Vo-Tech Studies

PRECAST CONCRETE

Precast concrete builds safe and strong career and technical education centers

— Monica Schultes

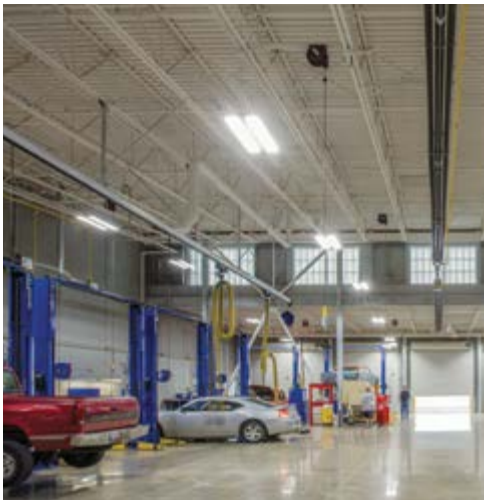
The past decade has seen a resurgence in what has traditionally been called "vo-tech" education. With the increasing demand for skilled workers, businesses have helped create a renewed enthusiasm for vocational and technical education and training. This is in stark contrast with the limited employment opportunities right out of school for recent graduates of four-year programs.

Vocational educators around the country believe trade schools are making a strong comeback because many businesses have a desperate need for journeymen. Many of today's high school graduates and students are learning to be computer science professionals, chefs, graphic designers, mechanics, engineers, nurses, and more, without racking up mountains of student loan debt.

Most of these skills cannot be learned through traditional textbooks. Therefore, educators are essentially starting to focus more on training for employability, as opposed to the typical knowledge-based education or degree.

The buzzword "new collar" is replacing "vo-tech" for technical jobs and reflects the changes in the way schools train students to fit new workforce demands. Hands-on learning in highly technical fields like information technology, computer-aided design, industrial design, and computerized metal machining are common in vo-tech curriculum. It deliberately addresses the skills mismatch in the United States.

The owners, designers, and contractors of these technical and career centers frequently turn to precast concrete for its speed, durability, and low maintenance. The following projects demonstrate how precast concrete can play a part in the new-collar school evolution. These examples of technical schools built with precast concrete examine the design and construction practices that went into them.



Salvaged precast concrete columns and double tees were reused in the new construction. Photos: Simon Hurst Photography.

CANADIAN VALLEY TECHNOLOGY CENTER

LOCATION
El Reno, Okla.

PROJECT TYPE
K-12 school/career technology center

SIZE
230,000 ft^2

COST
$43 million

DESIGNER
MA+ Architecture, Oklahoma City, Okla.

OWNER
Canadian Valley Technology Center, El Reno, Okla.

STRUCTURAL ENGINEER
KFC Engineering, Oklahoma City, Okla.

CONTRACTOR
CMS Willowbrook, Oklahoma City, Okla.

PCI-CERTIFIED PRECASTER
Coreslab Structures (OKLA), Oklahoma City, Okla.

PRECAST COMPONENTS
Insulated wall panels, double tees

Architectural precast concrete walls are visible from the courtyard looking north.

There was extensive collaboration with Coreslab to achieve the desired finish on the panel face.

CANADIAN VALLEY TECHNOLOGY CENTER (BUILDING 100), EL RENO, OKLA.

The community in El Reno, Okla., recently recognized the fifth anniversary of the widest tornado ever recorded in the United States. That tragic event in May 2013, with winds up to 295 mph, devastated numerous homes in the area as well as the Canadian Valley Technology Center (CVTech).

Cory Pivniska, project director at CMS Willowbrook, recalls, "Our owner was on-site that morning to assess the damage. We stayed there from the first day. We helped relocate students to other facilities and retrofitted an old auto dealership for the CVTech auto shop to use during construction."

Coleman Harrison, project consultant for Coreslab Structures (OKLA), recalls, "I was called by the insurance company a few days after the tornado hit to evaluate the damage. I was shocked at the widespread destruction. The areas with the least superstructure damage were the areas constructed out of precast concrete components."

Like many in the local community, Harrison has an emotional attachment to the school. As an alumnus, he was thrilled when Coreslab was asked for recommendations on how best to use precast concrete components.

The tornado received a rating of 5 (the highest) on the Enhanced Fujita (EF) scale of tornado intensity. It left the CVTech campus in ruins, and all nine buildings on campus were heavily damaged or destroyed. Thankfully, all 15 people who were at the school that evening were uninjured. A mere six months later, the school was breaking ground on new construction and a new start. During the rebuilding, CVTech had to lease space in multiple venues to house their diverse ongoing educational programs like health care, computer programming, cosmetology, welding, and automotive.

REBUILDING AND RETHINKING

MA+ Architecture had already completed a master plan for the school district but had not expected to implement it so quickly. The CVTech team took this as an opportunity to start over and rethink how they do things. "They want to do this once, and they want to do it right," says Gary Armbruster, principal architect/partner at MA+ Architecture. He met with all the end users of the building to incorporate their needs into the building design. Goals included building a safe and

'They want to do this once, and they want to do it right.'

secure facility that meets the needs of all programs, incorporating natural light, creating a facility with maximum flexibility, and redefining the layout to be more collaborative.

The building was gutted, but portions were able to be reused. One of the biggest challenges was to design more than 50% of the new space within an existing structure. "It was a challenge to work within that frame. The shop classes had to be reconfigured into different uses and configurations," recalls Armbruster.

Using the original master plan, they had to quickly evaluate various building systems and focus on how to rebuild as soon as possible. The design team considered masonry, but were concerned by the shortage of available masons as well as the need to fast-track the schedule. "We turned to precast for its speed," explains Armbruster.

'We turned to precast for its speed.'

Adding to the mix of challenges was the fact that the insurance provider took well over a year to determine the replacement cost. That put the total budget into question. Good stewardship contributed to the success of the project and keeping within the ultimate $44 million budget.

Construction manager CMS Willowbrook had a long-standing relationship with the owner and assisted with the insurance claim. The initial insurance reimbursement would cover only a portion of their loss. CMS Willowbrook helped CVTech make up millions of dollars with a more accurate estimate. "That is something we do as construction manager. We are not just a builder, we are part of the team, and have worked with Canadian Valley since the 1980s," explains Pivniska.

The storm blew out the existing exterior walls and most of the interior walls. Salvaged precast concrete columns and double tees were reused in the new construction. "It was difficult to reconfigure those spaces because the use had changed. We had to work with the original column spacing. Because of the depth of the existing structure, we struggled with how to get daylight into the center. It was difficult, but we were able to accomplish that," says Armbruster.

In addition to bringing in more natural light, MA+ Architecture designed the new facility to be a flexible and collaborative technology center. "When we designed the trade shop portion of Building 100, we selected precast concrete to give it a completely different look and make it more durable. These shops hold training in automobile technology, diesel tech, HVAC [heating, ventilation,

Precast concrete walls can withstand the harsh environment of the shop and training areas.

and air conditioning], and electrical trades. All those shop trades are abrasive and dirty, and so we chose precast because of its durability," recalls Armbruster. Another consideration for the selection was the need for low sound transmission from shop classrooms to adjacent rooms.

To set apart the shop classes from the rest of the campus, MA+ Architecture worked with Coreslab to develop samples and mock-ups to achieve the desired finish. "We wanted something clean and sleek. We visited Coreslab in Oklahoma City to review other panels that they had cast in the past. We looked at color and texture until we came up with what we wanted," explains Armbruster. There was a lot of coordination and collaboration with Coreslab to achieve the desired result.

Coreslab used two different concrete colors and three different finishes to accommodate the architect's vision. Precast concrete walls were painted where exposed inside the facility. "The main goal was to make it as durable as possible for those shop classes," Armbruster says.

"We learned a lot about interior finishes of precast panels, which comes down to understanding what the owner expects. The exterior is super crisp, but there are two sides to the wall panels," says Armbruster. If the wall panels were in an area other than shop class, then a more polished interior would be required.

'The main goal was to make it as durable as possible for those shop classes.'

SAFETY FIRST

Given the circumstances, critical to the new design was the inclusion of safe rooms/storm shelters capable of holding over 1300 people. The storm shelters were designed with precast concrete walls and double tees for an above-ground superstructure designed to withstand the 250 mph winds of an EF5 tornado.

It was determined the best solution would be multiple safe rooms spaced around campus, so students and faculty would not have to travel far to reach shelter. All five storm shelters comply with the International Code Council's *Standard for the Design and Construction of Storm Shelters* (ICC 500) and the Federal Emergency Management Agency's *Safe Rooms for Tornadoes and Hurricanes* (FEMA P-361). The shelter in the early childhood development wing has a bathroom, small storage area, and an area for play. Two of the shelters double as corridors with the main body used as a common area, meeting room, or study space. Two sets of double storm doors are shut in the event of a severe storm. The largest shelter has offices, classrooms, storage room, bathrooms, and a large work area. Each area is painted a different color, so students know where to go if they have to take cover.

Students will also feel more secure with the consolidation to one main building. When there were several buildings across campus, there were multiple egresses. The new campus will be more secure with a front entrance and prominent entryway.

Building 100 was finished and occupied in January 2017. "If that was all CMU [concrete masonry units], it would have taken much longer to get installed," says Pivniska. The new tech center was designed for future expansion, yet less than a year later CVTech came back to MA+ Architecture. "We thought we were designing for future expansion 5 to 10 years down the road. A 40,000-ft^2 precast addition is currently out to bid to enlarge the shop spaces," says Armbruster.

Every space was designed to provide an open and inviting environment that meets the requirements of its program while maintaining the ability to grow and develop with the varied industries. Pivniska concurs that vo-tech projects are very complex because of the varied uses and learning environments. "There were many changes during the construction phase," he recalls. "That is nature of the beast of vo-tech, because they are constantly changing to meet the needs of their students and the marketplace." He concludes, "CVTech liked the way the existing structure was made with precast, since it withstood the EF5 tornado that started them on this journey."

ROGER L. PUTNAM VOCATIONAL TECHNICAL ACADEMY, SPRINGFIELD, MASS.

The new Roger L. Putnam Vocational Technical Academy replaced a 73-year-old facility with a state-of-the-art academy designed to meet the criteria for the Massachusetts Collaborative for High Performance Schools (MA CHPS). Springfield Public Schools had a real need to prepare young people for up-and-coming careers and professions. They emphasize communication, collaboration, and creativity in the curriculum, and wanted to create a real-world, technology-rich environment where learning is rigorous and engaging.

Precast concrete wall panels provide durable exterior and interior surfaces that will require minimum maintenance. All photos: Greg Premru Photography.

ROGER L. PUTNAM VOCATIONAL TECHNICAL ACADEMY

LOCATION
Springfield, Mass.

PROJECT TYPE
K-12 school

SIZE
315,000 ft^2

COST
$114 million

DESIGNER
Drummey Rosane Anderson Inc. (DRA Architects), Waltham, Mass.

OWNER
City of Springfield, Mass.

STRUCTURAL ENGINEER
Engineers Design Group, Medford, Mass.

CONTRACTOR
Consigli/Morganti, Milford, Mass.

PCI-CERTIFIED PRECASTER
Coreslab Structures (CONN) Inc., Thomaston, Conn.

PRECAST COMPONENTS
Architectural precast concrete wall panels

The existing facility, constructed in 1939, no longer served the educational needs of today's career and technical students. After DRA Architects conducted a needs-and-existing-conditions assessment, it became clear that a brand-new facility would be the most cost-effective and best accommodate the desired educational goals.

Due to limited swing space and the lack of relocation options, the team determined that construction had to occur within the existing site while school remained in session. The new 315,000-ft² structure, located in the heart of Springfield, was sited on playing fields to avoid disturbing the existing school or parking.

To create smaller learning communities, the school's 1400 students are organized into four academies. Unlike traditional vocational schools, each career academy in Putnam features its own academic classrooms along with their dedicated shops. Grades 9 to 12 can choose from 22 vocational programs, including auto mechanics, carpentry, construction, cosmetology, culinary, commercial arts, electric, graphic arts, hospitality, HVAC, information technology, and robotics.

RESEARCH PROJECT

DRA Architects had investigated precast concrete technology several years prior to the Roger L. Putnam Vocational Technical Academy project. Vladimir Lyubetsky, principal at DRA Architects, recalls the process. "The best application for the high-performance precast panel system would be a large-scale project with significant volumes of space that could benefit from repetition of exterior architectural elements. When this high-profile technical school project came along, we thought it would be a good fit for a precast concrete system."

The new exterior features 37-ft-tall insulated architectural precast concrete wall panels.

Lyubetsky elaborates on why precast

Putnam Hall provides entry to core student spaces and for the public to access student-run services such as a restaurant, beauty salon, and conference center.

concrete was selected. "The high-performance precast panels offered high-energy efficiency and are proven to be durable and cost-effective when applied appropriately. The system also presented unique visual design opportunities that would be difficult and costly to implement using other materials."

There are usually several systems that meet project goals on K-12 projects. DRA has been involved in educational planning and design for vocational technical and education projects for over 60 years. Lyubetsky believes that these are the types of facilities where the wide range of precast concrete structural and architectural elements can be implemented efficiently. "There is an economy of scale that is required to bring the cost down and make these systems affordable and competitive with other exterior envelope and structural systems," says Lyubetsky. Putnam Vo-Tech proved to be a good fit for such an application.

'The high-performance precast panels offered high-energy efficiency and are proven to be durable and cost-effective.'

PRECAST VOCATION

The new school includes controlled lighting, controlled heat sensors, occupancy sensors, and rainwater harvesting, among other energy- and water-saving measures. In keeping with the MA CHPS philosophy, precast concrete was selected for its inherent resiliency and to reduce life cycle costs. Precast concrete panels were exposed to the interior of the building. "This approach allows us to eliminate 'extra' layers of finishes, saves on construction costs, and at the same time provides durable exterior and interior surfaces that will require minimum maintenance over the life of the building," explains Lyubetsky.

The project had its challenges. Given the requirements from the different programs and uses, as well as from after-hours community access, special attention was paid to working within the panelized layout. According to Lyubetsky, there was a significant number of "modular" spaces in the school building that work well with the panelized material systems. "Classroom and gymnasium spaces are often modular in nature. We also design large-scale vocational shop spaces to a module to promote future flexibility. With each project, we try to find unique ways to implement a design concept. Precast construction may not be the

Putnam students are organized into four academies, each with its own academic classrooms along with their dedicated shops.

One of the goals of the new design was to improve indoor air quality and bring in more natural light.

right answer in all cases. DRA Architects strives to find balance between various systems in each project."

The main feature of the design is Putnam Hall, a two-story, main street-like space serving as the central circulation. This main street provides access not only to the core student spaces such as the cafeteria, gym, and library, but also serves as a mall for the public to access student-run services such as a restaurant, beauty salon, school store, and conference center. The building is configured to allow for after-hours community access to all these programs and also features an aluminum rain screen system and metal wall panels.

Precast concrete fabricator Coreslab Structures provided multiple samples and mock-ups to develop final exterior colors and textures for the panels. Coreslab worked with DRA during the design phase to get all finish components tested on the samples. Samples were presented to the school district several times before completion of the construction documents. A final set of samples and the full-size mock-up panels were reviewed and approved early in the construction phase. The insulated panels also included embedded electrical boxes and conduit that required close coordination with the precast producer to address any issues early on.

The project was budgeted at $125 million but came in at $114 million. This substantial cost savings was due to the economic climate when ground broke in 2010.

Lyubetsky believes DRA is ahead of the curve by using precast concrete architectural and structural components in their recent technical high school projects. "We haven't noticed significant increase in the use of these technologies in our region. We do know, however, that the state agencies involved in funding public school construction projects both in Massachusetts and Connecticut have noticed the benefits of this approach, which may lead to more projects being built with precast systems."

The precast concrete panel finishes included light to medium sandblast, deep acid etching, a custom formliner, as well as several color mixtures. All photos: DRA.

TACONIC VOCATIONAL HIGH SCHOOL, PITTSFIELD, MASS.

Facing the same plight as many school across the country, the high schools in Pittsfield, Mass., are aged and worn. Taconic High School, built in 1969, was in dire need of upgrades to heating and ventilation systems, flooring, lighting, technology and electrical systems, plumbing, laboratories, library spaces, cafeterias, and vocational shops. Typical of facilities built five decades ago, the school was not energy efficient.

Taconic selected precast concrete for its vocational shops. The 246,530 ft^2 vocational high school replaces the 1969 structure and will serve the district's 920 students. After completion of the new building, the existing structure will be demolished. This project was also designed by DRA Architects. By applying green technologies, the new school will be more energy efficient. The design team is seeking LEED V4 silver certification.

The success of the Putnam Vocational Academy had a positive influence on DRA Architects and they again selected precast concrete for Taconic High School. Vladimir Lyubetsky elaborates: "Even though the Taconic Comprehensive High School project was slightly smaller in size than the Putnam vo-tech project, it was similar in a few key aspects. The school had several large-scale vocational shops, construction would be adjacent to the existing school, emphasis was on durable and long-lasting materials, and energy efficiency of the new building was a priority. Both projects had these requirements and goals."

Taconic combines both academic and vocational secondary education. The new building is three stories, with the academic classrooms on the top two floors and the vocational shops on

TACONIC HIGH SCHOOL

LOCATION
Pittsfield, Mass.

PROJECT TYPE
K-12 school

SIZE
246,520 ft^2

COST
$120 million

DESIGNER
DRA Architects, Waltham, Mass.

OWNER
Pittsfield School District, Pittsfield, Mass.

STRUCTURAL ENGINEER
Engineer Design Group, Malden, Mass.

CONTRACTOR
Gilbane, Boston, Mass.

PCI-CERTIFIED PRECASTERS
Coreslab Structures (CONN) Inc., Thomaston, Conn.; Unistress Corporation, Pittsfield, Mass.

PRECAST COMPONENTS
Wall panels, beams, columns, double tees, hollow-core slab

Taconic selected precast concrete to withstand the rugged environment in the vocational shops. Illustration: DRA.

the ground floor. The entrance to the building is situated close to the current visitor's parking lot and the main feature will be large glass windows to allow more natural light.

A one-story structural precast concrete podium floor plate will support a two-story steel structure that is clad with insulated architectural precast concrete panels on half of the building's footprint. A series of four mixture designs and various textures were selected, including some with custom formliners.

HOMEWORK

DRA maximized the precast concrete layout on the podium that supported the steel structure above it. According to Lyubetsky, "Using structural precast for the vocational shop areas was a natural progression of the concept of durable and flexible spaces for these areas. We used double tees to provide a clear span over the shops. The design was based on the equal bay spacing for the shop areas. This approach worked well for integration of double tees into the building structure."

'Using structural precast for the vocational shop areas was a natural progression of the concept of durable and flexible spaces for these areas.'

Integration of the steel and precast concrete required very close coordination between the two systems during the shop drawing and erection process. The design had to address the visual impact of the connections between the steel column base plates and the precast concrete structure. Column enclosures at the second floor were sized to conceal the base plates and anchor bolts.

Gilbane suggested that the precast concrete bid package be let early. The construction manager also procured design-assist services from Coreslab Structures as part of the early bid package. "We found that this approach was helpful and resulted in an improved schedule and better coordination and integration of the precast into the design of the building," says Lyubetsky. "The design team, the precast subcontractor and the construction manager had regular weekly meetings to review the progress and address open questions. The process was very cooperative, and we would not hesitate to use the same process on future jobs."

The precast concrete work for the vocational shop section was a tandem effort of Coreslab and Unistress. Coreslab manufactured

a variety of precast concrete components, including structural walls and columns, hollow-core and insulated wall panels, and spandrels. Unistress provided precast concrete beams and double tees for the ceilings of the new technical shop.

The vocational programs are Chapter 74-approved, which means they meet National Occupational Program Approval Standards. Taconic's programs include automotive technology, carpentry, electrical, facilities management, horticulture and landscaping, culinary arts, cosmetology, health and medical assisting, graphic communications, early childhood care, office technology, manufacturing/machine technology, engineering, and information support.

HEAVY-DUTY DURABILITY

The use of precast concrete was expanded into the building for the interior partition walls in the heavy-duty shop areas. Coordination with other trades was minimized by specifying all utilities, including electrical systems, which are face-mounted in the precast concrete walls. Portions of demising walls between the shops were also designed to be removable, providing more flexibility in the future. "That would be harder to achieve with typical concrete masonry units at these locations," explains Lyubetsky.

Even though the school building does not carry an official designation as an emergency shelter, some areas within the building can be used in an emergency. The precast concrete structure does help and fits well into these scenarios. "We incorporated multiple safety features in the design of Taconic High School, as the topic of security for school buildings is very relevant today. We have found that the precast components have helped implement the school's security strategies. The benefits of the precast structure were more of a natural extension of other more significant reasons for selection of the material for the project," says Lyubetsky.

Upon entering the building is a welcome desk with a sight line down each of two long corridors, one leading to the gymnasium, auditorium, and library, and the other to the vocational shops.

'We have found that the precast components have helped implement the school's security strategies.'

The new Taconic High School will include a 600-seat, two-tiered auditorium equipped with the latest technology. This flexible,

The new building is three-stories, with the academic classrooms on the top two floors and the vocational shops on the ground floor. Illustration: DRA.

multiuse venue will be used for a variety of activities such as performances, plays, concerts, and assemblies. The state-of-the-art auditorium will also double as a community space, with public access via a central lobby. Pittsfield Public School district hopes Taconic will be used over the summer and in the evenings as an educational space for the entire community.

Taconic High School features several wall textures and finishes. The panel surfaces included light to medium sandblasting areas, deep acid etching of the surfaces in a few areas, as well as application of the custom formliner, along with variation of the color mixtures for the panels.

According to Lyubetsky, "The city's goal for the new school was to convey a forward-looking and inviting image. The colors and textures of the precast elements were selected to reinforce these goals, while giving a sense of warmth. The site is surrounded by distant hills and the natural environment in the area is spectacular. The combination of all these factors informed the overall design concept, and we believe that the precast elements support that."

The project design did include the concept of potential future expansion. The concept wasn't impacted by use of the precast concrete. Says Lyubetsky, "We believe precast components would be a good choice for any future expansion.

"We had very positive experience in working with Coreslab and their engineering subconsultants during the predesign phase of the project. There was real value added to the project by following this process. We would recommend that if a project involves significant precast design elements, involving the precast subcontractor early during the design phase would only enhance the chances of a successful project."

The team worked well within the restrictions common to school construction projects. Given the proximity of the new facility, there were limitations to schedule and operations as well as shutdowns and noise constraints while school was in session. The project is on schedule and was expected to be completed by June 2018. In the fall, students will occupy the new building while the old one is razed and turned into playing fields.

The new Taconic, with an enhanced vocational/technical course curriculum and modern classrooms, shops, and other school spaces, is considered a key to boosting the city's economy by preparing students for well-paying jobs that are now sometimes going unfilled in the region.

The success of Putnam encouraged DRA to continue to use precast concrete building systems on other large-scale high school projects. They are currently completing construction of a new comprehensive high school for the City of Pittsfield and have two new vocational technical high schools in design, one located on Cape Cod, Mass. and the other in Milford, Conn.

REPORT CARD

These three projects depict how across the country, career tech schools are playing an integral part in educating and training workers. The technical schools are part of the equation to meet the needs of the workforce, and precast concrete is an integral part of meeting their design goals.

Many of the contractors and subcontractors in these projects partner with the vo-tech centers by offering internships and participating in career training. In the near future, students enrolled in construction trade curriculum at career tech centers may be future employees.