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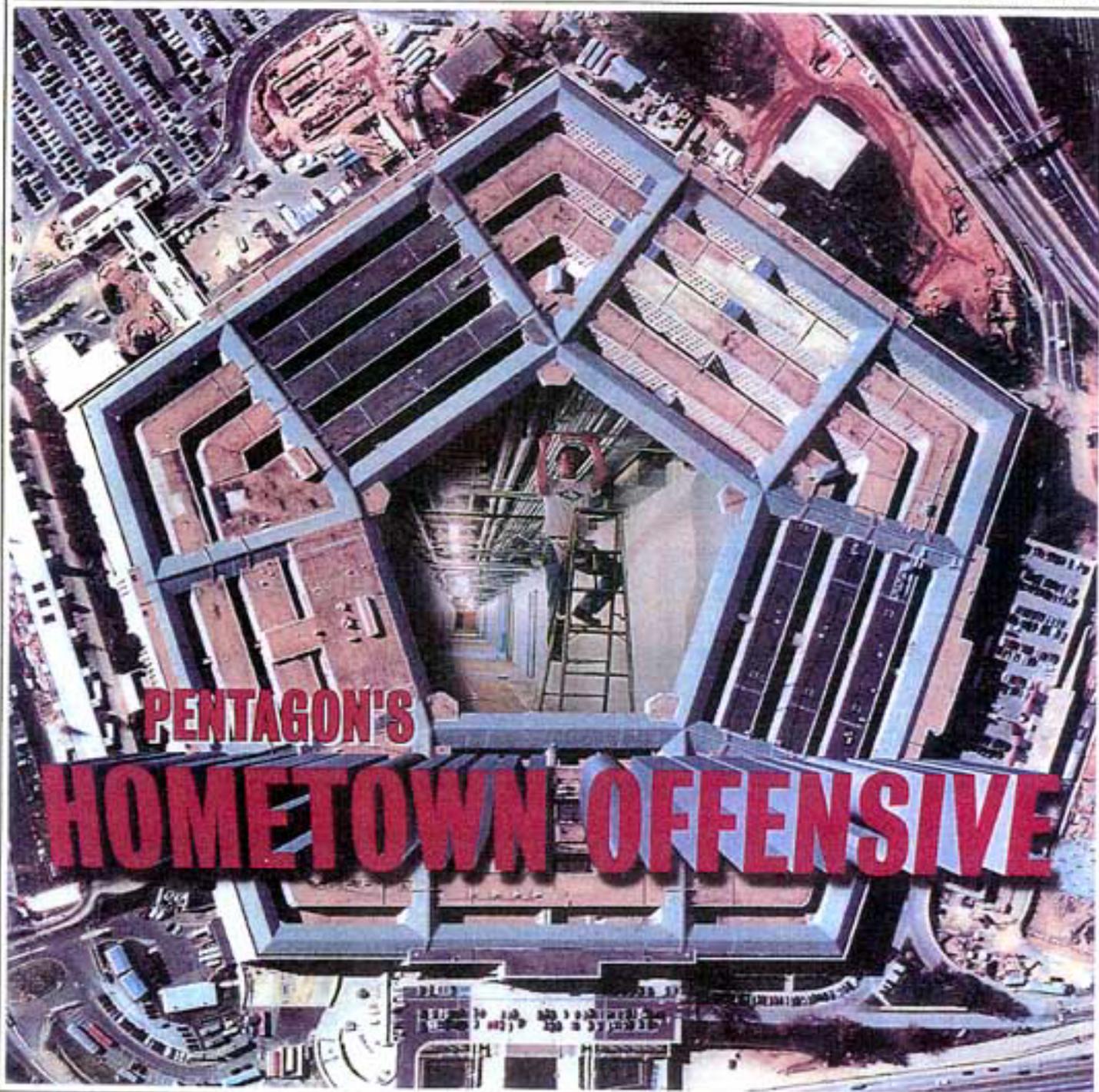
► **LABOR:** Unusual bonus payment is added to settlement of St. Louis concrete drivers' strike as delivery to stalled projects resumes

► **MATERIALS:** Fiberglass and carbon bridge in California is first to be designed for truck traffic

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PENTAGON'S HOMETOWN OFFENSIVE

Pentagon Contractors Divide and Conquer

Recovering from early losses at a 6.5-million-sq-ft reconstruction

The U.S. Dept. of Defense's 6.5-million-sq-ft headquarters, considered the world's largest building, is accustomed to around-the-clock government operations. But since 1993, the Pentagon has seen a different kind of action—its first significant renovation since it was built as a temporary facility 57 years ago. The 20-year undertaking, with its divide-and-conquer strategy, is as exacting as the \$1.222 billion congressionally set cost is precise.

The massive project has had its share of organizational nightmares. In the early stages, there was no single Pentagon program manager for the gut renovation and no clear chain of command. Communication breakdowns often led to inefficiencies, delays and, eventually, cost overruns.

"We were put together wrong," says Walker Lee Evey, the procurement official the government brought on board in 1997 to head up the Pentagon Renovation Program office.

As cost overruns escalated, particularly a \$50-million contract for one segment of the basement overhaul that ballooned to \$125 million, officials realized "there was a problem with the program as it existed and that changes had to be made," Evey says.

Evey was a stranger to construction, but he did have some practical ideas about how to administer the program and get it back on track while sticking to the budget (ENR 10/4/99 p. 10). He restructured the management team, including reducing overall government staff by 66%. The reorganization, which coincided with a shift

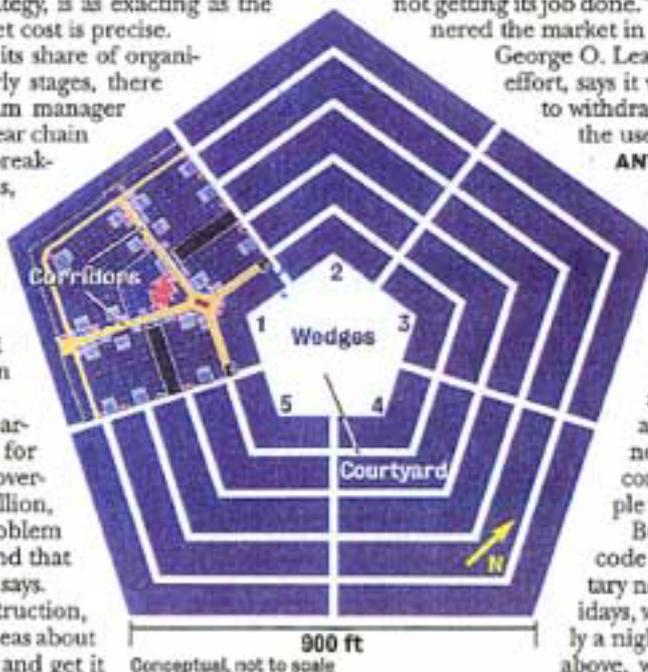
from design-bid-build to design-build contracting, led to the departure from the project earlier this year of the U.S. Army Corps of Engineers. The Corps had been responsible for the design and implementation of construction activities.

Evey refuses to place blame for the job's troubles solely on the Corps. Instead, he says, "the organization as a whole was not getting its job done." The Corps "certainly had not cornered the market in deficiencies," he adds.

George O. Lea Jr., who led the Corps' Pentagon effort, says it was "more of a business decision" to withdraw from the project as it shifted to the use of outside consultants.

ANTIQUATED. The Pentagon renovation was overdue. Infrastructure of the Arlington, Va., building was virtually obsolete. Telecommunication systems could not handle current demand and new ones would further compromise the already antiquated heating, ventilating and air-conditioning system. In addition, the five-story building had no passenger elevators and did not comply with accessibility laws for people with disabilities.

But bringing the Pentagon up to code is no simple operation. The military never shuts down, not even for holidays, weekends or vacations. "It was really a nightmare to keep this building alive above, while we were basically gutting it below," says Tom Rohrbaugh, the lead mechanical engineer in the Washington, D.C., office of URS. The architect-engineer worked on the expansion of the basement and creation of a mezzanine



FIVE NOT-SO-EASY PIECES

Officials divided the interior work, discounting the basement expansion, into wedges. Work, hampered by keeping four wedges operational, involves shuffling 25,000 building occupants.

directly above the basement.

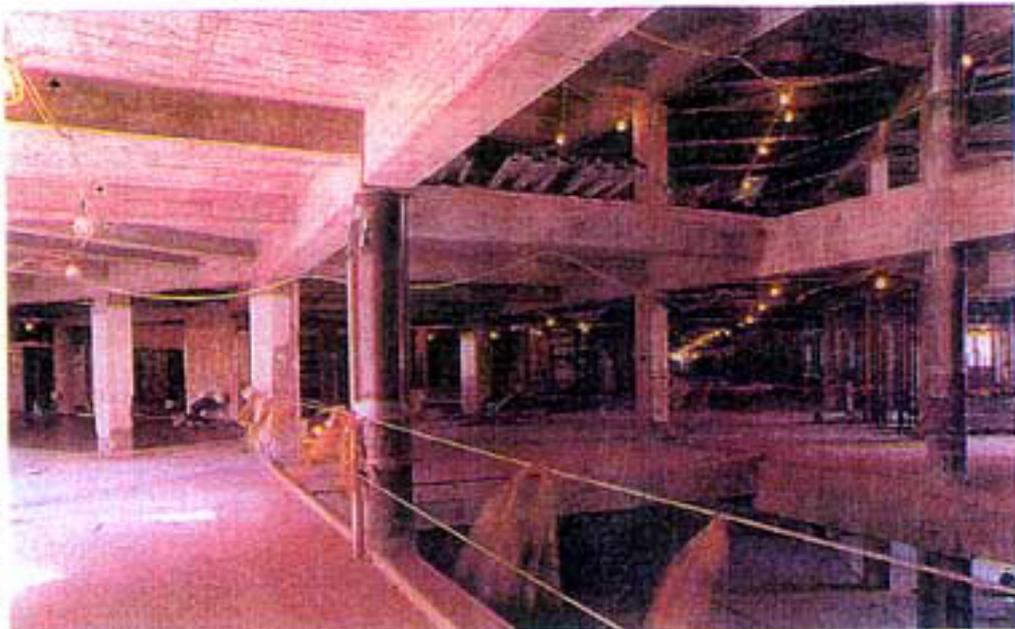
The Pentagon, with its five, 900-ft-long elevations, covers 29 acres and is built around a five-acre courtyard. In plan, the building is comprised of five concentric pentagons or bands, each a glazed building on the upper three floors. Building bands alternate with light-well bands that bring daylight into interior spaces. The Pentagon has 10 main cross-band corridors, which radiate from the front elevation toward a corner of the courtyard, where they meet and form a V. The radials outline five corner chevrons. Each chevron alternates with a rectangle to form the five-sided five-band shape.

Upgrading the Pentagon began in 1993 with construction of an adjacent heating and cooling plant including appropriate utility connections.

For phases three through seven—the gutting and rebuilding of the interior—the Pentagon's inhouse design committee divided the building into five wedges. In plan, each contains a corner chevron flanked on each building side by half of an adjacent rectangle.

Wedge sequencing was chosen because the building was originally constructed so that each wedge would function independently, with its own utility feed. Wedge one is 70% complete, with work on wedge two expected to begin next July. Reconstruction of each wedge is scheduled to take about three years.

The overall project also will relocate all entrances, including the Pentagon's subway entrance, to the second floor. Visitors will enter via new limestone-clad pedestrian bridges. Because of the building's landmark status, "the design, materials and textures had to be com-



GUTTED Wedge one work, full of surprises, has become a proving ground for the next four.

patible with the existing facade," explains Cecil G. Doyle, the president and CEO of Hayes, Seay, Mattern & Mattern Inc., the Roanoke, Va.-based architect-engineer for the bridges.

The bridges, one completed and the other set to open this fall, were simple compared with the basement expansion. Work went on under portions of wedges two, three and four.

The original plan was to double the basement and add a mezzanine, creating 1.1 million sq ft of usable space. Cost overruns in various parts of the project prompted completion of only one segment of the basement.

A 220,000-sq-ft section of the basement was dug out 3 ft, creating enough clearance to add a 220,000 sq ft mezzanine. Each level now has 12-ft ceiling heights.

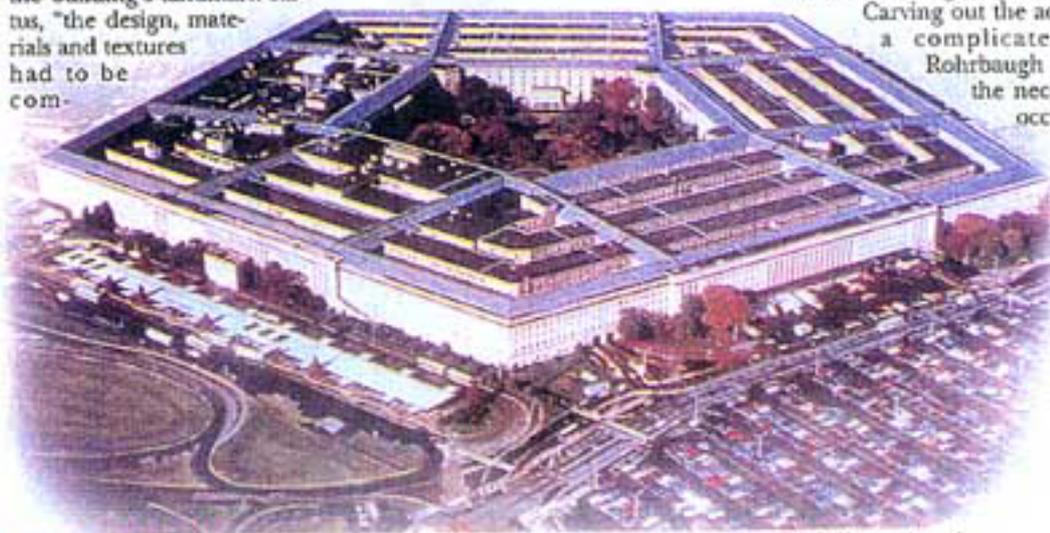
Carving out the additional space proved to be a complicated structural problem, Rohrbaugh says. It was compounded by the necessity to add piles under an occupied building.

Crews also discovered need for additional underpinning of existing foundations. Poor soil conditions due to a fairly high water table didn't make work any easier, says Rohrbaugh.

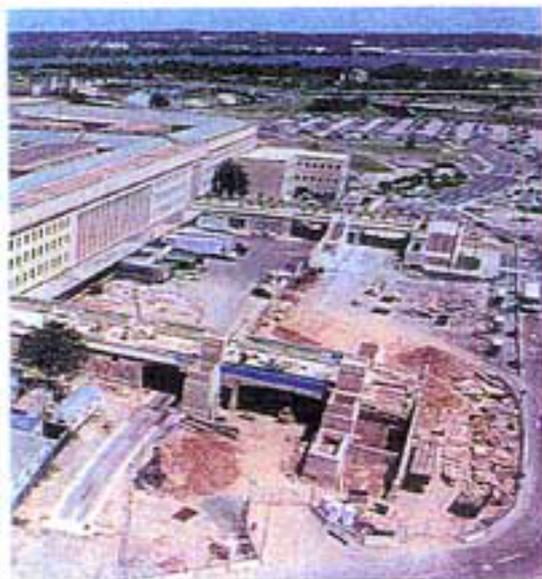
Basement work also included bringing pipes and conduit in from the central plant to feed up to the individual wedges. At the same time, utility service had to be preserved to the



DOYLE



CONCENTRIC MINORITY World's largest building, with antiquated systems, didn't meet codes.



WELCOME MATS New pedestrian bridges had to match historic facade.

rest of the fully operational building, says Rohrbaugh.

Wedge one encompasses nearly 1.2 million sq ft, about 240,000 sq ft on each of the five floors. Interior demolition began in January 1998, but only after 5,000 employees—the Pentagon serves 25,000 total—moved to temporary space in nearby office buildings. The original plan was to move those workers back into wedge one upon its completion early next year, and move the occupants of the next wedge to an off-site location. The moves off and back on site would last for years, as each wedge was completed and displaced workers moved back into renovated space.

That plan priced out to be too costly—\$300 million by one estimate. Instead, the first group of relocated employees will stay in the temporary location until the entire project is finished. Workers in wedge two will move into wedge one when it is renovated and following that, workers from wedge three will move into the new wedge two.

Work on wedge one turned out to be a proving ground for the four that will follow. Asbestos, much greater than originally expected, and other hazardous debris prolonged this portion of the project, says Tom Fontana, a spokesman for the Pentagon Renovation Program.

Workers from Austin, Texas-based Radian International, now part of URS, removed 2,000 tons of asbestos-containing material. Hazardous waste abatement also included removal of polychlorinated-biphenyl ballasts, mercury light tubes and switches and radioactive smoke alarms.

A similar amount of hazardous waste is expected to be removed from

each of the other wedges. Thanks to the learning curve, work will be more efficient and workers will "remove only what we absolutely have to," says Fontana.

David L. Diehl, Radian's project manager, says the hazardous materials went to landfills in Pennsylvania. Workers were able to recycle as much as 70% of the other building materials, including most metals.

SURPRISES. Radian workers, who also performed demolition, were frequently surprised by conditions not indicated on the original building plans. The haste to complete the Pentagon, erected in only 16 months beginning in September 1941, meant changes to the plans made during construction often went undocumented.

The lack of up-to-date documentation was the biggest challenge, agrees HSM&M's Doyle, which also served as the architect-engineer for wedge one. Simply identifying existing utilities—in use, abandoned or that needed to be abandoned—was



SECURE PERIMETER Blast-resistant windows, wall mesh installed to contain bomb fragments.

very complicated, he says. However, "the actual designs for the new systems are fairly straightforward," Doyle says.

Demolition workers also found items in the walls that weren't accounted for, including a secure vault that was obscured by drywall. That discovery brought out guards and police dogs. Unbeknownst to them, workers had set off a silent alarm in the ceiling as they opened the wall that hid the vault. The demolition team also found old whiskey bottles, Pentagon matchbooks and a newspaper from 1942. The headline was about Hitler. The items were turned over to the Pentagon's historical society.

Diehl explains that though the wedges were expected to be independent, most utilities and communications systems run in and out of wedge one into adjacent wedges. Workers had to isolate the wedge from the rest of the building, deadening electric wires or capping appropriate utilities.

Keeping all the other wedges fed turned out to be difficult. "We hadn't done a brilliant job of thinking that through," says the Pentagon's Evey. Crews had to add bypasses to keep chilled water lines pressurized, for example.

Often crews had to trace the pipes out before capping them. But maintenance workers in other areas of the Pentagon weren't always aware of the wedge one work. This lack of communication led to some surprises that scared workers, including a mishap involving what was supposed to be a dead utility line, says Diehl.

Unlike most construction, both demolition and new construction were sequenced from the top down, says David C. Kersey, vice president and project executive for Morse Diesel International, the general contractor.

This was dictated by the schedule set by DOD officials to move personnel out of the wedge, he explains.

Following demolition, structural modifications were made including the addition of heating and mechanical rooms in parts of the light wells, and their structural supports. Workers had to be cautious to avoid intruding upon utility tunnels under the first floor. The new facility, with its upgraded building systems, is expected to be about 20% more energy-efficient despite the increased demands of current technology.

The building is getting about 400 blast-resistant windows. Another security measure includes reinforcing the



REINFORCEMENTS Inside surface of historic facade wall readied for steel reinforcing.

brick backup walls of the limestone facade with a metal fabric mesh similar to the material used in vehicle airbags, says Kersey. The mesh would contain debris fragments in the event of a blast.

All of the building's 7,748 windows will be replaced. For historic preservation, the design incorporates a fake handle to resemble the original. And, for the first time, the building is getting passenger elevators, 40 in all.

Wedge one is two to three months behind schedule. The Pentagon attributes that to program-imposed changes. This fall, the contractor will begin turning over 40,000 to 50,000 sq ft each week, through summer.

Evey admits the fit-out could have gone better. "We were not thoroughly knowledgeable of who would be moving in and what the requirements would be," he explains, which added to cost. "I can't dump that on the contractor, that was poor planning on our part," he says.

The Pentagon will award one design-build contract for the remaining wedges, probably by next July. Three groups in contention are a Greeley, Colo.-based Hensel Phelps-led team; a Bethesda, Md.-based Clark Construction-led group called Pentagon Design-Build Inc.; and Team One, led by Dick Corp., Pittsburgh.

The winner will be selected based on a number of criteria, including which team "gives us the greatest confidence that they can give us the best for our money," Evey explains. "We've built enough time into this schedule to really understand this and work it out," Evey says. □

By Sherie Winston in Arlington



NEW ERA First spaces on line are in basement.