

MRU Analysis And Other Vehicle Equivalency Techniques

In the age of utility competition, correct staffing levels are crucial. Here's help in figuring out the optimum levels for your fleet organization.

By Sal Bibona

For years, fleet managers have asked themselves, "How many mechanics do we need? How large should our fleet staff be? How do we compare with others?"

Questions are easy. Answers have been harder to come by.

Come they must, however, as fleet managers encounter the harsh reality of a marketplace filled with competitive forces spurred by deregulation in the utility industry and managed competition in the public sector.

Other factors are involved, as well -- the significant cost of fleet equipment, the growing complexity of fleet operations, and rising customer expectations.

All this has led forward-thinking fleet managers to seek tools that will help them determine how competitive their fleet operations are, how competitive they must be, and what levels of staffing are needed to acquire and keep that competitive edge.

MRUs

One tool managers can use to address these issues is "vehicle equivalency analysis" -- specifically, a particular form of this technique known as "maintenance and repair unit (MRU) analysis" pioneered by this writer.

MRU analysis provides a common basis to analyze and compare fleets of varying size and composition by weighting fleets according to their relative maintenance requirements. We have used this tool successfully to analyze a broad range of fleet-staffing, competitiveness, cost and service issues among government, utility and private-industry fleets. This technique has a number of advantages:

- Flexibility: It works with many types of fleet and can be specific to each organization's needs.
- Adaptability: Fleet conditions change, and MRU analysis can change with them.
- Simplicity: It is user friendly.

- Transparency: MRU analysis can be easily and quickly understood even by laypeople -- your fleet customers, for instance.

Finally, you should note that vehicle equivalents are not work standards. While work standards are used to analyze very detailed increments of work, such as the number of hours required for removing and replacing a brake pad, vehicle equivalents such as MRUs are used to estimate the average annual labor required for maintaining *an entire class of vehicles*. Such measurements work best at a high or strategic level.

A timeline representing the evolution of vehicle-equivalency analysis is presented in figure 1. As best we can document, this technique was developed in the 1960s. The balance of this article presents the major milestones along the evolutionary path of vehicle-equivalency analysis, and what the changes mean for your fleet organization today.

Early attempts

Articles addressing questions about fleet staffing and other resources began to appear in transportation-industry magazines in the early 1960s.

Ratios such as the number of mechanics needed per truck or bus began to appear from time to time.

A statistical report submitted by for-hire carriers to the Interstate Commerce Commission (ICC) was published. By examining publicly available data from the ICC, it was possible to derive the ratio of staffing and expenses as they related to the size of the carrier fleet.

Armed services

Also in the 1960s, the U.S. Air Force and the U.S. Navy conducted studies of their motor vehicle fleets and derived fleet staffing standards.

The Air Force system consisted of the following steps:

- Calculation of the number of vehicle equivalents in the fleet.
- Application of formulas to estimate the number of personnel hours needed per month for fleet mechanics, maintenance controllers, material controllers and maintenance managers.
- Division of the estimated number of personal hours needed by the number of available hours per month per staff person.

The process was used to officially estimate staffing, facility and facility equipment needs.

Unofficially, it was also used to budget for shops, predict contractor maintenance costs and explain cost variance among the fleet operations of different Air Force bases.

The vehicle equivalency factors were based on Air Force studies regarding the average annual number of maintenance hours needed for a sedan. Originally, this was found to be 25.5 hours per year. In latter years, it was found to be 18 hours. To determine the equivalency factors for other vehicle classes, researchers used the collective opinion of transportation officers. The Air Force developed factors for more than 300 vehicle categories. Now, the factors are automatically updated by the Air Force's maintenance-management computer system.

At about the same time, the Naval Facilities Engineering Command (NAVAC) developed an analogous process to estimate the number of mechanics needed for each of the Navy's vehicle facilities. The NAVAC process differed slightly from the Air Force in that it based the resource factors on vehicle usage and estimated direct (i.e. mechanics) only staffing requirements. (The U.S. Army later adopted the NAVAC approach to estimate their vehicle-maintenance staff requirements.)

The resource factors covered 250 different classes of vehicles and were calibrated on the basis of mechanic-hours per vehicle, miles of travel or hours of use, as tabulated in figure 2. Applying these factors produced the number of mechanic hours needed each year to maintain and repair the fleet. Dividing these products by the man-hour availability factor (MAF) yielded the number of mechanics needed. The NAVAC assumed that the MAF was 1,728 hours per year for military personnel and 1,676 hours per year for civilian personnel.

Lewis and Marron

In 1965, Lewis and Marron wrote a book entitled *Management of Vehicular Operations and Maintenance*, in which they discussed three methods for estimating staff needs.

The first method described a "Staffing Guide Table" for "average requirements on an automotive fleet." This table predicted the number of inspectors, estimators, costs clerks, supervisors, and mechanics needed for a specified range of fleet size. The ranges were: 0 to 50, 50 to 100, 100 to 150, ... 900 to 1,000 vehicles. There was a caveat noted in this method -- the staffing ratios assumed that the fleet operation was centralized. If shops were independent, the results needed to be modified.

The second strategy described a vehicle-equivalency approach. The sedan was considered the base unit and had a factor of one. Other vehicle classes were given factors that represented their maintenance complexity relative to the sedan. For example, a self-propelled, rotary snow-removal unit had a factor of 5.0. Researchers estimated that one employee, inclusive of overhead staff, was needed for every 14 vehicle equivalents.

The third method related vehicle usage and mechanic-hour requirements. Tables provided the estimated number of mechanic hours needed for vehicle maintenance based on the vehicle's accumulated mileage or engine hours and projected usage for the following year.

Electric Council of New England

In 1967, the Transportation Committee of the Electric Council of New England sought a process to predict the number of mechanics needed to support the number of vehicles in a utility fleet. They needed a way to plan for new garage facilities and compare mechanic performance among different facilities. They, in turn, surveyed their members and developed a vehicle-equivalency process that used a measurement termed a VMU (vehicle maintenance unit).

Passenger cars were established as the base unit, and 14 other classes were expressed in factors relative to the passenger car. The largest factor was 6.7, for a digger derrick.

Initially, the VMUs accounted for direct time of mechanics and only equated to 44 hours per year. Then, the Transportation Committee developed adjustment factors to account for the "non-direct" time of mechanics. These adjustments increased the VMU factor by 61 percent to 70 hours per year. The non-direct time included allowances for:

- Miscellaneous activities, including vehicle work charged to a garage but not to an individual vehicle.
- Maintenance of non-fleet equipment, such as chain saws and lawnmowers.
- Non-fleet duties such as messenger services and chauffeuring.
- Non-worked time such as vacations, holidays and sick leave.

They estimated that one mechanic could service 29.8 VMUs. This estimate was based on 2,088 hours (52.2 weeks per year multiplied by 40 hours per week) in the year divided by 70 hours (inclusive of indirect time) per VMU.

Stone & Webster Surveys

Beginning in 1976 (and every few years thereafter until 1991) Stone & Webster Management Consultants, Inc. conducted a survey of the utility industry to develop a series of vehicle equivalents known as MRUs (maintenance and repair units).

Data were analyzed from hundreds of small, medium and large utilities throughout the United States, Canada and the Caribbean. The MRU factors ranged from 1.0, for sedans, to 6.5 for digger derricks. The base MRU factor was initially estimated to be 30 hours per year. In latter years the factor declined to 20 hours per year.

Besides relating vehicle equivalents to staff and facility sizes, Stone & Webster for the first time also related them to maintenance costs.

In 1985, this writer -- who was at that time working for Stone & Webster -- introduced the concept of in-house MRUs to provide greater precision in staff size analysis.

The City of Phoenix

In an article presented to the International Public Works Congress and Equipment Show, Robert M. Brown of the city of Phoenix presented a paper on "Staffing and Utilization of Personnel." In this paper, he reviewed vehicle equivalents and work

measurement techniques, and how they could be used to better manage public-agency fleets.

During 1974, the city of Phoenix adopted the vehicle equivalency that the U.S. Air Force had used to evaluate fleet staffing requirements. As far as the city knew, it was the first time this approach had been applied to a municipal fleet, and it came to be referred to as the "Phoenix System."

The city developed factors for some 150 separate categories of equipment, intending to update the categories periodically. The sedan, which was the base unit, equated to 22.3 mechanic hours per year. One mechanic, they estimated, could support 75 equivalency units. (This was based on a mechanic producing 1,670 hours of productive work a year and dividing 1,670 by 22.3 hours per equivalency unit.) The vehicle equivalents were only intended to estimate the number of mechanics needed.

Brown noted that vehicle equivalents could vary considerably from one agency to another because of differences in operation, procedures, shop facilities, quality of the available work force, record-keeping systems and similar factors.

The American Public Works Association

In 1989, the American Public Works Association (APWA) developed a basic series of vehicle equivalents (see figure 3).

APWA estimated that one mechanic could service 73 vehicle equivalents. This was based on 1,679 available direct hours per year per mechanic divided by 23 hours per equivalent. An update to this publication is scheduled for release in September 2000. What is most interesting is that APWA noted, "No perfect formula exists . . .," adding that many factors can influence the results.

Stone & Webster and City and State

Stone & Webster and *City and State Magazine* cooperated to conduct the first national survey of government fleets to develop staffing ratios using the MRU approach.

Surveys were conducted in 1992 and again in 1993. Seventy jurisdictions participated, and factors were developed for 21 vehicle classes. The passenger car had a base unit of 16 hours in 1992 and 17 hours in 1993. The number of in-house MRUs per mechanic was 62.5, while the number of in-house MRUs per total fleet (including indirect staff) was 36.2.

Chatham Consulting, Inc.

This writer led the Stone & Webster fleet survey efforts and continued the benchmarking tradition within his own firm -- Chatham Consulting, Inc. -- which he established in 1994.

Beginning in 1995, the Chatham surveys expanded the number of vehicle categories to 37 and the number of staff categories to 28. Proprietary databases were developed relating fleet size and composition to staffing, facility, cost and other fleet benchmarks.

The process

Figures 4 through 7 illustrate the application of the vehicle equivalency process.

First, the vehicle equivalents for the fleet are computed as shown in figure 4. *(Please note that these are illustrative figures only and do not represent national standards or averages. They were derived, though, from a benchmarking survey of small to medium size municipalities in a Midwestern state.)*

Next, the number of direct hours per mechanic is estimated as shown in figure 5. For this example, the estimate was 1,560 hours per year, which equates to a 75 percent mechanic-utilization rate (1,560 divided by 2,080).

Figure 6 then estimates the number of mechanics needed by using the direct-hours approach. The number of vehicle equivalents, computed in figure 5, is multiplied by the estimated percentage of maintenance done in-house (for this example, 95 percent). This produces 613.5 in-house equiva-

lents. At 10 hours per equivalent, these in-house equivalents generate 6,135.0 hours of work. Dividing this work by the previously estimated 1,560 direct hours available per mechanic yields an estimated 3.9 mechanics needed.

Alternately, the staffing-ratio approach can be used to estimate overall fleet-staffing needs. As shown in figure 7, the number of staff per 100 in-house equivalents is multiplied by the number of in-house equivalents (631.5) to produce the total fleet staff of 6.9 persons needed.

Sources of information

In developing equivalency factors, several approaches can be used. One is to obtain the expert opinion of your own staff. A second is to analyze historical work-order data. A third approach is to survey other fleets.

Finally, data may be available from third parties, such as consulting firms, trade publications, fleet-software vendors, fleet-leasing companies, and maintenance-service companies. In any case, the manager needs to be aware of the quality, independence, and reliability of the data to be used.

Caveats and cautions

In comparing notes among the different approaches used, a fleet manager must know what is or is not included in the vehicle-equivalency data.

For example, does "staff" include administrative and support personnel, or is it limited to mechanics only? Has outsourcing been taken into account? If so, to what extent?

In evaluating your own fleet, make sure that that non-fleet duties of mechanics have been properly accounted for. Also, keep maintenance and repair work separate from capital work — vehicle outfitting, aerial-device-rebuilding programs and accident repairs.

Finally, it is important to recognize that vehicle-equivalency analysis should not be used exclusively in evaluating an organization's fleet operation; it is an art as much as it is a science.

We have found that it is vital to consider operating environment, fleet-customer requirements and cost-accounting methodologies. Sometimes it is necessary to develop customized factors to handle unique situations or to make further adjustments to vehicle-utilization, facility-condition, workforce, and environmental factors as well. But when used by an experienced consultant, the results have been quite informative, useful and worthwhile.

Sal Bibona is president of Chatham Consulting, Inc. He can be reached at 973-966-9262 or slb@chathamconsulting.com.

Exhibit 1: Time Line of Vehicle Equivalency Approaches

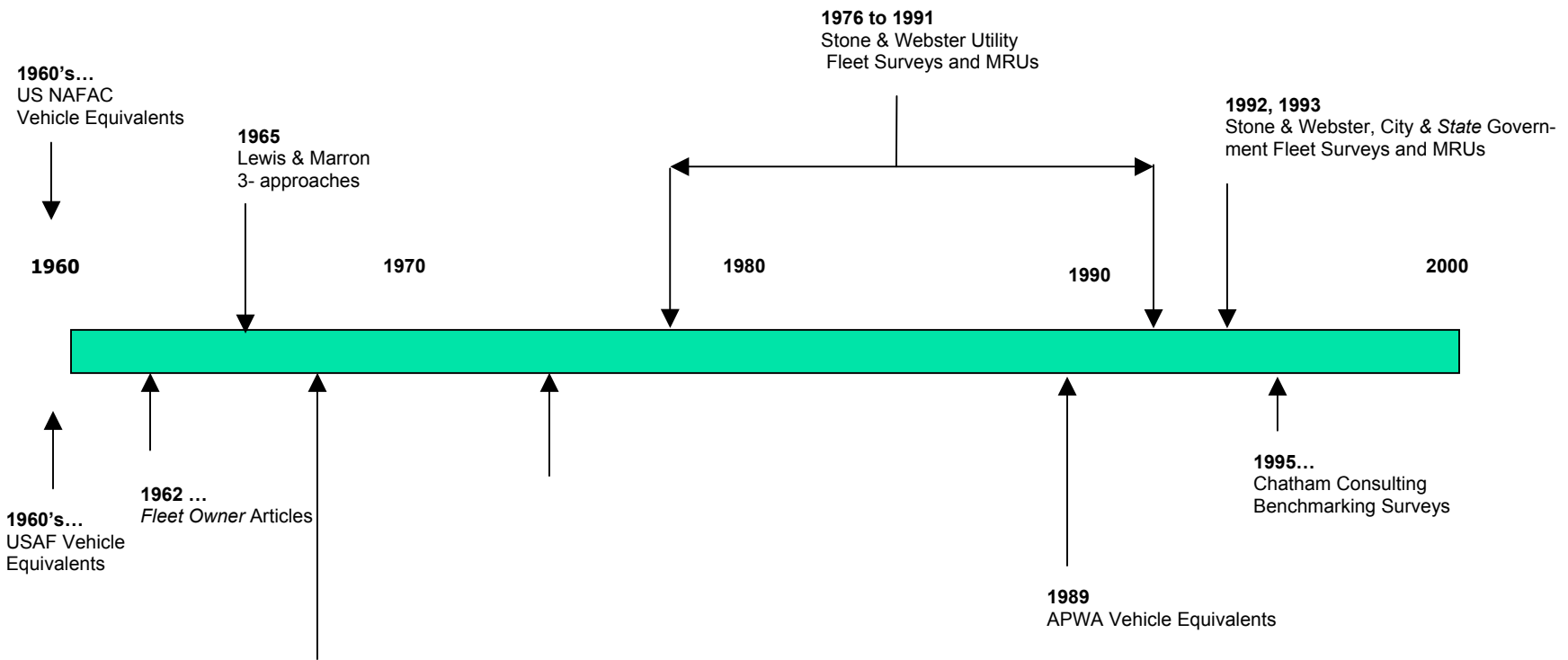


Exhibit 2: NAFAC Factor Categories	
Per	Unit Type
1,000 miles	Cars, pickups, dump trucks
Hours of use	Graders, loaders, and other heavy equipment.
Year	Other units: drills, trailers, etc.

Exhibit 3: APWA Factors	
Type	Factor
Sedan	1.0
Light Trucks	3.0
Heavy trucks	7.0
Factor of 1.0 = 23 mechanic hours per year.	

Exhibit 4: Calculate Vehicle Equivalents *			
Vehicle Class	Number	Factor	Equivalents
Sedans	20	1.0	20.0
Pickups	40	2.0	80.0
Vans	10	1.4	14.0
Patrol cars	40	5.6	224.0
Rescue vehicles	4	2.7	10.8
Dump trucks, tandem	20	10.0	200.0
Backhoes/loaders	10	2.0	20.0
Misc. motor. Equipment	20	2.8	56.0
Trailers	30	0.7	21.0
Total	194		645.8
* Illustrative only and not representative of national averages.			

Exhibit 5: Estimated Direct Hours Available Per Mechanic		
Item	Basis	Hours/Year
Hours in year		2,080
Less holidays, vacation and illness	30 days x 8 hr./day	(240)
Less breaks and cleanup	230 days x 0.5 hr./day	(115)
Less miscellaneous indirect time	Parts chasing, training, etc.	(165)
Direct hours available per mechanic		1,560

Exhibit 6: Estimate Mechanics Needed Based on Direct Hours Available *		
Item	Basis *	Quantity
Total Fleet MRUs	From Exhibit 4	645.8
In-house MRUs	95% x 645.8	613.5
Direct hours per year	613.5 x 10 hrs/Equivalent	6,135.0
Estimated mechanics needed	6,135.0/1,560 hrs. per mechanic (Exh.5)	3.9
* Illustrative only.		

Exhibit 7: Estimate Fleet Staff Needed Based on Staffing Ratios *		
Category	Staff Per 100 In-House Equivalent	Estimated Staff (For 613.5 In-House Equivalents)
Fleet Administration	0.13	0.8
Garage Supervisors	0.16	1.0
Mechanics/Technicians	0.63	3.9
Other floor personnel	0.01	0.1
Parts personnel	0.04	0.2
Clerical	<u>0.15</u>	<u>0.9</u>
Total	1.12	6.9
* Illustrative only and not representative of national averages.		