's possible in research-focused design. From hallway-only access to advanced climate control systems and smart zoning, the MSU project is a blueprint for long-term performance. And we're proud to have helped bring it to life.

We don't believe in one-size-fits-all design. Our experience as both designer and builders help us serve as your advocate, navigating peaks and valleys in supply/demand and negotiating the best deals on your behalf.

If you're thinking long-term—and want a team that designs, constructs and maintains greenhouses that way—let's talk. Visit us at www.llk-solutions.com, stop by our booth, call 440-236-8336 or email us at Info@llk-solutions.com.

We'd love to hear where you're headed.

—The LLK Team

PLAN YOUR WORK, WORK YOUR PLAN:
DECKER'S NURSERY GROVEPORT, OH

The start of every great project begins with devising a plan to meet goals and expectations. Executing the plan requires teamwork and cooperation between all parties involved to transform a vision into a finished product. At Decker's Nursery, LLK worked with owner Brian Decker and manufacturers to build a greenhouse that met all expectations while finishing ahead of schedule.

The key to maximizing productivity and staying within both the time frame and budget is communication and cohesiveness. Like a stool with three legs, LLK, Decker, and manufacturing worked together to create a foundation that kept the project upright. If one leg were to break or fail to work the same as the others, they all will follow.

Despite unset gravel and unideal padding conditions causing a month delayed start, LLK was able to collaborate with Decker to identify the proper sequence of events that propelled our team to finish ahead of schedule. By coming together to plan our work and work our plan, the two-acre project was completed with zero items on the final punch list.

"...THEY WORKED AS A COHESIVE UNIT AND FINISHED AHEAD OF SCHEDULE..."

Brian Decker

"From day one, the LLK team showed up ready to work their plan and executed it in an efficient and productive manner. The crew was respectful and adhered to all sanitation and housekeeping rules and procedures with no complaints. Due to clear communication and cooperation on site preparation, they worked as a cohesive unit and finished ahead of schedule even with near record rainfall and a weather induced start delay. They came out and did exactly what they said they would do, did it well, and had zero items on the final punch list. This attention to all detail in a two-acre project is rare in construction."

-Brian Decker, President, Decker's Nursery

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START WITH THE END IN MIND:
A GREENHOUSE DESIGN PLAYBOOK FOR SMART OPERATORS

Most greenhouse projects fail before the first beam is even installed. Not because of bad materials, poor construction, or even cost overruns—though those don't help. The real killer? Shortsighted planning.

As Sylvia Courtney, Vice President of Design at LLK, puts it: "It's very shortsighted if we start designing, especially on a site level with specific utility needs, and we're only thinking about today. We're not thinking about five years from now."

Translation: If you don't plan for the future, the future will hit you like a truck. And it'll cost you—big time.

Here's how to avoid that fate.

STEP 1:
STOP THINKING ABOUT TODAY—DESIGN FOR EXPANSION FROM DAY ONE

Your greenhouse is not an island. It's part of a bigger ecosystem—utilities, regulations, land constraints, and yes, market forces. So before you start sketching floor plans, ask yourself:

- **Will your utilities support expansion, or will you be stuck paying a fortune to upgrade later?**
- **What about site constraints? Is there enough room to scale, or are you boxing yourself in?**
- **Are there hidden regulatory traps waiting to bite you in five years?**

Sylvia has seen it all. She recalls a project that required about a dozen revisions before the client realized their gas line was too small—and the utility company had no intention of upgrading it. "It was a huge pivot," she says. "And those things are really important."

Lesson: It's cheaper to overbuild infrastructure upfront than to retrofit it later.

STEP 2:
SITE SELECTION—KNOW THE DEAL BREAKERS BEFORE YOU SIGN

A piece of land might look perfect—until you dig into the fine print.

Take water, for example. It's the lifeblood of any greenhouse operation, yet many buyers don't even test it before purchasing.

"In my opinion as a horticulturist," Sylvia says, "I would always want to get a water test before I bought a piece of property to know what I'm going to have to spend to make this water ideal to grow crops."

And then there's runoff. "It used to be the case that you could just have stormwater runoff go onto the ground," Sylvia explains. "Now, in a lot of places, any runoff is required to be captured and either hauled away or put in evaporators."

The takeaway? Before you buy:

- **Test the water—don't assume it's good.**
- **Check stormwater rules—new regulations could cost you millions.**
- **Know your utility capacity—a weak power grid or gas line can capsize your project.**

STEP 3:
EQUIPMENT PLACEMENT—BECAUSE MAINTENANCE SHOULDN'T BE AN AFTERTHOUGHT

Greenhouse designers are often obsessed with maximizing production space. That's great—until you realize you've trapped a critical control panel behind five benches of plants.

"Positioning equipment in the space so that maintenance can be performed is huge," Sylvia says.

If maintenance is hard, it won't happen. If it doesn't happen, your greenhouse stops running. It's that simple.

STEP 4:
THE AUTOMATION TRAP—TECH WON'T SAVE YOU FROM BAD DESIGN

Many greenhouse operators assume automation will solve all their problems.

Reality Check: More tech means more maintenance.

Sylvia recalls working with a grower eager to automate.

"The questions that were being asked by the automation company were just overwhelming to them," she says. "It's hard to go from being a traditional small-scale grower to full automation."

Here's the golden rule:

- **Automate only what makes sense for your operation.**
- **Ensure you have a qualified maintenance team before adding high-tech systems.**
- **If your greenhouse can't function without human oversight, no amount of automation will fix that.**

STEP 5:
LIGHT MANAGEMENT—WHY "MORE" ISN'T ALWAYS BETTER

For years, growers focused on the quantity of light. But the really important metric is quality.

"What we've really learned," Sylvia says, "is that scattering the light and using a diffuse glazing creates a better environment for the plants. We still have the same amount of light, but scattered around."

This simple shift can:

- **Prevent scorching on plants near sidewalls.**
- **Improve overall light distribution.**
- **Eliminate the need for costly shading equipment.**

It's a perfect example of designing with the end in mind—using materials that work with the environment instead of fighting against it.

STEP 6:
DON'T JUST LOOK AT PRICE—LOOK AT THE WHOLE PICTURE

A mistake Sylvia sees too often? Basing decisions purely on price, particularly upfront CAPEX price.

"When a general contractor is responsible for making the decision on a project, he is often only looking at price," she says.

The cheapest option is rarely the best. In one case, LLK helped a client select a mid-priced proposal over the cheapest option because the faster turnaround time on engineered drawings meant meeting a critical project deadline.

START WITH THE END IN MIND:

LESSONS FROM MICHIGAN STATE UNIVERSITY'S GREENHOUSE MODERNIZATION

At Michigan State University's Plant Science Research Greenhouses, a phased, $35+ million renovation and new build project is under way, a model for how long-term strategic thinking drives better outcomes for complex greenhouse operations.

More than 400 researchers rely on these facilities for everything from basic plant science to applied agriculture studies, with at least 100 different projects happening at any one time; all of Michigan's commodity crops are represented within the facilities. Success here means balancing diverse operational needs, future-proofing infrastructure, and managing budgets, all while maintaining active research production.

At the helm of this project is Chrislyn Particka, who is the director of the research greenhouses. When she joined the institution in 2019, she inherited aging infrastructure, inconsistent environmental controls, and more than 60 faculty users whose research needs were not always being met due to the condition of the greenhouses.

In fact, just a few weeks into her tenure, she received an initial assessment of the facility. The report contained suggestions on how to renovate each greenhouse; there were no plans to tear down and rebuild any. Over time, however, Chrislyn and her colleagues were able to offer their ideas on how the plan could be adjusted to include tearing down and rebuilding the greenhouses, as some of the shortcomings of the greenhouses that limited research capability could not be corrected with renovations. "Luckily, we were eventually able to dream bigger," Chrislyn said.

Over the next five years, she would lead the transformation of one of the nation's most complex research greenhouse facilities, all while keeping operations running, with a lot of help from the other greenhouse staff members. Here's what she learned.

UNDERSTANDING THE UNIQUE NEEDS OF RESEARCH GREENHOUSES

Unlike commercial greenhouses, research facilities like MSU's serve dozens of different users simultaneously, who have a wide variety of needs. Tree research needs tall space, as one example, while pathology studies need precise environmental control to encourage disease development.

At MSU, 60–70 faculty are active in the facilities at any time, spanning eight academic departments across three Colleges (Agriculture and Natural Resources, Natural Science, and Engineering). The variety of research conducted includes crop breeding, herbicide resistance in weeds, how plants respond to and tolerate environmental stress, and development of photovoltaic glass and evaluating plant growth under it.

Lesson Learned: Design with compartmentalization first. Separate, individually controlled zones are essential. Operators should plan for isolated airflow, independent lighting, and autonomous environmental control systems to protect research integrity across a facility.

RECOGNIZING THE HIGH COST OF AGING INFRASTRUCTURE

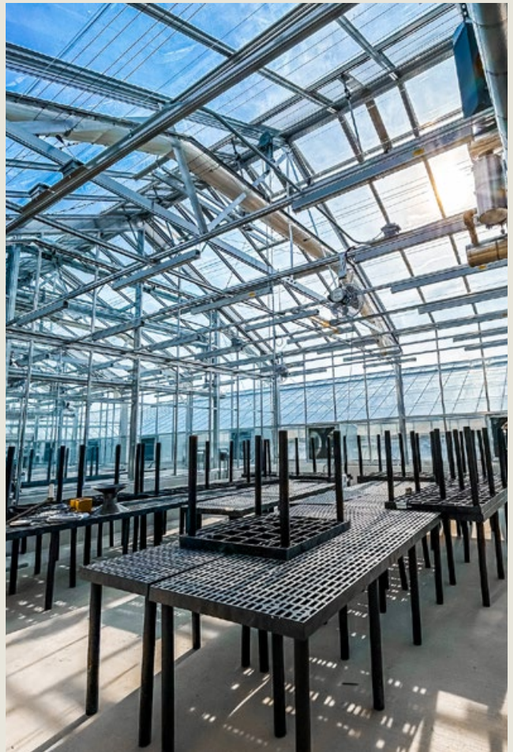
Prior to renovation, many greenhouses had no computerized environmental controls, just independent thermostats triggering fans or heaters individually. Furthermore, 24-hour flat temperature setpoints were the norm — no day/night variation.

Vents were sometimes open while the heat was on, wasting energy and destabilizing the crop environment. Leaky or undersized evaporative cooling pads severely limited summer operation.

This issue at that point was that inconsistent temperatures created uneven crop development, even in research.

Lesson Learned: Operators must eliminate multiple, isolated control points that "fight" each other. Invest early in centralized environmental controls, even simple programmable logic controllers (PLCs)—to avoid this slow operational death spiral.

Install temperature and equipment overlay reporting: overlay vent status, fan speeds, and temperature readings to quickly diagnose system mismatches.



TIMING MATTERS: A SNOWSTORM SPARKS NEW FUNDING

In January 2021, a critical turning point occurred: a new university provost visited MSU's greenhouses—on a slushy, sleeting day—and was snowed on *inside* a greenhouse.

That chance event spurred $4 million in funding from many sources at MSU. Over the next three summers, MSU used the funds to retrofit 41 zones with LED lighting and complete full renovations to 24 zones, including repairing floors, replacing old glass glazing with acrylic, and installing all new heating and cooling equipment along with Wadsworth Seed environmental control systems. Much of this work was done quickly and efficiently, using in-house staff, including the greenhouse staff electrician who managed the lighting installs.

But that was just the start of a capital stream that would change the course of Michigan State University's greenhouses.

Lesson Learned: Always maintain an up-to-date, data-driven business case for investment. Have cost analyses, ROI projections, and operational risk assessments ready, because moments of opportunity can be unexpected and decisive.

And if your leadership sees facility failure firsthand, be prepared to immediately present your funding case.

PRACTICAL LESSONS FROM MSU: BUILDING WITH THE FUTURE IN MIND

By July 2022, the State of Michigan approved $23 million in capital funding to overhaul the greenhouse complex. MSU also allocated an additional $12 million. Chrislyn and her colleagues had used the time between 2019 and 2022 to clarify which greenhouses needed to be torn down, which could be renovated, and what the future layout should look like. Now, they had an idea of how to allocate this new money.

The key was to start with the end in mind. What were the ultimate goals of these greenhouses?

Every design and engineering decision at MSU focused on long-term operational benefits, not just short-term construction costs.

Here's how they did it:

1. Corridor-Entry Only Design

Among the first non-negotiables was access. In the legacy houses, researchers would often have to pass through one greenhouse to reach another, an operational nightmare.

"If we had to spray pesticides in 16A, then we'd have to block off 16B too," Chrislyn said, "even if a totally different group was using it. There is also a greater risk of spreading pests from one zone to another with walk-through houses."

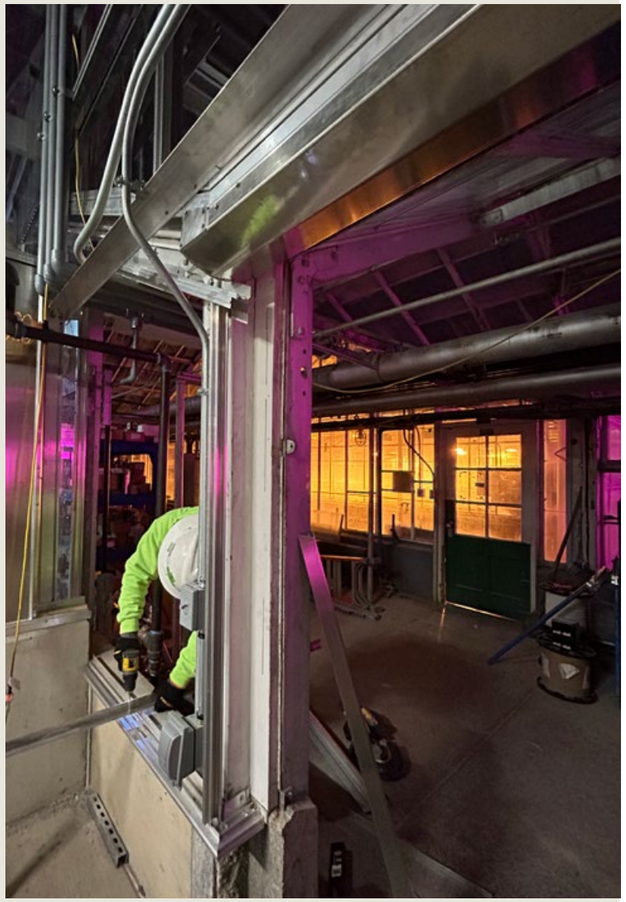
Instead of pass-through designs, all new greenhouses use corridor-only entries.

North-facing corridor entries open south into individual greenhouse zones. This eliminates cross-traffic, minimizing pest transfer and pesticide exposure risks, and also facilitates containment protocols for regulated pathogen trials.

Lesson Learned: Biosecurity-first designs are now standard in research greenhouse design. Operators working with sensitive crops or multiple commercial clients should mirror this layout to protect crop integrity and worker safety.

2. Taller Greenhouses, Better Climate Control

The second major upgrade was height. Most of the old houses had sidewalls barely seven feet tall, with peak heights around 16 feet. It made growing tall species—corn, energy sorghum—difficult. It also trapped heat close to the plants.



"Taller greenhouses manage heat better in the summer," Chrislyn explained. "You want that hot air pooling higher, away from the crop."

To achieve this goal, new greenhouses feature 13-foot sidewalls and 21-foot peaks.

This expanded vertical space supports those tall crops without mechanical pruning. It also vastly improved heat stratification, reducing crop stress and energy costs.

Even in commercial greenhouses, increasing vertical space improves climate stability and reduces cooling loads. Consider 10+ foot sidewalls even for production houses focused on bedding plants or ornamentals.

Then came shade curtains. Previously, staff would laboriously apply whitewash each spring—a tedious, weather-dependent process. The new curtains automated that work, providing not just summer shading but also winter insulation.

"It's a massive time, energy and labor savings," she said. "We do our best to make 'whitewash day' fun, but it's still a lot of work!"

3. Modernized Climate Control Systems

Wadsworth Seed control systems are deployed across all renovated and new structures. This allows for independent zone programming for lighting, vents, temperature, as well as real-time data overlays for fast troubleshooting.

Think of the future, too: The control systems at MSU now offer pre-built expansion capacity for future misting, additional sensors, or custom research equipment.

Lesson Learned: Future-proof your control panels during initial install. Always leave 20–30% spare capacity for add-ons. Retrofitting control panels later is exponentially more expensive.

4. Zone-Based Layouts for Maximum Flexibility

Instead of fewer large zones, each new greenhouse is subdivided into multiple smaller zones (four to nine per structure). This supports small plot studies without excessive space waste and enables stricter pest and climate isolation. At a place like MSU, with so many faculty and students moving in and out of the greenhouse space, this provides more flexibility to better meet the researchers' needs.

Lesson Learned: Sub-zoning is a critical efficiency model even for production-focused growers: it allows side-by-side growing strategies and reduces energy costs by targeting conditions only where needed.

MANAGING BUDGETS, INFLATION, AND HARD CHOICES

In summer 2023, MSU completed those renovations on the 24 greenhouse zones previously updated with emergency funding—leveraging leftover budget and a supplemental internal investment.

On April 12, 2023, the university held its official groundbreaking ceremony for the state-funded portion of the project. Demolition began in earnest on May 6, starting with the three oldest greenhouses on campus. In their place, a new headhouse and one new greenhouse were constructed. Another new greenhouse was built on the site of a former structure that was demolished in 2020. Renovations of two other greenhouses were also completed during this first phase, which wrapped up in early 2025.

If that sounds like a lot to manage from a budgetary standpoint, it was.

Post-COVID inflation and labor shortages hit hard as this project ramped up.

MSU faced significant cost escalations compared to early estimates and value-engineering reductions including cutting one full new greenhouse and one major renovation. The team had to eliminate high-cost equipment like autoclaves from the build.

Lesson Learned: Build projects with structured decision-making frameworks before budget cuts happen. Pre-define mission-critical elements ("must-haves") versus secondary elements ("nice-to-haves")—so hard choices protect operational priorities.

OPERATIONAL FLEXIBILITY: PLANNING FOR THE "MUSICAL GREENHOUSES" PHASE

Because construction was phased, MSU faced a giant logistical puzzle: greenhouse users had to be moved—sometimes repeatedly—as greenhouses were renovated or demolished and rebuilt, without interrupting research projects.

The keys to this transition?

- Planning relocation several months in advance.
- Knowing an individual researcher's needs intimately (temperature and light requirements and pest management needs).
- Offering researchers pre-identified alternate spaces before disruption occurred.

Lesson Learned: Every phased construction project needs an internal relocation master plan as detailed as the construction plan itself.

Greenhouse operators pursuing renovations while remaining active must treat user relocation like a standalone workstream, with the same level of foresight, stakeholder engagement, and precision as the facility construction itself.

SETTING THE FACILITY UP FOR LONG-TERM MAINTENANCE

Crucially, MSU embedded maintenance crews into commissioning and system training—a step often missed.

If maintenance teams aren't trained on day one, even the best-engineered systems will eventually fail.

Lesson Learned: Operators should insist on full documentation (as-builts, specs, warranties) and live system walkthroughs and as well as internally scheduled preventative maintenance programs. Involve management and maintenance technicians in the commissioning and training processes.

FLEXIBILITY, READINESS, AND STRATEGIC VISION

Phase 2 of this project began in 2025 with the demolition of two small greenhouses. A new greenhouse is currently under construction on that footprint and is expected to open in August. Another new greenhouse will be built at the site of the old headhouse after it is demolished during the summer, and will open in January 2026. There's still a ways to go, but with the ending in mind, each step along the way is as clear as possible.

Following Phase 2, the final leg of the project will involve the removal of two additional greenhouses, though only one new greenhouse will be constructed to replace them—due to space constraints and earlier budget trade-offs.

Through this phased, multi-year process, Chrislyn emphasized that long-term relocation planning was the most critical—and most underestimated—element of success that was solely her responsibility. Every move required strategic reshuffling, with entire research programs relocated more than once to accommodate demolition schedules. Despite delays created by COVID, the extra time ultimately gave MSU the clarity to make decisions that prioritize infrastructure that supports high-throughput research, long-term maintainability, and true operational flexibility.

Michigan State University's greenhouse modernization is proof that strategic vision, operational discipline, and data-driven flexibility drive success.

By starting with the end in mind—operational needs, research flexibility, maintenance realities—MSU has positioned its greenhouse facilities not just for 2025, but for 2045 and beyond.

For greenhouse operators across education, agriculture, and controlled environment production: future-proofing begins with design, but succeeds with discipline.

Start with the end in mind, and be ready when the snow comes through the roof.

The Ohio State University CEARC Complex Production Greenhouse

GREENHOUSE EFFICIENCY:

25 ACTION ITEMS FOR TOMORROW'S GROWERS

With rising energy costs and increasing environmental regulations, optimizing greenhouse operations is more important than ever. We're here to help.

A streamlined approach that begins with the end in mind can not only cut costs but also boost sustainability.

What You Need to Know: The team at LLK Greenhouse Solutions has developed a straightforward list of action items to enhance efficiency in greenhouses, addressing everything from insulation to water use.

DETAILS:

- **Insulation:** Inspect and seal to prevent energy leaks.
- **Heating and Cooling:** Upgrade systems for better energy management.
- **Water Efficiency:** Implement systems to reduce water waste.
- **Lighting:** Switch to LED to decrease energy consumption.
- **Ventilation:** Clean and adjust systems to improve air quality and temperature control.
- **Maintenance:** Regular checks can prevent costly breakdowns.

Be Smart: Regular maintenance and strategic upgrades are key to staying ahead in the competitive greenhouse market. Each item on this list not only contributes to operational efficiency but also aligns with broader trends towards sustainability in agriculture.

The Big Picture: As the industry evolves, those who prioritize efficiency and proactive maintenance will find themselves at a competitive advantage, ready to meet future challenges head-on.

Consider incorporating this list into your regularly scheduled preventative maintenance routines.

Let us know how the LLK team can help along the way!

INSULATION

Check for leaks: Regularly inspect seals on doors and glazing panels.

Upgrade insulation materials: Consider double-layered or thermal insulating materials for walls and roofs.

Seal gaps: Use weatherstripping around doors and windows.

Insulate heating ducts: Ensure that all heating ducts and pipes are properly insulated to prevent heat loss.

Reflective surfaces: Apply reflective paint or panels to increase light diffusion and reduce heat loss.

HEATING AND COOLING

Install programmable thermostats: Automate temperature control to reduce energy waste.

Regularly service HVAC systems: Ensure optimal operation through regular maintenance.

Upgrade to energy-efficient systems: Consider newer, more energy-efficient models for significant long-term savings.

Optimize greenhouse orientation: Maximize natural heating and cooling by adjusting the orientation of the greenhouse.

Use thermal curtains: Deploy during non-operating hours to maintain temperature and reduce energy use.

WATER EFFICIENCY

Implement drip irrigation: Minimize water wastage with targeted watering at plant roots.

Collect rainwater: Set up a system to capture and reuse rainwater.

Use moisture sensors: Automate irrigation based on soil moisture levels to prevent overwatering.

Check for leaks: Regular inspections and repairs to hoses and faucets.

Opt for water-efficient nozzles: Upgrade to misters and nozzles that reduce water use without sacrificing irrigation quality.

LIGHTING

Switch to LED lights: Lower energy consumption and longer lifespan than traditional bulbs.

Utilize natural light: Maximize use of sunlight before supplementary lighting.

Install light timers: Ensure lights are only on when necessary.

Use energy-efficient ballasts: Opt for electronic ballasts for fluorescent lights.

Regular cleaning: Keep light fixtures clean to maintain intensity and efficiency.

VENTILATION

Clean vents and fans: Ensure they are free of dust and debris to improve efficiency.

Adjust ventilation rates: Tailor to current weather conditions and internal greenhouse temperatures.

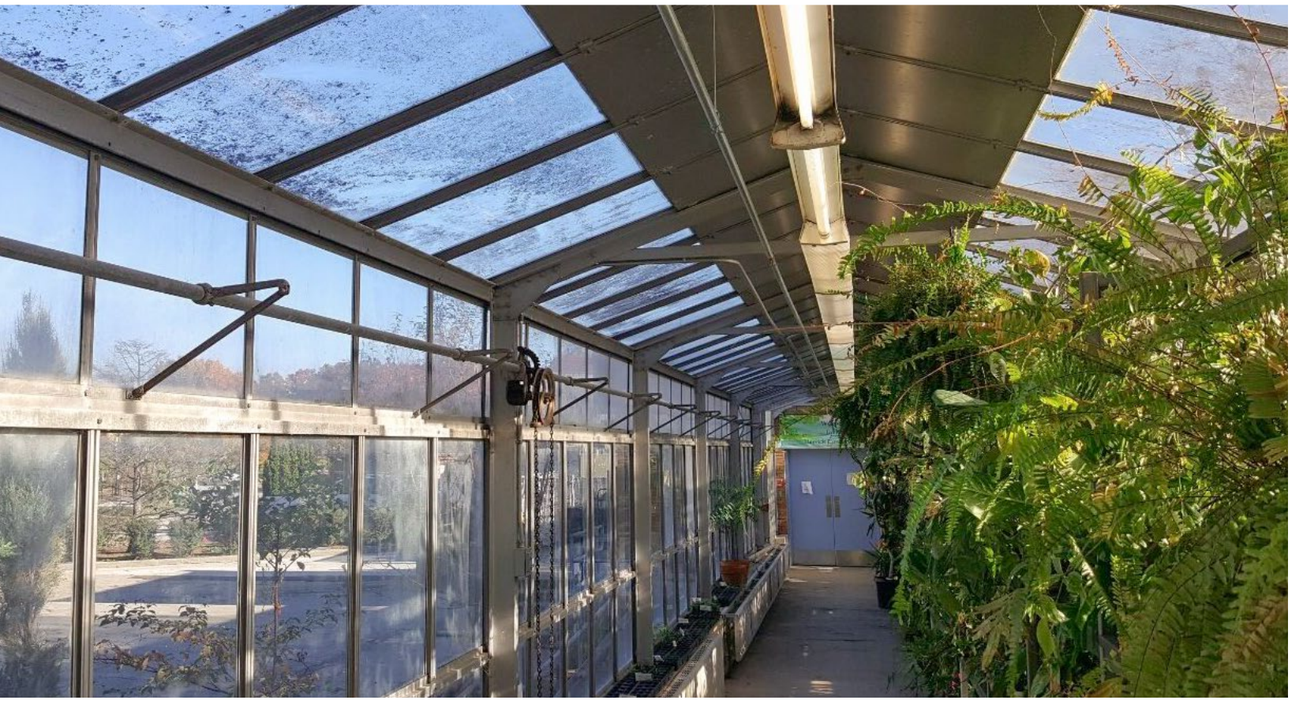
Install variable speed fans: Reduce energy consumption by adjusting fan speeds based on need.

Optimize air circulation: Strategically place fans to eliminate hot and cold spots.

Seal unused vents: Prevent loss of heated or cooled air during off-peak times.

PREVENTATIVE MAINTENANCE ENSURES LONG-TERM SUCCESS:

AN INTERVIEW WITH KENT STATE UNIVERSITY'S MELISSA DAVIS



In greenhouse management, success often hinges on one unglamorous but essential principle: preventative maintenance.

Melissa Davis, Horticultural Facilities Director at Kent State University, knows this better than anyone. Her leadership has transformed Kent State's aging greenhouse into a thriving hub of innovation and productivity, offering a blueprint for proactive management.

REVITALIZING A LEGACY

Kent State's greenhouse has come a long way since its 1960s origins, the facility was in dire need of a refresh—a challenge Davis embraced head-on.

Working with LLK Greenhouse Solutions, she and the university oversaw a sweeping renovation that upgraded everything from glazing to environmental controls.

The result? A modern greenhouse with eight specialized bays designed for precise plant growth. "When I took the directorship, it really was in disarray," Davis says. The team was still pulling chains to open and close vents, as an illustration. "We've built a facility that can truly support the work we're doing now."

Renovating the greenhouse (and later building a new 1,500-sq.-ft. research facility next door) was a major step forward.

But to keep those facilities in order... That long-term goal required ongoing preventative maintenance, something that Davis takes seriously each year.

ROUTINE MAINTENANCE AS A NON-NEGOTIABLE

For Davis, preventative maintenance is the backbone of the greenhouse's operations. Twice a year, her team conducts comprehensive maintenance to ensure all mechanical components are in peak condition—just before the spring startup and after the growing season.

This semi-annual practice includes servicing motors, addressing rust caused by high humidity, and ensuring the facility is ready to withstand seasonal shifts.

The key is to think about the consequences of each piece of equipment–consider what goes right when it's working and what goes wrong when it's not.

Here are her pro tips:

Routine Maintenance Scheduling

Twice annually, before the onset of the spring growing season and again as part of winter preparations, thorough checks and maintenance are crucial. This schedule ensures that all systems are optimized to support robust plant growth and to endure dormant periods without degradation.

Systematic Overhaul and Servicing

Key mechanical systems, such as ventilation motors and racks, require regular inspections to keep them running smoothly and to prevent the accumulation of rust and wear, especially in the high-humidity environments typical of greenhouses. Regular greasing, adjustments, and replacements of worn parts can prevent the sudden failures of these critical systems.

Adaptive Maintenance for Changing Needs

Given that research and cultivation needs can shift dramatically throughout the year, maintenance protocols must be flexible to adapt to new demands. This might mean altering the setup for different crops or research projects, requiring the maintenance team to understand and respond to these dynamic needs swiftly.

Proactive Issue Management

Addressing minor issues before they escalate into major problems is a cost-effective strategy that extends the lifespan of greenhouse infrastructure. Regular maintenance checks help identify potential issues early, reducing downtime and the costs associated with significant repairs or replacements.

Comprehensive Maintenance Approach

An effective maintenance plan covers more than just mechanical and structural checks. It also includes ensuring that environmental controls are properly calibrated and that the physical infrastructure, such as glazing and seals, is intact and functional. This holistic approach not only preserves the physical assets but also ensures that the internal environment is always conducive to plant growth and research activities.

LEVERAGING TECHNOLOGY FOR EFFICIENCY

Under Davis's direction, the greenhouse has embraced technology, transitioning from labor-intensive manual operations to streamlined automation.

Automated systems now handle key environmental controls, reducing workload while improving precision. Looking ahead, she envisions adding automatic shading capabilities to further optimize efficiency.

This shift from manual to automated systems has been transformative, enhancing the precision of environmental controls such as temperature and humidity regulation, which are crucial for plant health and research accuracy. Broadly speaking, the university's embrace of tech and automation reduces the human labor required and also elevates the consistency and reliability of the conditions within the greenhouse.

Looking forward, Davis plans to implement automatic shading, which will further refine energy efficiency and control over light exposure, optimizing conditions for plant growth and facilitating even more sustainable operations. This progression toward automation in greenhouses underscores a broader trend in agricultural technology, where precision and efficiency lead to better outcomes and more sustainable practices.

NAVIGATING THE UNPREDICTABLE

Even with a meticulous maintenance schedule, challenges arise.

Extreme weather events, for instance, can test any facility's limits.

To mitigate these risks, Kent State's greenhouse relies on integrated weather stations that adapt to changing conditions in real time.

Davis shares an example: "If the vents are opened, and wind speeds suddenly reach damaging levels, the system will automatically adjust. It's a safeguard that's become invaluable."

Navigating unpredictability is a crucial theme in preventative greenhouse maintenance because

unexpected events can severely disrupt operations. Disruptions (such as severe weather) could damage plants, delay production cycles, and increase costs unexpectedly. By anticipating these risks and having adaptive systems in place, such as weather-responsive controls, greenhouses can maintain stable environments, safeguard crops, and ensure continuity in operations despite unforeseen challenges.

A MODEL FOR PROACTIVE MANAGEMENT

Davis's emphasis on consistent maintenance, technological innovation, and risk mitigation preserves infrastructure while fostering optimal growing conditions.

Her proactive measures ensure that Kent State's greenhouse remains a leading example of how thorough care and innovation can coalesce to create an optimal environment for both academic research and plant cultivation.

> "I would like to express my sincere appreciation to LLK for their professionalism, integrity, and highest level of performance while conducting the renovation working on the existing Kent State University Herrick Conservatory Greenhouse. The entire team (from owner to laborers) were accessible throughout the project and the accommodations were uninterruptedly made to insure the protection of the facility's plant collections. I highly recommend LLK for all greenhouse service needs and look forward to working with them on future projects."
>
> **Melissa Davis**

LLK | GREENHOUSE SOLUTIONS

GREENHOUSE MAINTENANCE CHECKLIST & LOG

A successful growing season and harvest is the ultimate goal for growers. Proper cultivation practices are necessary, but regular greenhouse maintenance and cleaning are equally important. Without regular equipment, structural, and sanitation upkeep, the risk of lost yields and money down the drain increases exponentially.

To help ensure your operation stays profitable, efficient, and regulated, we've compiled a checklist of routine procedures to use throughout the year.

PANELING & GLAZING

TASK	DATE
☐ Clean Panels	
☐ Repair Holes/Tears	
☐ Repair Poly	
☐ Seal Gaps	
☐ Tighten Poly	
☐ Replace Panels	
☐ Repair Energy Screens	
☐ Replace Glass Panes	

EXTERIOR FRAMES

TASK	DATE
☐ Clean/Sanitize Superstructure	
☐ Address Aluminum Rust or Corrosion	
☐ Bolt/Screw Tightening	
☐ Damaged Frame or Bracing Repair	
☐ Collar Tie Tightening	
☐ UPVC/Metal Clip Checking	

VENTILATION & FANS

TASK	DATE
☐ Lubricate Vent Components	
☐ Tighten Vents	
☐ Check Vent Position Switches	
☐ Check Hinges/Catches	
☐ Clean Fan Blades	
☐ Clean/Disinfect Cooling Pads	
☐ Repair Worn Belts	
☐ Tighten Screws	
☐ Replace Deteriorated Pads	

HEATING & BOILERS

TASK	DATE
☐ Inspect Heating Units	
☐ Check Efficiency Status	
☐ Remove Debris	
☐ Inspect Heat Exchangers For Corrosion/Leaks	
☐ Clean Heat Exchangers	
☐ Clean Radiators/Fan Pipes	
☐ Assess For Gas/Fuel Leaks	
☐ Conduct a Combustion Test	
☐ Conduct Test Run	
☐ Inspect Barometric Draft Control	
☐ Tighten Flue Connections	
☐ Check Fuel Supply	
☐ Test Run Back-Up Heaters	
☐ Check Thermostat/Sensor Accuracy	

ENTRANCES & FLOORS

TASK	DATE
☐ Replace Weatherstripping	
☐ Replace Broken/Worn Doors	
☐ Lubricate Hinges	
☐ Disinfect Door Handles	
☐ Clean/Disinfect Floors	
☐ Repair Cracks in Concrete	
☐ Insulate Around Floor	

PEST MAINTENANCE

TASK	DATE
☐ Disinfect Propagation Equipment	
☐ Remove Excess Debris	
☐ Fill Interior Gaps/Openings	
☐ Check/Refill Pest Mitigation Supplies	
☐ Remove Algae From Irrigation/Holding Tanks	
☐ Mow/Trim Exterior Grounds	
☐ Assess For Weeds	

IRRIGATION SYSTEMS

TASK	DATE
☐ Test Emitters	
☐ Unclog/Repair/Replace Sprinkler Heads	
☐ Test System Controls For Accuracy	
☐ Recalibrate EC/pH Sensors	
☐ Assess Water Pressure	
☐ Repair Leaks	
☐ Sanitize and Flush/Unclog Supply Lines	

TURNING A PROBLEM SITE INTO A DESTINATION: INSIDE PETITTI'S BOLD NEW BUILD IN BATH TOWNSHIP

After 20 years of waiting for land to become available, Petitti Garden Centers finally found its way into Bath Township, Ohio.

When a six-acre site with an office building went up for sale, A.J. Petitti jumped at the opportunity.

However, the site was so complex – with steep grade changes and nonconforming infrastructure – that even the architecture firm's owner urged him to walk away.

"There was just zero [real estate] available anywhere," Petitti said. "So, when we saw that it had the land, we put a lot of time and effort into really looking at it hard and figuring out how to make it work without tearing the building down."

> "...NOW THAT IT'S DONE, IT MAKES IT SO MUCH MORE SPECIAL."
>
> **A.J. Petitti**

The new location, which is their tenth in Northeast Ohio, became a rare chance to build something unique out of a building the community knew well but had become an eyesore.

"It's something that when we were doing it, I wish we would have torn it down. It made it so much harder. But now that it's done, it makes it so much more special," Petitti said.

BUILT ON COMPLEXITY

The site came with more than a few logistical puzzles: the street falls on a downhill grade, the basement required reinforcement, and the whole building needed to be brought up to code and rezoned for retail.

"There was not a flat spot on that whole site," Petitti said.

And that was a big problem.

> "IT'S JUST THAT FEELING YOU GET BEING IN THERE. YOU FEEL LIKE YOU'RE OUTSIDE, BUT YOU'RE INSIDE."
>
> **A.J. Petitti**

To install the Cravo retractable roofs, which are a focal point of the new location, the site needed to be flat.

"We brought in 30,000 yards of soil and put in underground retention. Then we were able to create a pad big enough to put the Cravo structure up," he said.

The Cravo structure is a retail favorite for A.J. It's Petitti's fourth project using the retractable-roof system, which is not only functional but creates an atmosphere.

"I love [the Cravo] for retail because it's different than any other kind of greenhouse. It's just that feeling you get being in there. You feel like you're outside, but you're inside," Petitti said.

The blend of openness and control is what makes the structure so effective.

"It creates a really nice environment... and you can kind of manipulate how far open you want to have [it] – whether it's 25%, 50%, 75%. That all works to create a nice airflow for the customer and the plant material."

The Cravo structure also helps Petitti's save on cost throughout the winter, when they don't use all their outdoor space.

"When you don't need the space, you don't have to heat the space – you can just leave the structure open, let the snow fall through, and it reduces your cost that way," Petitti explained.

They paired the Cravo roofs with corrugated poly siding for durability and performance.

"Corrugated poly holds up really well. It's relatively inexpensive comparatively, and it'll hold up. It'll block the wind, it diffuses the light, it works out really well."

MULTI-LEVEL RETAIL, REIMAGINED

Rather than fight the structure of the office building, Petitti's team used it to their advantage, building a distinct customer experience across three levels.

"When you walk in, you walk into indoor plants, boutique, home décor, kitchen... [we] were able to create a lot of different nooks and crannies for people to walk through and discover," he said.

Then on the second floor, it's much more spread out. You'll find patio furniture, which transitions into lawn & garden and garden accent.

Finally, the third floor features greenhouse structure and additional lawn & garden before checkout.

Not to mention, the office building's original construction adds a rustic flair to the interior.

"It's post and beam construction on the inside. It's an all-wood building, so it adds a lot of warmth and character," Petitti said.

The architecture and layout set the tone the moment you walk in.

"It's a totally different shopping experience. I've never been in another retail store that's anything like this," Petitti said.

COLLABORATION MADE IT POSSIBLE

Executing a retrofit like this takes more than a vision, it takes the right partners. For Petitti, that meant bringing in LLK Greenhouse Solutions early to align their vision with the right structural solution.

"Shawn at LLK was one of the first people I called," he said. "He's really a guiding hand – helping you with renderings, getting approvals through the county, the city, self-performing the construction, and anything they can help with. They're just incredible partners."

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Together, they collaborated to bake workflow efficiency into every decision.

"Staffing, checkouts, how you're going to run in high season, how you're going to run in low season – those are all considerations," Petitti said.

LLK Greenhouse Design pictured above at Petitti Family Farms in Perry Ohio

Over the years, the LLK team has worked with Petitti's to transform several atypical sites into garden centers.

They've converted an amusement park, a racquet club, a grocery store, and a movie theater into full-scale garden centers across the region.

"Every time we do a project, there's a different need. There's no one size fits all for any of the projects and that's why we continue to work with LLK," Petitti said.

A LONG-AWAITED WIN

For all its complexity, this project was personal achievement for A.J.

"This was an area that there weren't any really great garden centers in probably within a 20-minute radius," Petitti said.

"To take a project that was this complex and be able to really knock it out of the park – and have the community really support it – it just feels really good."

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Delivering Solutions Nationally for

90+ Years

Design

LLK self-performs the customized design of a greenhouse environment focused on **YOUR SUCCESS**

Supply

LLK leverages our relationships to procure structure, equipment, and controls for **YOUR SOLUTION**

Construct

LLK self-performs the renovation or construction of your greenhouse to provide turn-key execution of **YOUR PROJECT**

Maintain

LLK develops, manages, and self-performs a maintenance program tailored to maximize profits of **YOUR OPERATION**

Reach out to discover how our experienced team at LLK can help with your next greenhouse project

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