The Planning and Design of a Fleet Maintenance Facility

Sound theory is crucial, but it depends on a foundation of well-organized practical information. Architect Larry Jacobsen provides some tools.

Outside the Norfolk, NE Equipment Services Building, currently under construction.

I don't know what I want, but I'll know it when I see it," or "Design me a fleet maintenance facility that's just like the one in the next community." These two diverse, but all too common, approaches to facility design ignore the essential first step to building a successful fleet maintenance facility—planning.

This first article in a two-part series will address the planning process for a fleet maintenance facility. The second article will discuss the process of design and development of the construction documents. The articles are based on the Norfolk, Nebraska, Equipment Services Building, which was designed by my company and is currently under construction. The processes of planning and design presented here are not exclusive to fleet maintenance facilities, but work equally well for most types of buildings.

"A Plan is What You Have When You Get Tired of Planning"—Murphy For those unfamiliar with the process of planning, Murphy's Law of Planning may seem like the norm. But actually, planning is a very objective pre-design process. First, it is a pre-design process that defines the problem for the designer. Designing the project before the design scope is determined leads to inefficiencies, and often a poorly functioning facility.

Interior of the Norfolk, NE Equipment Services Building currently under construction supervised by The Schemmer Associates, Inc..

Planning is also known as facility programming, which is a more accurate description of the pre-design process. Webster's Dictionary defines programming as "a process leading to the statement of an architectural problem and the requirements to be met in offering a solution." William Pena, author of Problem Seeking – An Architectural Programming Primer, stated it this way: "If programming is problem seeking, then design is problem solving." This is probably as basic a distinction between planning and design as you will find. So let us proceed to the problem.

A typical fleet maintenance facility ranges anywhere from about 5,000 square feet to several hundred thousand square feet, depending on the size of the city or a company's fleet. The case study in this

article is based on a community of about 25,000 population. The main purpose of the fleet maintenance facility is, of course, to provide an adequate number of maintenance bays along with support areas such as maintenance shops, central lubrication systems, parts rooms, general storage areas, supervisor's office, break rooms, restrooms, lockers and mechanical space. This list is by no means all-inclusive. The objective of the planning process is to clearly identify exactly what functions are required. That begins with the first step in the planning/programming process: data gathering.

There are several important types of information needed to begin programming a fleet maintenance facility. First, how many and what types of vehicles are in the fleet (e.g., 12 automobiles, 15 pickup trucks, 14 heavy dump trucks, etc.)? Second, how many people are currently assigned to the maintenance operations and how many shifts are worked? Third, what maintenance functions are performed in-shop and which ones are contracted out? (**See Figure 1** for an example of a data gathering form.)

This information alone will significantly affect the type of maintenance facility to be designed. Obviously, a facility that services all the same type of vehicles will be drastically different than a facility that maintains everything from automobiles to fire trucks.

Figure 1: FLEET MAINTENANCE FACILITY DATA
Location: City of Norfolk, Nebraska - Equipment Services Building

1. VEHICLES/EQUIPMENT

Type of Vehicle	Quantity	Length	Height	Weight
Trucks	35	25 ft.	10 ft.	28,000#
Pickups - Vans	37	18 ft.	61/2 ft.	3/4 ton
Cars	22	18 ft.	51/2 ft.	3,000#
Heavy Equipment	14	28 ft.	12 ft.	23,000#
Tractors	9	13 ft.	91/2 ft.	8,500#
Miscellaneous Equipment	60			
TOTAL	177			

2. PERSONNEL

Category	Shift A	Shift B	Shift C
Supervisor	1	N/A	N/A
Foremen	0	N/A	N/A
Mechanics	3	N/A	N/A
Servicemen	1	N/A	N/A
Clerical	0	N/A	N/A

3. FLEET MAINTENANCE FUNCTIONS

Functions	Performed In-Shop	Contracted Out
Fueling	100%	0%
Washing	100%	0%
New Vehicle Preparation	100%	0%
Lube and Oil Changes	100%	0%
Unit Repair (Alternators, Generators etc.)	95%	5%
Wheel Alignment	0%	100%
Front End Alignment	0%	100%
Brake Work	100%	0%
Tire Work	0%	100%
Welding Repairs	100%	0%
Collision Repair, Frame and Body Work	50%	50%
Painting	60%	40%
Transmission and Axle	95%	5%
Hydraulic System Repair	100%	0%
Radio Service	5%	95%
Diagnostics	90%	5%
Small Engine Repair	100%	0%

An incredible amount of equipment is housed in a fleet maintenance facility. In many cases however, the municipality or company has never conducted an equipment inventory. This step is a must in the planning of a fleet maintenance operation. Almost all new or expanded facilities will reuse some or all of the fixed and movable vehicle maintenance equipment. A detailed inventory will include a description of the equipment, manufacturer, physical dimensions, utility connections and a photograph of the piece of equipment. (**See Figure 2** for a sample equipment inventory form.) When this equipment information is all tabulated the programmer and the owner can sit down and objectively determine if a piece of equipment should be relocated, discarded or replaced. This information is essential for the planner/programmer for it can dramatically affectthe size and

configuration of the spaces in the proposed facility.

Site data, or site selection, is another key component in the data gathering phase. If you are selecting an entirely new site, the process of gathering information to make an informed decision can be very demanding, and the subject is worthy of a separate article in Petroleum Equipment & Technology at a later date.

In many cases, however, the site is already determined, or someone may be adding space on an existing fleet maintenance facility site. Information needed includes accurate topographic information (including location and sizing of all underground utilities and other improvements, location of easements, right-of-ways, zoning setbacks and access points), environmental restrictions, soil conditions and other conditions. The planner and owner should review a detailed checklist of the site data during the early stages of the planning/programming process.

Figure 2

Data analysis involves several key components:

1) a calculation of demand (how many vehicles will be serviced in a year);
2) an analysis of the individual spaces required in the facility; and
3) an analysis of the alternatives available to you in siting the facility.

Calculating the demands for vehicle maintenance, or facility utilization, is an essential part of the planning process. It requires documentation or an estimate by the shop foreman of the number of planned maintenance and breakdown visits per year, and the average service time for each of the different vehicle types. (See Figure 3 for an example of the demand form.) This information provides a good indication of the number of maintenance stalls required and the number of staff required to service the current number of vehicles in the fleet. If you are given the population projections of a municipality, or trends for a company, you can use the data to project the number of maintenance stalls required over the next 5 to 10 years.

Look at the utilization chart (**see Figure 3**) for an example of this analytical approach to determine maintenance bay needs. The total planned and breakdown maintenance visits per year totals 3,620 hours or 452 workdays. This is the time spent on maintaining or repairing the 117 vehicles in the Norfolk City fleet. It does not include the time spent on maintaining and repairing the 60 pieces of miscellaneous equipment, such as mowers and other small engine equipment.

Assuming that mechanics work a 40-hour week with a utilization of 75 percent (vacations, sick leave, holidays, nonbillable time), the annual hours per mechanic available for vehicle maintenance work is 1,560. This figure justifies the need for three full time mechanics, balanced against the 3,620 hours required for maintenance of the Norfolk City fleet (3,620÷1,560 = 2.32). (The difference between 2.32 required personnel and 3.0 actual personnel is justified by the time required to maintain the remaining 60 pieces of small, miscellaneous equipment.)

Figure 3: FLEET MAINTENANCE FACILITY UTILIZATION
Location: City of Norfolk, Nebraska - Equipment Services Building

	Auto/ Van	Small Trucks	Med. Trucks	Heavy Trucks	Heavy Equip.	Misc. Veh.
Number of Vehicles	25	34	31	4	14	9
Number of Planned Maintenance Visits Per Year (Total Per Category)	100	129	62	8	42	21
Average Duration of P.M. Visit	4 hr.	5 hr.	7 hr.	8 hr.	9 hr.	9 hr.
Number of Breakdown Maintenance Visits Per Year (Total by Category)	103	39	70	20	84	189
Average Duration of Breakdown Maintenance Visit	3 hr.	2 hr.	2 hr.	4 hr.	4 hr.	3hr.

The City of Norfolk is projected to grow moderately over the next 10 years, and its growth would justify the need for additional vehicles and one additional mechanic. Therefore, the facility is being planned as a four-mechanic facility.

On a single shift operation, it is common practice to provide two maintenance bays per mechanic. This provides the opportunity to stage one vehicle while the other is being serviced, or if delivery of parts delays one vehicle, the mechanic can work on he other one. This arrangement maximizes the mechanic's efficiency and keeps more vehicles awaiting maintenance out of the weather.

With four mechanics, and based on the usage data, we analyzed that the facility would need a minimum of six maintenance stalls plus three preventive maintenance stalls. We also recommended that the bays be drive-throughs with two stalls per bay because this facility will service numerous pieces of large equipment and fire trucks; and the drive-through buys will facilitate maneuvering of vehicles.

Once we determined the number of maintenance and service stalls required, it was very tempting to immediately begin to design the facility. But there is an important step to take here that will save the designer and the facility user a lot of grief down the road: the program space analysis form. This is a standard form that is filled out for each and the activity to take place, the goals and objectives of the space, the desired adjacencies to other functions, the special building and utility requirements that are to be provided in the space and a listing of all the equipment that will be housed in the space. (**See Figure 4** for a sample of the space analysis form.) Each form is accompanied by a diagrammatic floor plan sketch that depicts, to scale, the desired space configuration, and the equipment and utility services in the space. (**See Figure 5**.)

Figure 4: PROGRAM SPACE ANALYSIS
(Excerpt of original form)
Norfolk Equipment Services Building—Vehicle Maintenance Facility Data

Activity Area Code No.	Activity Name	Number of Occupant(s) Per Space	Number of Spaces Required	Area Per Space (NASF)	Total (NASF)
1.01	Maintenance Bays	1	6	22x37.3	4,950
Description:	• Maintenance and repair of vehicles and equipment		• Storage of large equipment in inclement weather • Two-speed, 3 ton bridge crane • Drive-thru bays - 2 stalls per bay • Adjacent to supervisor's office		
Goals:	• Flexibility for routine and special maintenance operations				
Functional Relationships:	• Adjacent to P.M. and fabrication • Adjacent to parts				

Special Architectural & Utility Requirements			
Characteristics		**Mechanical and Electrical**	
Ceiling Height	120' clear1	Nat. Lighting	diffused preferable
Floor Finish	sealed concrete-impenetrable to grease and oil	Artif. Light.	metal halide
Wall Finish	paint-washable finish	Services	110V and 480V
Ceiling Treat.	paint	Security	lockable doors
Acoustic Treat.	N/A	Fire Protect.	sprinklered
Special Req.	14'W x 16'H - high lift overhead doors	Special Req.	compressed air; hose bibs; carbon monoxide alarm
Description of Fixed Equipment Requirements			
Existing Equipment to be Reused (Examples):		**New Equipment (Examples):**	
No.	Description (include size if applicable)	No.	Description (include size if applicable)
1	Generator-alternator starter tester (bench mount)	1	3-ton, 2-speed bridge crane over two bays, motordriven trolley, electric wire rope hoist.
2	Metal workbench - 36"W x 60"L x 34"H		Hook height minimum of 14'.
1	Metal workbench - 36"W x 144"L x 34"H	2	12,000#, 2-post vehicle hoists
1	Parts cleaner - 36"W x 28"D x 36"H	1	Oil dump to 550-gallon storage tank
1	Parts cleaner - 20"D x 36"H	2 sets	Lube reels • motor oil 10W/30W • anti freeze motor oil 15W/40W • ATF hydraulic oil • air
Description of Fixed Equipment Requirements			
Existing Equipment to be Reused (Examples)			
No.	Description (include size if applicable)	No.	Description (include size if applicable)
1	Defueling cart 24"W x 24"D x 58"H	1	Engine hoist 40"W x 66"D x 72"H
1	Miller AEAD 200LE welder 64"W x 126D x 78"H	1	Engine stand 34"W x 44"D x 39"H
4 pr.	1-1/2T and 5T jackstands	1	Axle jack 10"W x 54"D x 10"H
4	Floor jacks 2-2T, 1-4T and 1-7T	1	Lincoln engine jack 40"W x 40"D x 39"H
1	Walker 7T bumper jack	1	Wheel dolly 38"W x 44"D x 34"H
1	Transmission jack	2	Craftsman tool chests 44"W x 20"D x 52"H

Figure 5: Example of a floor plan sketch.

This approach to planning/programming for the Norfolk facility resulted in a building program that had the following functional components:

Activity Name	**Net Square Feet**
Maintenance Bays	4,950
Preventive Maintenance Bays	2,475
Welding Bay	825
Wash Bay	1,650
Maintenance Shop	396
Central Lubrication/ Flammable Storage Room	190
Parts Room	620
General Storage	650
Supervisor's Office	150
Break Room	225
Restrooms/Lockers	330
Mechanical Room	400
Total Net Assignable Area	12,861
Circulation, Walls, Structure	1,286
TOTAL GROSS AREA (square feet)	**14,147**

Will the site be able to accommodate maneuvering and stacking all the vehicles that will be serviced at this site? This is the major criteria in analyzing the site for a proposed fleet maintenance facility.

Given the proposed facility square footage determined in the preceding space analysis phase, the planner/programmer should determine if the site area is adequate for the proposed improvements. This phase usually involves studying alternative site layouts to assure that circulation, access and vehicle storage space can be accommodated.

One of the main objectives of planning/programming is to balance the proposed scope and quality of the project with the owner's budget. Too often, the final design phase commences with an intuitive feeling that the project can somehow be built for the amount the client has allotted. This frequently results in many modifications to the design to bring it within the budget; time is lost and often, the design is compromised. Project budgeting in the planning phase looks at the entire project budget,

not just the cost of construction. Given a definitive program of space and equipment needs, the planner can accurately budget the project with the client, and make necessary changes in the proposed project scope or intended quality well before the project moves into the design stage.

The preliminary budget accounts for construction cost, equipment costs, land acquisition, fees, administrative costs, contingency and a cost escalation formula. The budget of the Norfolk Equipment Services Building begins with a construction cost estimate that is based on (1) a building systems approach taken from the data and (2) assumptions developed in the planning process. The building systems approach allows the planner to make some broad modifications to the intended materials and systems well before the design begins. (See Figure 6 for the format for the programming budget.)

The planning/programing document is, first and foremost, a guide for the designer. As indicated earlier, it clearly defines the problems that the designer will solve, and it serves as a checklist during the design process to ensure that all functions, equipment and building systems are accounted for. The document can also serve the purpose of a financial pro-forma. When the lender or bonding agent wants to substantiate the need for the project, or understand where the money will be spent, the planning/programming document will answer those questions. It can also be used as an equipment procurement list. Since a detailed equipment inventory is included in the document and the equipment items are itemized for each functional space, that list can serve as the equipment checklist.

Many times the planning/programming process organizes vital information about a fleet maintenance operation that has never before been documented. It can serve as a catalyst for improving the efficiency and organization of a fleet maintenance program.

“You can’t be lost as long as you don’t know where you’re supposed to be.” Murphy

Don’t be caught by Murphy’s Law of Directions. Good buildings, whether they are fleet maintenance facilities or corporate office buildings, don’t just happen. They are planned. The myth of designing a great building on the back of a napkin is the stuff of Hollywood. Planning, it must be understood, is a process: a process that involves significant client involvement, a process that promotes effective communications; and a process that uses qualitative and quantitative information to produce objective design criteria.

In the next issue we will examine the process of facility design using the programmatic information presented in this article.

Figure 6: PRELIMINARY PROJECT BUDGET
City of Norfolk, Nebraska–Equipment Serivces Building
Assumptions: Building area of 14,147 s.f.,
masonry walls, steel bar joist and metal roof deck construction

Item No.	Budget Item	Est. Cost	Subtotals
1.	Construction		
1a.	Site Development	$86,000	
1b.	Foundations	$70,500	
1c.	Substructure	$35,600	
1d.	Superstructure	$26,400	
1e.	Exterior Closure	$95,800	
1f.	Roofing	$48,900	
1g.	Interior Construction	$42,400	
1h.	Mechanical	$185,000	
1i.	Electrical	$65,300	
	SUBTOTAL		**$655,900**
2.	Special Construction		
2a.	Air Compressor	$5,000	
2b.	3 - 12,000 lb. Hoists	$24,000	
2c.	1 - 54,000 lb. Hoist	$16,000	
2d.	Lubrication Equipment	$22,000	
2e.	Crane Rail and Hoists	$40,000	
	SUBTOTAL		**$107,000**
3.	Overhead & Profit (15%)		$114,000
4.	A/E Fees (7.5%)		$64,500
5.	Moveable Equipment		$10,000
6.	Administrative Costs		$8,700
7.	Contingency (5% Const. Cost)		$43,900
	TOTAL PROJECT BUDGET		**$1,004,400**

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