Design For A Fleet Maintenance Facility

From the drains on the floor to the lights on the ceiling, architect Larry Jacobsen shows how successful projects always win on the details.

In the last issue of PE&T, Larry Jacobsen presented the basics of planning and programming a fleet maintenance facility. This second article examines the design and construction processes. Larry uses as an example the Norfolk, Nebraska, Equipment Services Facility, which was designed by The Schemmer Associates, Inc. and completed in November of this year.

The competed project

Project Information

Equipment Services Facility City of Norfolk, Nebraska

Area: 14,150 square feet
Construction Time: March 1996–November 1996
Construction Cost: $1,030,030.00
Owner: City of Norfolk, Nebraska, Jim Koch, Director of Transportation, Buildings and Grounds

How can you design a building if you do not know the owner’s needs? Yet that is precisely how many projects begin. The facility owner may give some general guidelines like, “I need eight maintenance bays, a wash bay, a maintenance shop, parts room and support spaces”; and the architect will begin sketching and modifying—and sketching and modifying some more—until the owner begins to visualize all the spaces and equipment needed. However, by that time both the owner and architect often become frustrated with each other. The owner may feel the architect “just doesn’t get it,” and the architect wonders if the owner will ever make up his mind on what he wants.

What’s the difference?
In the last issue of PE&T, I distinguished between programming and design. Programming states the problem. Design solves the problem.

Programming simplifies the process and makes it so much more logical. Jim Koch, the Director of Transportation, Buildings and Grounds for the City of Norfolk, describes the advantages of the programming process. “Before we ever began to design, our mechanics and foreman went with the architects to visit several other municipal facilities to see what functional and operational systems worked well, and which did not. Then we began a process with the architects in which all our mechanics participated in defining the needs of the facility. I firmly believe the reason we had so few change orders on this project was because we had so much participation in the programming phase," Jim Koch says. "We defined exactly what we needed, down to the smallest piece of equipment, before the architect ever began designing the building."

The cost of a well-detailed program is usually in the range of H to one percent of the construction expense. It is not uncommon for owners to budget 3–5 percent of the construction cost just for changes during construction; so if a good program eliminates most of these changes, then programming is definitely a good investment.

Transition to design

In addition to defining the facility needs, the program will often serve as the basis for the building's source of funding. Therefore, it is not uncommon to have a time gap between the completion of programming and the start of design. In the case of the Norfolk facility, two years passed before the City could budget the $1 million dollars needed to construct the facility.

As a result of a time lapse, there may be an interim phase that we call program augmentation. This is an opportunity to revisit the program, make sure the scope and budget are still in balance, ensure that any changes in the municipality's operations have been accounted for, and bring any new employees up to speed on program goals.

Once the program is finalized, here is what it defines: all the spaces; the area and volumes required; the desired adjacencies; the physical characteristics of each space; the mechanical and electrical requirements; and the equipment required for each space.

Now, for the first time, the owner and the architect begin to solve the design problem and explore alternative ways of putting the pieces together. The transition from programming to design is a continuation of the planning process. There is as much owner participation in the design phase as there is during the programming phase. Jim Koch, speaking for his department, notes, "We asked a lot of questions. As a result, we caught a lot of things early in design before they became construction problems."

The problems to solve are many:

• Functional adjacencies
• Vehicular circulation
• Coordination of building systems
• Lighting
• Safety
• Temperature control

A problem has many solutions

By exploring alternative floor plan schemes, the user groups can model their operations against the facility layouts to determine how to achieve the greatest efficiencies of vehicle maintenance and service. In other words, are side-by-side or tandem bays the best for mechanics? How far do you have to travel to the parts room? Where do we place the support functions that serve all bays?

In the Norfolk project, the program determined the need for two maintenance bays per mechanic. This allows one vehicle to be staged while the other is being serviced. Again, Jim Koch comments, "Our planning for maintenance will be so much better when we move in the new facility because we planned ahead on design. In our old building, there was no way we could measure our efficiency; but with the new facility, efficiency can be measured, and it's the design of the facility that allows us to do that."

It's the Details, Stupid!

Clinton won in 1996 on the economy issue. Successful projects always win on the details. And there are many details that make for a successful fleet maintenance facility. The Norfolk facility is a 14,000 square-foot building. The desired configuration of spaces permitted the building to be a simple rectangular structure. The framework of the structure is a pre-engineered metal building with standing seam metal roofing and metal wall panels above the masonry wainscot. This highly efficient structure allowed us to build the quality into the functional and operational details of the building.

Figure 2 is the floor plan of the Norfolk facility. All the maintenance bays are set up on a drive-through arrangement. It allows enough flexibility for large vehicles to come straight through the facility without backing up. At the same time, other bays are used as head-end bays. The bay widths are a generous 22 feet, which allows for ample working space between vehicles. In cases where an overload of vehicles might be expected, two automobile-size vehicles can actually fit side by side in one bay. **Figure 1** is a cross section of about half the building. From the drawing you can get some idea of the enormous coordination required between the building structure and the equipment (mechanical, electrical and maintenance) in the building.

Figure 1: Cross Section of the Building

Figure 2: Floor Plan—Norfolk Facility

Light fixtures are positioned between the bays to ensure that the overhead doors, when open, will not block the light. The perimeter radiant heating system is carefully coordinated with other building systems so that the heat does not damage other components. The routing of lubrication lines is carefully planned so that it does not interfere with overhead cranes, doors and lights. In short, everything must be planned.

Look at it this way: the building and its equipment components are like a large engine. If anything is out of place, the facility will not run at optimum efficiency. In a worst case scenario, the facility may simply not function at all.

Norfolk, like many municipalities, services many different sizes of vehicles and equipment. For that reason, we provided three different sizes of hydraulic lifts: two at 8,000 lbs. for cars, vans and pickups; one at 36,000 lbs. for medium size trucks; and one at 54,000 lbs. for lifting the City's largest equipment.

The wash bay is designed to be used by other City department vehicles that may not be housed at this site. Therefore, a touchpad remote overhead door operator was provided that allows them to use the wash bay without disrupting the maintenance operations in the building. These are examples that point to the importance of details and proper planning.

Let there be light

The old days of dark, cavernous maintenance spaces with multitudes of trouble lights looking like a miners' caravan are gone. Efficiency experts long ago determined that more and better light (to a point) will increase productivity. The Norfolk maintenance bays are designed to 50 foot candles per Illuminating Engineering Society (IES) standards. This is the same level of light typically provided in office spaces, and for good reason: the level of detail for tuning an engine is as exacting as any office function. The Norfolk maintenance area lights are high bay metal halide. Putting all the lights in the maintenance area on the same phase could cause a strobe effect. Strobe lighting could be very dangerous around moving engine parts, so we were careful to stagger the phasing of the lights to avoid it.

To achieve energy efficiency and flexibility, the lights for each of the bays are separately switched. This allows servicing after hours to be done in one or two bays without turning on all the lights in the maintenance area.

A safe bet

Justifications for a new maintenance facility are often driven by needs for additional space and improved efficiency, but among the greatest benefits of a new facility are the built-in safety features. Most of the older facilities were constructed before OSHA became a household word. Safety used to be the employee's responsibility. Today, it's mainly the employer's responsibility; and the new maintenance facilities we see today have "safety" stamped on just about every physical feature of the structure.

The Norfolk facility was designed according to the 1993 BOCA Code and the 1993 National Electric Code (NEC). In the NEC, vehicle maintenance spaces are classified as Class 1, Division 2, Hazardous, up to a level of 18 inches above the floor. The hazard could be anything from explosion due to fumes to the environmental hazard of inhaling the fumes, or a multitude of other concerns.

Any potential concerns require the attention of the facility designers. For example, all electrical outlets are mounted at 48 inches off the floor to protect from the possible explosion due to the low lying gas fumes. Electrical outlets in the flammable storage room are explosion-proof fixtures, and all electrical raceways entering or exiting these areas are provided with seal-offs.

In repair garages, the BOCA National Mechanical Code requires mechanical ventilation capable of exhausting 1.5 cfm per square foot of floor area throughout the entire repair garage (this is exhaust in addition to any vehicular tailpipe exhaust systems). The exhaust system is controlled by carbon monoxide and diesel detection systems.

The detection systems activate this “general” exhaust system when the concentration of carbon monoxide or diesel fumes exceeds the levels dictated by the code.

An overhead vehicle tailpipe exhaust system for carbon monoxide and diesel removal has been installed at all vehicle maintenance bays. This exhaust was designed to be the lowest quantity possible to be consistent with adequate ventilation and safety according to the BOCA code.

The hydraulic lift pits have been provided with pneumatically driven sump pumps; this will minimize the possibility of explosion due to the low lying gas fumes.

The waste oil containment system has been designed with a 550-gallon double-wall fiberglass tank, a leak detection and inventory control system, and with alarms and wiring connected to a leak detection and level measurement system. The tank and all interconnecting piping has been installed in accordance with Title 159 Nebraska Administrative Code Rules and Regulations for Underground Storage Tanks.

Continuous trench-type floor drains have been provided at each overhead door. These trench drains are piped to a waste oil separator system. It consists of two basins piped in series—with the first basin used as a sedimentation pit to settle and float the waste, and a second basin used as an oil separator. Safety and environmental protection go hand-in hand; few can argue with the positive benefits to employees and the public as a result of the improvements described above.

Figure 3: Schematic of Lube Room Piping
1. All components shown in this area are required for each individual pump.
2. All components shown in this area are required for each compressed air drop (from overheard main) to a series of pumps.

The 35,000 pound ice cube
If someone placed an ice cube in a metal lunch bucket, how long would it take for the space in the lunch bucket to become cold? Look at it a different way: set a 36,000 lb. public works truck outside in zero-degree weather for 10 hours and then bring it into the maintenance shop for service. How long will it take for this 36,000 lb. ice cube to make life uncomfortable for the mechanics in the maintenance shop?

We often plan for heat loss through the building wall, or for the condition of cold outside air entering the building when the doors are opened and closed. However, we rarely plan for the effect of this cold hunk of steel setting in the middle of our space, giving off cold and absorbing the heat. Equilibrium may be measured in hours, not minutes.

It is situations like this that have given rise to the popularity of radiant heating systems, where the objects—not the air—are heated, and the objects radiate the heat back. The Norfolk facility was designed with a gas fired radiant heating system around the perimeter of the maintenance area, immediately above the overhead doors, at about 16 feet above the floor line. There is also a make-up air unit at the end of the space. The maintenance space was designed to be heated to a temperature of 65°F.

A more effective and more costly system is to provide radiant heating in the floor, whether it be a recirculating hot water system or electric mats. For the mechanic who spends most of his time near the floor, the radiant floor system is often the system of choice, but initial costs and operating expenses often dictate the overhead system.

Summary

I have, of course, only touched the surface of the technical issues related to the design of fleet maintenance facilities. A thorough examination of this subject would consume an entire book. The purpose of this article is to demonstrate that a fleet maintenance facility is only a means to an end.

In other words, ask yourself:

• Does the facility provide for proactive, consistent maintenance of the vehicles and equipment?
• Does it provide adequate space for all the maintenance functions?
• Do the facility and equipment promote more efficient vehicle service at the lowest cost?

These are the economic factors that make a new facility worth its salt.

The second purpose of this article is to demonstrate that facility planning and design is a continuous process. When asked why the Norfolk project proceeded so smoothly through programming, design and construction, Bill Cramer, A.I.A., project manager for The Schemmer Associates responds, "There are three main reasons. First, we let the process work. Programming and design are both logical approaches for involving the owner in the decision-making process. So people set aside their preconceptions of what they thought the building should be and let the programming and design process define the best building that could be.

"Secondly, we paid attention to the details, and remembered that no one's details are mutually exclusive to the rest of the design. Coordination is as much a part of the quality process as the details. "Third, we functioned as a team of partners. The process is so much more fun when everyone works together for the common good of the project as opposed to each participant watching out for number one. We were extremely fortunate on the Norfolk project to have a participating client in the City of Norfolk, and a quality contractor in J.H. Hespe Company."

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