SCDOT Vehicle and Equipment Management

A Certified Public Manager Research Project

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Supply and Equipment Office
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Executive Summary

Governments have a responsibility to operate as efficiently and effectively as possible while still maintaining the adaptability and flexibility to address ever-changing priorities and respond to emergencies and disasters. It is the adaptability and flexibility requirement that necessitates some over-capacity in essential services. Sometimes this gives the appearance of waste and uselessness. In actuality, this is proactive planning and risk assessment.

For many years, fleet replacement, fleet repair, and agency accounting operations have been computerized and have amassed tremendous amounts of data relative to equipment operations and performance. Until this past year, SCDOT lacked the analytical software to review past performance and guide current and future equipment decisions. Additionally, the equipment request, review, approval, ordering, receiving, and turn-in management processes have been revised and integrated into one software package. Process measurement and reporting is built into this revised software.

Traditionally equipment utilization has been used to measure vehicle and equipment management operations. However, equipment utilization is a hybrid measurement. It is affected by causes external to vehicle and equipment management operations. There are other metrics that can be used to measure vehicle and equipment management performance.

As intelligent data analysis is now more readily available, some re-distribution and re-emphasis of equipment management decision-making, accountability, and responsibility is
It is recommended that the District Mechanical Engineer in each of SCDOT’s seven districts have direct supervisory responsibility over their equipment repair shops. At the Equipment Depot, a Used Equipment and Pool Operations work group is created. Also, there are recommendations on the future distribution and locations of equipment repair shops and the types of repairs they perform.

Vehicle and equipment selection and configuration should continue to be standardized. This not only helps reduce initial cost, repair downtime, and repair expenses, but it also presents a more uniform and better public image.

Alternate solicitation methods should be considered to improve flexibility, foster competition, and control costs and quality.

Replacement cycles of 001-014 series vehicles and trucks and 237 series backhoes should be shortened to approximately five years. As another state agency, the State Fleet Management Office, oversees vehicle and truck fleet replacement, approval for this will have to be received from their office. Replacement cycles of other heavy equipment should continue to be reduced to reach an eleven year replacement cycle.
What is Vehicle and Equipment Management?

The overall goal of SCDOT’s vehicle and equipment management program is to provide reliable equipment that is easy to operate and maintain and that performs the intended purpose to enable SCDOT staff to better build and maintain roads and bridges and provide mass transit services for the residents of South Carolina.

Before anyone at SCDOT receives a new piece of equipment, SCDOT’s vehicle and equipment management operations have:

- Obtained approval to purchase the equipment,
- Written specifications for the equipment,
- Requisitioned the equipment,
- Reviewed and approved bids submitted for the equipment,
- Assigned a unique “DOT NUMBER” to the equipment,
- Received the equipment when the vendor delivers it,
- Checked the equipment to verify it meets specifications,
- Coordinated with the vendor to resolve any specification discrepancies,
- Ordered a fuel card for the equipment (as applicable),
- Titled, registered, and issued a license tag for the equipment (as applicable),
- Populated the computerized record of the equipment with required fields,
- Submitted paperwork to authorize payment for the equipment,
• Added agency decals and identify equipment with the “DOT Number”,

• Add 2-way radio, warning lights, fire extinguishers, first aid kits, mounted major equipment, and any other additional accessories to the equipment to prepare it for delivery to the custodian (add bodies to cab-chassis trucks, trailer hitches and wiring harnesses, back-up alarms, digital mileage indicators, etc.),

• Contacted custodian and prepared transfer paperwork to issue equipment, and

• Accepted the old “turn-in” piece of equipment for re-issue or disposal.

After the custodian receives the equipment, the equipment management organization is still involved with the equipment. They inspect, repair, and monitor its performance in relationship to other equipment and established parameters until the equipment is finally turned-in and sold at auction.

Vehicle and equipment management is the process of wisely and efficiently selecting, using, maintaining, and replacing vehicles and equipment. Simply put, vehicle and equipment management is managing these assets from inception to grave.
Why Vehicle and Equipment Management?

Vehicle and Equipment Fleets accumulate over time and become sizable investments. Summary information for SCDOT's fleet is as follows. See Appendix A for an additional description of SCDOT's vehicle and equipment fleet.

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>Initial Cost</th>
<th>Replacement Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles and Trucks</td>
<td>3035</td>
<td>$69,220,685</td>
<td>$83,942,956</td>
</tr>
<tr>
<td>Equipment Fleet</td>
<td>5552</td>
<td>$94,600,008</td>
<td>$121,507,738</td>
</tr>
<tr>
<td>Total</td>
<td>8587</td>
<td>$163,820,693</td>
<td>$205,450,694</td>
</tr>
</tbody>
</table>

* Quantity includes active assets and those currently in replacement cycle

** Estimated replacement cost calculated assuming 2.5% price increase per year

Vehicles and equipment fleets also incur maintenance expenses and are replaced when necessary. Recent total annual vehicle and equipment maintenance ($18.4 million) and replacement expenses/budgets ($10.8 million) are included in Appendix B and C, respectively. Current total fleet replacement cycle based on initial cost is:

\[
\frac{\$163,820,693.00}{\$10,800,000.00} = 15.1 \text{ years}
\]

In 2001, the total fleet replacement cycle based on initial cost was approximately 20 years. The reduction is a result of fleet size reduction and, more recently, an increased replacement budget.
Comparison to Other Southeastern States

A survey was performed to collect information from other members of the Southeastern States Equipment Manager’s Conference (SSEMC). Formed under the direction of the American Association of State Highway Transportation Officials (AASHTO), the SSEMC is a group of thirteen state’s equipment managers. Throughout the year and, at an annual meeting, they share information on equipment and equipment management related issues. By way of this association, each state benefits from shared experiences.

A copy of the survey and the survey results is included in Appendix D. Throughout this report there will be references to the results of this survey.

For most states:

1. An asset’s importance to operations is the most important factor in deciding what equipment to replace. Repair expenses and utilization fall next in importance.

2. Decisions on what equipment to replace and approval of the equipment request are made at the equipment manager’s level and above. Other’s input is primarily taken as recommendations.

3. Equipment managers are looking for good value and vendor support when replacing assets.
4. The equipment manager, vendor, and operators are involved in the specification writing process. Information from other SSEMC states is also used.

5. Usually the equipment manager reviews the bid responses and makes recommendations for award; although, sometimes the procurement office does this without the equipment manager’s involvement.

6. Relevant performance measures currently being used include usage, accumulated expenses, age, and amount of repairs subcontracted to outside repair vendors.

7. The average fleet replacement cycle based on initial cost is 11.7 years.

8. Either most states already have or is presently working on software solutions to help them better manage their equipment management needs.

9. Most states have one or more repair shops in each district and one or more statewide repair shop. Only one state actively services outside agency fleets.

10. The most important issues facing equipment managers over the next 1, 5, and 10 years include funding and repair technician training and retention.
Software Tools

Through the Southeastern Association of State Highway Transportation Officials (SASHTO), Texas shared the source code for their equipment management program, TxDOT TERM. SCDOT modified the code to work with it’s database variables, made some program corrections, and added some additional analytical and reporting features to create a revised Transportation Equipment Replacement Model System (TERMS) program.

TERMS allows one to quickly and easily compare assets to other assets to rank them on cost to own, operate, and continue to own and operate. The vehicle’s and equipment’s current physical condition is included in this analysis. The program normally analyzes up to twenty quarters of operational and repair data to produce results; thus, analyses generally accurately represent reality. The program allows one to compare and rank equipment based on year, model, manufacturer, age, cost, average usage, annual usage, age, fuel usage, oil usage, repair costs, and repair downtime. Additionally, the program calculates for any vehicle or equipment it’s equivalent uniform annualized cost (EUAC) to allow replacement comparisons of assets with unequal lives. A copy of the TERMS user manual with screen shots and sample output screens is included as Appendix E for additional information. An example of program output graphs for 85 hp
tractors and a particular type of mower mounted to them, a slope mower, is included in Appendix F. A brief discussion on EUAC is included in Appendix P.

TERMS is written in the Statistical Analysis Software (SAS) programming language. SAS contains the statistical routines and has the computational abilities to manipulate large databases and produce meaningful graphs and summaries. The Supply and Equipment Office staff should become more proficient in SAS to better utilize this software and its abilities.

The TERMS program graphical and tabular outputs are posted to SCDOT’s Supply and Equipment Intranet web site after each quarter’s update. Managers, supervisors, shop personnel, and anyone with access to SCDOT’s intranet can access these files to help them make equipment repair and replacement decisions.

The TERMS tabular equipment ranking output has been integrated with equipment usage data from the Highway Maintenance Management System (HMMS). This results in a re-designed Equipment Request and Order program. This program is an extremely versatile and powerful software tool. It allows fleet replacement recommendations to be based upon the following:

- Local management input as to what they believe they need,
- Age,
- Usage last 12 months,
- Accumulated Usage to Date,
• Last 12 Months Downtime,
• Accumulated Downtime to Date,
• Last 12 month Repair Costs,
• Accumulated Repair Costs,
• Purchase Price,
• Depreciation,
• Actual Physical Condition of the Equipment,
• Other Like Items able to do similar tasks,
• Hours Used reported by HMMS,
• Relative ranking of operation and repair expenses,
• Fuel and Oil Costs,
• Make/Model Operation and Repair Cost History, and
• Primary Intended Use for the Equipment.

A description of this program and sample input screens are included in Appendix G. Feedback from each of the users who used the revised equipment request program this year indicated unanimous approval of the revisions. According to more than one, it was much easier and quicker to use than in previous years.
Performance Measures

Most fleet operations use equipment utilization as a measure of the success of their operations. Appendix H includes aggregate fleet utilization measures by fiscal year for SCDOT from July 2001 through October 2004 and also includes the utilization requirements for vehicles and equipment. Since this measure has been recorded, equipment utilization has increased due to management emphasis on better work planning and scheduling with HMMS, fleet size reduction (see below), and increased replacement of older fleet assets with newer vehicles and equipment.

However, there is a problem with using equipment utilization as a performance measure. Equipment utilization is actually a measure of two separate processes: 1) Vehicle and Equipment Management, and 2) Maintenance and Construction Operations. It measures how often the fleet vehicle or equipment operator uses a functional vehicle or piece of equipment. Thus, the factors that effect equipment utilization include:
• Available staff to operate vehicles and equipment,
• Adequately trained operators,
• Equipment unavailability due to malfunction or preventative maintenance,
• Equipment unavailable due to accident or abuse,
• Availability of trained repair staff,
• Repair parts availability,
• Frequency of the task performed that requires the equipment,
• Choice of measurement (hours or miles) and target utilization value, and
• Emergency response equipment being used only during emergencies.

In lieu of equipment utilization, specific equipment management performance measures possible include:

• Percent scheduled repairs: In theory, an effective preventative maintenance program is able to plan and schedule seventy-five percent of the repairs, excluding tire, battery, accident, and operator abuse repairs. In other words, there should be three scheduled services to one emergency repair.¹ This would be an effective performance measure for the vehicle and equipment management program.

• Rework Rates – the amount of repairs that have to be repeated because they were not properly completed the first time.

• Vehicle and Equipment Availability

¹ Idaho Department of Transportation Road Equipment Maintenance Manual, Section 760.3.1, July 2003.
For the processes specific to the equipment order, receipt, preparation, and delivery, the revised equipment request and order program previously discussed will track the following items and allow the following to be measured and reported:

1. Dollars Committed by Account Number

2. Cycle Time Detail and Summary for:
   - Days until requisition sent to Director of Maintenance Office
   - Days until Purchase order written
   - Days until item received
   - Days until equipment check in complete and explanation of specification deficiencies
   - Days until fuel card requested
   - Days until fuel card received
   - Days until title, registration, and tag processed
   - Days until equipment preparation complete
   - Days until custodian picks up new equipment

3. Disposition of turn in equipment (reissue, surplus, pool, hold for parts)
Organizational Structure

The existing structure of SCDOT’s fleet management organization and a more specific organizational chart for the Supply and Equipment and Equipment Depot organizations are shown in the first section of Appendix I. This or similar equipment management organizational structures have been in effect for SCDOT since the Supply and Equipment division was formed in 1950.

Some recommended changes to the organizational structures at the District Offices and at the Equipment Depot are shown in second section in Appendix I. At the District Offices, the District Mechanical Engineer’s responsibilities as the district equipment manager should be re-affirmed and direct supervision of the equipment repair shops should be added. Over the years, several of these duties had been shifted or shared among various office personnel. The shared duties results in confusion, decision delays, and missed opportunities. The District Mechanical Engineer’s equipment related responsibilities would therefore include:

- Direct supervision of shop operations in the District,
- Performing random checks to verify preventative maintenance inspections are adequate,
- Provide equipment replacement recommendations to Supply and Equipment,
- Provide equipment repair recommendations and approvals,
• Review equipment usage and redistribute equipment within their district as necessary,
• Manage a district vehicle and equipment pool,
• Utilize various equipment management software programs and interpret results,
• Monitor specific performance measures and take corrective action as required,
• Review and coordinate equipment modification and malfunction requests,
• Investigate equipment malfunctions and accidents and make recommendations for future avoidance, and
• Sit on a specification authoring and review committee.

The Equipment Depot’s role in 1) refurbishing and reissuing equipment and 2) managing a vehicle and equipment pool is expected to continue increasing. As such, a new work group reporting to the Equipment Depot superintendent entitled “Used Equipment and Pool Operations” is recommended. This is accomplished using existing positions and re-alignment of existing responsibilities. The new work group creates additional promotion possibilities for the staff and also creates a career path for some non-technical personnel.

To properly manage the Equipment Depot pool operations and to improve the scheduling process, the Equipment Depot should work with SCDOT’s IT Services to develop pool operations software. Program requirements include:
• Graphical schedule display for vehicles and equipment showing periods of availability and unavailability,
• Point and click to begin a reservation,
• Vehicles and equipment grouped by categories with + boxes to see all the vehicles and equipment in the category,
• Emails automatically generated and sent as required,
• Security features to prohibit unauthorized reservation cancellation,
• Pool vehicle and equipment usage reports, and
• Be compatible for managing a district pool operation (seven locations state wide).

**Equipment Selection**

SCDOT purchases vehicles and equipment by way of public bids. Bids received must meet or exceed specification requirements that are included with the solicitation. Staff at the Supply and Equipment Office writes specifications. Both the specifications and the form of the solicitation affect the quality of the bid responses.

Each individual writes specifications differently, and each specification has to be tailored for the item being purchased and its intended use. The purpose of each specification is to fairly and reasonably describe reliable equipment that is easy to operate and maintain and that performs the intended purpose. A specification for a recent
solicitation for medium duty and heavy duty backhoes is included in Appendix J. This particular format was introduced to SCDOT this past year and has worked well. It can be used to purchase one backhoe or to establish a contract for numerous backhoes. It is easy to refer to specification requirements as the entire document is enumerated.

Perhaps the most important factor that controls specification quality is who prepares the specification. Specifications should focus on what the equipment NEEDS to do and what features it NEEDS to have. When WANTS begin to make their way into specifications, cost begins to increase quickly, and often the wanted items are not used. The specification author should keep the specification focused on the NEEDS. Any WANTS should be listed as optional equipment.

SCDOT is presently working to reestablish standard vehicle and equipment selections and configurations. This process should be aggressively pursued until it is completed. This not only reduces vehicle and equipment initial cost, repair downtime, and repair expenses, but it also presents a more uniform and better public image.

There are four groups whose contribution is extremely important in developing a specification to adequately describe an item.

- The engineer or staff person responsible for the specification,
- The operator who uses the equipment and is familiar with the intended use for the equipment being purchased,
- The repair technician who maintains the equipment, and
• The vendor(s) who represents or manufactures the equipment.

If any one of these four groups is not involved in the specification development process, or if the specification author is not sufficiently informed to adequately include their needs, the specification will be less than ideal. For instance, if the vendor or vendor information is not included, the specification may describe an antiquated technology that has been replaced. If the operator is not involved, the asset may not be able to perform as required once it is placed in service. If the technician is not involved, downtimes may become excessive or repair costs may become high. Therefore, it is the specification author’s responsibility to be knowledgeable of industry standards and safety requirements and to bring together or coordinate with the other required group members.

Currently, Supply and Equipment works with group members using email, phone calls, or site visits. Sometimes equipment demonstrations or trials are scheduled. Ideally the committee would meet twice a year and include members of all four groups. Based on experiences from other states, an operator’s supervisor should not be involved in the meeting when the operator is present.

The form of the solicitation also affects bid responsiveness and prices. There are four basic types of solicitations for vehicle and equipment purchases:

• Low bid single award,

• Low bid multi-award,

• Best value single award, and
• Best value multi-award.

Most individuals are familiar with the low bid single award. In this case, bids submitted are evaluated against the specification requirements, and the lowest responsive bidder is recommended for the award.

The low bid multi-award is useful to establish contracts when multiple agencies or municipalities can utilize the same contract so volumes are high. In this case, the award is made to the lowest responsive bidder for each manufacturer of an item. A sample of this type of solicitation is included in Appendix K. In this case, the multi-award for a backhoe was made to the lowest responsive bidders representing John Deere, Caterpillar, Terex, New Holland, Case, Volvo, JCB, and Komatsu. Eight vendors were on contract for competing items. Participating municipalities could purchase whatever they wanted that was on contract. SCDOT was able to purchase several make and model backhoes. This allows SCDOT to develop a repair and use history of many makes and models of equipment to establish our own data that will be useful in the next type of solicitation, the best value solicitations.

One other unique feature of the backhoe bid was that the bid price was the sum of a base machine configuration plus several options usually ordered. In this case: Unit Price = Base Machine + Enclosed Cab + 4WD + Ext. Dipper + 4-in-1 Bucket. This gives SCDOT the flexibility to order several machine combinations for different needs. It also
gives the vendor the opportunity to propose special pricing for the combination identified.

The South Carolina Procurement Code allows best value bidding. Sixty percent of the award must be based on price. Numerical weighting factors are applied to each pre-determined criteria identified by SCDOT. Possible factors to include in this type of solicitation are:

- Anticipated preventative maintenance costs,
- Anticipated repair costs, based on historical data,
- Percent discount on repair parts,
- Length of warranty beyond minimum requirements,
- Anticipated value in five years,
- Fuel economy (as applicable),
- Operator comfort,
- Ease of operation, and
- Reduced operational costs.

Vehicle and Equipment specifications and solicitations should be scheduled such that delivery of the assets is made prior to any seasonal need. Vehicle and truck orders should be scheduled prior to their end-of-year cutoff, which has usually been from January to March of each year. Backhoes should be ordered in time to receive them before November.
One peculiarity to vehicle purchases is that federal law requires states to purchase seventy-five percent of vehicles less than 8,500 gross vehicle weight rating (GVWR) in an alternative fuel vehicle (AFV) configuration. However, in South Carolina, there is presently very little infrastructure to support these vehicles; although, some federal grants may improve this. Generally, purchasing an AFV increases the price of each vehicle.

**Equipment Preparation**

Often it is more economical and quality is more consistent if some additional accessory equipment is installed after the asset is delivered to SCDOT. Appendix L lists the additional accessories added to equipment either when it is delivered to the Equipment Depot or after it is in service.

Almost all equipment is received at the Equipment Depot for the following reasons.

- They have the proper equipment to safely offload large equipment deliveries from transport trucks;
- They have the expertise to perform a receiving inspection of the equipment to verify it meets specification requirements;
- They prepare new equipment receipt reports and enter pertinent equipment data fields into a computerized Equipment Control System (ECS);
- Equipment is not authorized for payment until all receiving inspection deficiencies are cleared. As such, it is best to maintain receipts at one location;
- Required accessories are purchased and stocked in bulk which reduces equipment preparation cost and time; and
- Consistent quality control for new equipment preparation is maintained.

No major changes to the equipment preparation process are recommended until the metrics are put in place to monitor the process. However, it is recommended that the District Mechanical Engineers participate in the equipment receipt process to inspect major items that are assigned to their districts.

**Equipment Maintenance**

Vehicle and equipment maintenance represents significant amounts of investment at SCDOT. Statewide, there are forty-nine equipment repair shop facilities, one Equipment Depot, and 338 personnel employed. These personnel perform duties that are unequalled at any other commercial repair facility. In any one day, the same individual may work on a vehicle inspection, the hydraulic system on a large motor grader, replace seals on a small gasoline powered pump, the electrical system on a variable message board, and on any other system on any of the vehicles and equipment assigned to their location. Also, during emergencies, they transport bulk materials and equipment and
perform other duties otherwise considered highway maintenance functions. These personnel should be congratulated each day for the work they perform!

The latest version of SCDOT's vehicle and equipment repair record keeping software, Shop Work in Progress System (SWIPS), has been in use since at least 1992. Each repair record includes:

- A task code to classify the repair into categories,
- Vehicle or Equipment number,
- A description of work performed,
- Labor hours required,
- Parts used and cost,
- Outside services cost,
- Mechanic number,
- Date work began, and
- Date work completed.

With the availability of modern database analysis software, it is possible to perform many analyses with this data. As previously discussed, SAS is particularly well suited for this analysis. Some analysis examples are:

- Frequency of identical repairs to a equipment to identify:
  - Possible defective equipment.
  - Additional training required for a mechanic, or
  - Operator misuse;
• Amount of time it takes to perform tasks on similar equipment to establish standards of measurement and identify shops outside statistical bounds;

• More than normal replacement of parts to identify possible misappropriation;

• Make recommendations to the specification committee for areas where equipment specifications need to be strengthened because of more than normal repair frequency;

• Identify equipment makes and models that perform exceptionally well so they would be highly recommended for future purchases as well as those that would not be recommended for future purchases;

• Shops that need to outsource more of their repairs or ones that need to do more of their repairs in-house; and

• Shops with excess personnel level or with insufficient personnel level.

Repair technician training is important and is often hard to arrange. New equipment specifications have been modified to require the following. This is proving to be very helpful.

**TRAINING:** In conjunction with delivery of the first unit, the successful bidder shall conduct a minimum one-day school on the safety, operation, maintenance, and diagnostics of the unit by factory trained expert personnel at the SCDOT Equipment Depot or at their facility in South Carolina. In addition and for each subsequent unit, the successful
bidder will conduct a minimum one day school in the county where the unit is to be assigned with the Department's operator(s) and service personnel, after the equipment has been delivered to the county where it is to be assigned."

SCDOT on occasion produces its own training videos for new employee orientation and refresher training. There are plans to produce videos on dump body installations onto dump truck chassis and on standardized hydraulics installations onto dump truck chassis.

SCDOT is presently developing skill levels, or competencies, for all department classifications. The repair technicians can demonstrate their competency by correctly performing two repairs that use these new skills on different vehicles or equipment. Then the shop supervisor would recommend the employee for a nominal salary increase as they progress in competencies. Copies of the service tickets showing that the employee performed the repairs should be attached for documentation.

Many shop locations currently outsource the following to local vendors, and this outsourcing is encouraged and should be continued:

- Minor preventative maintenance inspections on vehicles and light trucks,
- Air conditioning work,
- Hydraulic cylinder work,
- Transmission rebuilds,
• Tire replacement and balancing,
• Wrecker service, and
• Glass replacement.

Each county has its own equipment repair shop facility, and it is hard to reduce the serviceability that county supervisors enjoy having their own repair shop. However, as the equipment replacement recommendations in this report are implemented and more new vehicles and trucks and less old vehicles and trucks are in the fleet, repairs other than preventative maintenance should decrease. Also, a task code analysis may indicate some shop locations may be combined with other locations. To perform this analysis, shop repair tickets total time they were open, labor hours, and parts cost would be evaluated to identify shop locations outside statistical bounds. This analysis would be performed for each task code. Then, a statistical analysis of the frequency plot showing the number of times a shop was outside statistical bounds would reveal shop locations that require additional observation.

Appendix M contains several types of task code analyses as examples:

1. A sample task code analysis for some transmission repairs to identify shops with measures with possible special causes
2. A cost savings analysis of wear and tear expenses performed on vehicles during the warranty period.
3. A frequency analysis of the most frequently performed task codes.
There may also come a time where it will become advantageous to station “mobile mechanics” in some counties that operate out of fully outfitted service trucks. These individuals would travel to the county(s) maintenance units to perform preventative maintenance service, minor repairs, and emergency repairs to equipment. They would maintain a supply of spare parts at a location convenient to them. When service above-and-beyond preventative or minor levels is required, the repair would be sent to a larger district shop.

The district shop and reduced number of county shops would perform more major vehicle and equipment repairs. Repairs above and beyond their capability or capacity would be sent to the Equipment Depot or to an outside repair facility.

The Equipment Depot has the personnel, tools, equipment, and facilities to routinely perform all routine equipment repair and preventative maintenance work as well as minor and major body work, frame straightening, engine replacements and rebuilds, and removal and replacement of major mated equipment. When they have repairs above and beyond their capability or capacity, they send them to an outside repair facility.

When constructing new facilities, consideration should be given to construct them in a location such that they can service more than one county.
Shops should be staffed and sized to handle the expected routine work volumes. No recommendation is made for an ideal number of mechanics to a certain number of vehicles or equipment. Instead, results from the task code analysis should be used to identify those shop locations with insufficient or excessive personnel.

After South Carolina state government agencies were restructured in 1993, SCDOT stopped servicing outside agency vehicles and equipment. Many municipal governments with small fleets enjoyed the cost savings and customer service they received while they had their vehicles maintained by SCDOT. This can represent a small revenue source for shops; however, it can divert SCDOT personnel from maintaining SCDOT equipment and present repair priority conflicts. Should this service be re-instituted in the future, the agency will need to ensure it recovers all its actual and overhead costs, will have to have agreements in place regarding repair priorities, and will need to receive payment guarantee. The likelihood of repair priority conflicts occurring can be reduced if outside agency equipment is repaired during a "second-shift" and is staffed with additional personnel.

Repairs requiring $1500- $4999 parts or outside services should require approval of the District Mechanical Engineer. This averages to about 100 approvals per year per district. Repairs exceeding $5000 parts or outside services should require approval of the Supply and Equipment Office. This averages to about 100 approvals per year.
Equipment Replacement

Equipment age, utilization, accumulated use, and average costs are useful in setting target replacement criteria. When an asset meets these target replacement criteria, it should not automatically mean the asset is replaced. Instead, each asset should be compared to other like items, and their relative costs, ranking, and physical condition should be reviewed. Then replacement lists can be developed. Through this process, sometimes assets will be identified that should be transferred from one District to another to meet greater need.

As previously discussed in the Software Tools section, the equipment replacement process has been revised and now utilizes a re-designed Equipment Request program. The District Mechanical Engineers, review their equipment’s ranking on the TERMS reports from the Supply and Equipment intranet site and put together an equipment request. Turn-in pieces of equipment are identified at the time of the request. The primary intended use for the equipment is identified, and each request requires a justification. Wherever possible and justified, equipment is turned in without replacement. SCDOT considers the use of equipment pools, vehicle and equipment rental vendors, and contractors when developing the vehicle and equipment request.

The Supply and Equipment Office reviews each request, adds or deletes requested equipment, and makes recommendations to management for final order approval. Their
recommendation is based ratios of the following to their corresponding values for each piece of equipment:

- TERMS score,
- Most recent 12 months utilization,
- Age,
- Accumulated use,
- Amount of downtime in the last 12 months, and
- Number of hours the equipment was reported used in HMMS.

Assets are ranked relative to other similar items and compared to the district’s requests. Each district’s original request and Supply and Equipment’s recommended request is presented to management for approval. A copy of Supply and Equipment’s ranking for backhoes is included in Appendix N.

Additional changes to the above process that needs to still be done is to 1) qualify which expenses are included in the “Period Repair” and “Accumulated Repair” dollar amounts, and 2) evaluate if an additional criteria of (Accumulated Repair Expenses/Original Cost) should be included. Presently, “Period Repair” and “Accumulated Repair” include expenses for equipment modifications and accident repair. Vehicle and Equipment Repair dollar amounts should include only costs to perform periodic inspections and maintenance and actual repairs. For example, backhoes 237-04-0242, 237-04-0246, and 237-04-0255 are ranked high on the replacement ranking. However, they are only two to three years old. Further investigation of the details
surrounding the costs for these machines identifies high equipment downtime, high repair costs due to damage, and high usage. This information is shown in Appendix O.

Each asset has an economic life. Assets are compared to each other using what is known as the equivalent uniform annualized cost, or EUAC. The EUAC becomes a minimum at the recommended economic life of an asset. However, it is not unusual for an asset to be in service for longer than its economic life. A more detailed discussion of the EUAC and a EUAC calculation for a pickup truck is included in Appendix P.

Again, assets are usually kept longer than their economic life. For instance, if pickup trucks were disposed at their economic life (approximately 2 – 3 years), auction prices would soon drop. Also, the truck dealers may also raise their prices to SCDOT. Higher initial price and lower resale value would extend the economic life, so the process would defeat itself.

However, selling high-demand vehicles and equipment earlier in their lives will increase resale value and reduce overall repair expenses. Although somewhat intangible, operator satisfaction usually increases when they operate newer vehicles and equipment, too.

Current auction sales price of used vehicles and trucks in fair condition is approximately 10% of the original purchase price. For backhoes this is approximately
17%. Estimated auction sales prices for selling newer vehicles and equipment is as follows:

<table>
<thead>
<tr>
<th>Key Series</th>
<th>Description</th>
<th>Age</th>
<th>Estimated Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>001 - 009</td>
<td>Vehicles and Light Trucks</td>
<td>4 - 5 Years</td>
<td>40%</td>
</tr>
<tr>
<td>010 - 011</td>
<td>Medium Duty Trucks</td>
<td>4 - 5 years</td>
<td>40%</td>
</tr>
<tr>
<td>012 - 014</td>
<td>Heavy Duty Trucks</td>
<td>4 - 6 years</td>
<td>40%-60%</td>
</tr>
<tr>
<td>237</td>
<td>Heavy Duty Backhoe</td>
<td>4 - 5 years</td>
<td>40%-60%</td>
</tr>
</tbody>
</table>

SCDOT purchases 001-014 series vehicles and trucks and 237 series backhoes at extremely good prices, and these assets have good resale value. Consequently, it does not make economic sense to lease these assets. Also, if SCDOT were to lease these assets, the finance cost would exceed SCDOT’s current rate of return it receives on money invested at the State Comptroller General’s office.

Municipal leases available from the major vehicle and truck financing corporations are a fixed term leases. They are essentially a lease-to-own type of lease with an added non-appropriations clause. In the event future budgets do not include sufficient monies to pay the lease payment, the asset is returned to the financing corporation. Advantages (+) and disadvantages (-) of this type of lease is as follows. A sample proposal from Ford Motor Credit is included in Appendix Q.
+ Allows replacement of large numbers of assets without increasing initial annual budget.

- Future available budgets are reduced because monies are already encumbered for annual payments.

- May reduce SCDOT debt capacity for road and bridge projects.

- If asset value reduces or if asset becomes non-productive, lease payments are still due.

- Interest rate charged for lease is higher than the SCDOT's money cost and current rate of return. This rate is presently 4% per year.

There are other companies that offer municipalities the ability to lease assets for a fixed period of time and then return the vehicle to get another vehicle. Advantages (+) and disadvantages (-) of this type of lease is as follows:

+ Periodic asset replacement is already committed.

+ Allows introduction of large numbers of new assets at beginning of contract.

- Excessive usage penalties established upon turn in.

- Physical condition penalties upon turn in.

- Penalty for early turn in.

- No equity develops even though lease payments are required.

- May reduce SCDOT debt capacity for road and bridge projects.
Turned-in Equipment

Equipment being replaced, no longer needed, beyond economical repair, or otherwise non-serviceable is turned into the Equipment Depot. Turned-in equipment is evaluated and placed into one of six categories:

1. Reissue immediately,
2. Perform minor repairs and reissue,
3. Hold for up to six months in case another asset in service needs to be replaced,
4. Hold for parts,
5. Cannibalize serviceable parts and prepare for auction, and
6. Prepare for auction immediately.

Item number three was begun this year to address the need for mid-year vehicle and equipment replacements. As Districts have turned in vehicles and equipment to increase utilization, they sometimes get in a situation where an asset becomes uneconomical to repair, and they need a replacement. In lieu of purchasing a new asset in mid-year, a serviceable asset is re-issued to them. To assist equipment repair shop supervisors and District Mechanical Engineers in managing their equipment repairs and additional equipment needs, a list of turned in equipment that is in re-issuable condition
should be made available and maintained. This will be incorporated into the revised equipment request and order software.

Both turned-in equipment and new equipment are sometimes placed in equipment pools. A statewide vehicle and equipment pool is operated at the Equipment Depot, and pools are also recommended at each of the districts. Operating pools is a very cost effective method to minimize asset quantities, provide for capacity in the event of emergency need, and increase vehicle and equipment utilization.

Vehicles and equipment sold at auction are sold “as-is, where-is”. However, in the event it is obvious an item may present a public safety hazard because of being in worn condition, the Equipment Depot usually either replaces the defective part(s) or incapacitates the asset. This proactive practice is commended and should be continued.

Replacement Budget Forecast Needs

The current total fleet replacement cycle based on initial cost has been decreasing and is presently 15.1 years. Continued progress towards a five-year replacement cycle for vehicles, trucks, and backhoes and an eleven-year replacement cycle for all other equipment will require additional financial support. However, the benefit is reduced operating and maintenance expenses in the long term.

More newer equipment means more major repairs are avoided. More equipment is covered under manufacturer’s warranty, so parts and labor costs decrease. Labor hours
are made available to work on other equipment. Repair and preventative maintenance downtime decreases. As the necessary vehicles and equipment are more consistently available for use, overall SCDOT productivity increases. Consequently, overall agency productivity increases.

The budget forecast presented in Appendix R is greatly simplified. It can be improved after the following activities are accomplished:

1. Re-assess maintenance, construction, engineering, and administrative operation’s vehicle and equipment needs. This task involves a thorough evaluation of each operation’s needs, staffing level, and capabilities. This project could be accomplished with support from existing agency staff from across the state, but an outside consultant may perform it quicker and with less impact on SCDOT personnel’s time.

2. Evaluate other state, municipal, and private contractor operations to identify “best practices” which can be integrated into SCDOT operations.

3. Develop recommended “equipment complements” and quantities for each operation and office. Include needs to staff vehicle and equipment pools.

The analysis presented assumes all assets need to be replaced with similar assets. In other words, it assumes no additional fleet size reduction. For convenience, the projected funding needs chart is reproduced here.
Projected Vehicle and Equipment Replacement Funding Need
5 year Vehicle, Truck, and Backhoe and 11 Year Heavy Equipment Cycles

Conclusion

SCDOT’s equipment management organization is a vital organization that impacts every person at SCDOT. New software tools already in place and organizational and procedural changes will enable the equipment management organization to operate more efficiently and effectively. Ultimately, improvements to the equipment management organization will enhance SCDOT’s capability to be adaptable and flexible, to accomplish the primary mission objectives, and to address ever-changing priorities and respond to emergencies and disasters.