ALBUQUERQUE'S GEOGRAPHICAL PAVEMENT MANAGEMENT SYSTEM

Raymond Chavez

This paper describes the Geographical Pavement Management System as developed by the city of Albuquerque. Included in this paper are the procedures used for acquiring the system and different application of the system for the Pavement Management and Street Maintenance.

In 1978, Albuquerque started developing a street inventory system and, in 1985, the city acquired a Geographical Information System (GIS). In 1987, Albuquerque's Street Maintenance Section merged the two systems to develop a most valuable tool in the field of pavement management—a Geographical Pavement Management System.

In 1978, Albuquerque was in need of a pavement management and inventory system. Information such as miles of paved and unpaved street were scaled from maps for informational reports. With the aid of the Asphalt Institute, a street inventory and rating system was begun. All inventory and ratings were done on a block-to-block basis. Streets were rated on the following 10 elements: 1) raveling, 2) weathering, 3) longitudinal and transverse cracking, 4) alligator cracking, 5) chuck holes, 6) rutting, 7) shoving, and 8) block address. Also, 9) preventive maintenance needs and the 10) year that maintenance was last performed were gathered, when available. The total initial inventory took 13 months to complete and was keypunched into a data-card system.

In 1982, the city hired a consultant to evaluate this information and develop a Street Pavement Evaluation and Computerized Street Inventory System. The program was written for a Prime Computer System

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utilizing Henco Software Inc. INFO language. The consultant supplied
the city with computer reports summarizing the data base. The city would
then reinventory the streets and update the data base, keypunching the
update into this system. A local consultant with the same computer
system as the original consultant was then hired to run and supply the
city with the computerized reports.

In 1984, a consulting firm was retained by the city to develop a
specific study methodology for GIS and to compile and analyze
information regarding the functions of the various city departments and
their need for geographical information. It was at this time also that the
Albuquerque Geographical Information System (AGIS) was created. AGIS
is a city agency within the planning department responsible for the
implementation and management of the GIS System. In 1985, the city
released a request for proposals (RFP) soliciting proposals from major
vendors for different GIS systems. After exhaustive evaluation of each
proposal, the Environmental System Research Institute (ESRI) was
eventually chosen as the vendor that could best meet the GIS needs of the
city. ARC/INFO, a software developed by ESRI, was enhanced to meet the
city’s needs and was installed in the latter part of 1985 into a newly
acquired PRIME Computer System. Staff training began in January 1986.

In 1987, the city’s street maintenance section decided to load the
latest street inventory data base into the city's new system and save the
city the consultant fee. With minor reprogramming, the data base was
loaded by AGIS staff and the existing reports, as written by the consult­
ant, were produced. With the assistance of AGIS staff, the street
maintenance engineer was trained on the INFO language. In a short
time, the Street Maintenance Section was producing various reports. The
original data base was then expanded to include measurements of
missing sidewalks and missing curb and gutter, the council district
number, unit costs for various rehabilitation processes, street surface
area, cost to perform desired rehabilitation, cost to put in sidewalks
where missing, different types of rehabilitation recommended, and condi­
tion scores for intersections and street maintenance satellite stations. At
this point, a reinventory of the entire city was again started to include the
added items. Street Maintenance then purchased a terminal and printer
and a communication line was installed from the city’s prime computer
system to Street Maintenance Division’s office which is approximately 10
miles away. The reinventory was completed in six months. Once it was
completed, Street Maintenance was able to produce reports live on the
terminal and print them, if necessary.

Information like total miles of missing sidewalks, information by
council district, and costs for street rehabilitation were now accessible
instantly without having to search bulky computer reports for
information.

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It was at this time that a new effort was initiated by Street Maintenance and AGIS to convert this data base to GIS graphics. The AGIS staff had already created a data base network, which contained an address range for all blocks, for all city streets. The Street Maintenance Inventory System also had an address item. An address match of the Street Maintenance System was run against the AGIS address network. This created a point coverage of the matched records and, with further programming, the point coverage was converted to a block-to-block line coverage. This meant that for every address in the Street Maintenance System that matched against the AGIS network, we were able to draw a line or arc the length of a block on the screen. The lines were located where the address matched on the network. Our first address-match attempt resulted in creating lines out of about 70 percent of the data base. This meant that 30 percent of the addresses in the Street Maintenance System was incorrect or left blank during the inventory. We had to locate the correct addresses for these records and rerun the address-match program. We currently have an approximate 99-percent match.

Once the address match process is complete, a coverage is created. The coverage created has all the items within the data base. At this point, it becomes a reselect process. For example, if we want to plot dirt roads within the city, we reselect from the PMS.NETCURR (the created coverage) SRFMAT = “DR” where SRFMAT is the item name for the type of road surface and DR is the symbol for dirt road. The result is that only dirt records are selected. These are then drawn on the screen with a simple arc plot command, again using the ARC/INFO System. Separate coverages have been created to eliminate the reselect process for frequently used coverages. Separate coverages have been created for each of the council districts, worst streets, dirt roads, concrete roads, asphalt roads, missing sidewalks, annual programs, etc.

Once coverages are created, very innovative plots can then be produced. The GIS system has many coverages, including the major street network, city-limit boundaries, council-district boundaries, parcels, roadway centerline, roadway right-of-way, census data, etc. By combining the major street coverage with the council district coverage and overlaying the worst street coverage, a plot showing all the worst streets within a council district can be produced. The combining of the different coverages is almost endless and the information produced is very valuable.

Besides creating coverages from the data base gathered from the inventory, we have created coverages directly out of the telephone book. We’ve created a data file containing the addresses of all the schools and churches within the city and run an address match again, creating a point coverage. We then “buffered” a one-mile radius around all the churches and schools and plotted the missing sidewalks. This gave us a plot showing all the churches and schools with a one-mile radius circle surrounding that school or church and overlayed with missing sidewalk arcs. This plot...
was created to show the missing sidewalk within a one-mile radius for all schools or churches within the city.

As mentioned earlier, we also rate the streets during the inventory for the 10 elements of deterioration. Each element is given a condition of score between 0 and 5, where 0 is excellent and 5 is very poor. Once this information is brought in and keypunched, a program is run to calculate the condition scores for all records on a block-to-block sequence. Each element has a weighed factor depending on its classification. These factors are included in the program. Once the program has been run, an item showing the condition score for each block of the city is created.

Currently, the city has over 17,000 blocks or over 1,600 miles, each containing a condition score. As we know, the condition score is the most important item in a pavement management system. The following is a breakdown of condition scores by classification and categorization of street condition:

<table>
<thead>
<tr>
<th>Road Classification</th>
<th>Condition Level</th>
<th>Condition Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial</td>
<td>EXCL</td>
<td>0.0-2.4</td>
</tr>
<tr>
<td></td>
<td>V.G.</td>
<td>2.4-5.0</td>
</tr>
<tr>
<td></td>
<td>GOOD</td>
<td>5.0-10.0</td>
</tr>
<tr>
<td></td>
<td>FAIR</td>
<td>10.0-20.0</td>
</tr>
<tr>
<td></td>
<td>POOR</td>
<td>20.0-40.0</td>
</tr>
<tr>
<td></td>
<td>V.P.</td>
<td>40.0-59.8</td>
</tr>
<tr>
<td>Collector &amp; Commercial</td>
<td>EXCL</td>
<td>0.0-2.0</td>
</tr>
<tr>
<td></td>
<td>V.G.</td>
<td>2.0-4.0</td>
</tr>
<tr>
<td></td>
<td>GOOD</td>
<td>4.0-8.0</td>
</tr>
<tr>
<td></td>
<td>FAIR</td>
<td>8.0-17.0</td>
</tr>
<tr>
<td></td>
<td>POOR</td>
<td>17.0-35.0</td>
</tr>
<tr>
<td></td>
<td>V.P.</td>
<td>35.0-69.5</td>
</tr>
<tr>
<td>Residential</td>
<td>EXCL</td>
<td>0.0-1.5</td>
</tr>
<tr>
<td></td>
<td>V.G.</td>
<td>1.5-3.0</td>
</tr>
<tr>
<td></td>
<td>GOOD</td>
<td>3.0-7.0</td>
</tr>
<tr>
<td></td>
<td>FAIR</td>
<td>7.0-15.0</td>
</tr>
<tr>
<td></td>
<td>POOR</td>
<td>15.0-30.0</td>
</tr>
<tr>
<td></td>
<td>V.P.</td>
<td>30.0-59.8</td>
</tr>
</tbody>
</table>

With the reselecting process, we can produce plots showing streets in any condition, by classification, in any area of the city. For example, if we
wanted to see where all the poor or worst arterial streets are within the city, we would reselect the PMS.NETCURR coverage for CLASSIF = 1 where 1 is arterial and COND-SCORE 20. We would then overlay this selected set on the GIS coverage that we have selected. If we wanted to add dirt roads to this plot, we would change the line color and reselect for SRFMAT = “DR” and draw these arcs. The plot would then contain all the worst arterial streets in one color, and dirt roads in another color. After adding titles, legends, logos, scales, etc. to dress up the plot, you produce a plot suitable for presentation.

**Different Uses of the GIS System at the Street Maintenance Division**

The Street Maintenance Division is responsible for the design, implementation, and construction of the annual street rehabilitation program. The city currently has four annually scheduled rehabilitation programs, 1) heater repave program - arterial, collector, and commercial streets, 2) overlay program - residential streets, 3) rubberized crack sealing program, and 4) slurry seal program. For each of these programs, a list of streets proposed for work must be prepared far in advance of the construction start. This list is sent for review to all utility companies and other city agencies to eliminate the streets that are in conflict with other projects. The GIS has given us a tool to rehabilitate the worst streets by area, if desired. We first reselect for a certain condition of street to be rehabilitated depending on the budget. We are then able to draw these streets on a screen or plot on a hard copy. When we select a certain condition score for streets needing rehabilitation, we usually plot streets with condition scores of at least two points better on a different color to catch all streets in a certain condition range within a certain area. We then use our engineering judgment as to whether we should include these streets for rehabilitation also. This would then save on construction cost due to less mobilization by the contractor.

We also have requested and received, from other city agencies, work completed by them. A listing of all sliplined sewer lines and replacement of water lines has been keypunched into our system. We are now able to plot those streets and overlay the condition of the street over this coverage. This gives Street Maintenance a priority of streets that need overlaying due to the tearing up of the street during the replacement and sliplining procedure. We can plot the year that a street was sliplined or lines replaced and monitor it thereafter. On our last Heater Repave Contract, the contractor was required to give us a street schedule for construction. We produced a plot showing the major street network and overlayed this with the streets to be heater-repaved. Each street to be heater-repaved was numbered, with the number corresponding to a schedule for construction for that street. The schedule also was printed on the plot, giving us a check on the construction schedule.
the plot. This gave both us and the contractor a visual method to monitor the contract time and sequence of construction.

Another item that is part of the inventory process is the rating of a street for crack sealing. Depending on the need for crack maintenance, a 0-5 rating again is used. Thus if a street needs crack sealing immediately, a score of 5 is given. Reselecting for this item and for a score of 5 produces a plot showing streets needing crack sealing. Obviously, this is only a tool for helping prepare programs—engineering judgment and field verification are still necessary to propose these programs for funding.

This graphical tool also can be used in everyday routine maintenance scheduling. As an example, dirt roads can be plotted and, as mentioned earlier, with the contractor's schedule, these roads can be scheduled for watering and blading similarly. Street sweeping also can be scheduled. Streets with high priority during winter snow storms can be plotted so that all superintendents and foremen know exactly which streets are priority. The system also has been very helpful in answering the public's questions on street conditions and when streets will be overlayed. By knowing the condition score of that street and looking at other streets in the same area, a time frame for repaving can be given depending on the budget. If questions arise as to whether a street is public or private, again by drawing the street and overlaying certain coverages, the questions can be answered from a terminal. Another item that is part of the inventory process is the need for pothole patching. Again, a worst area for potholes can be selected and plotted and, with some judgment, scheduling can be accomplished. To expedite the reinventory and keypunching of the re-inventory, Street Maintenance has just begun to research the possibility of putting terminals on the vehicles used for the reinventory. Therefore, when streets are being inventoried, they can be updated live in the field, thus eliminating the office keypunching.

The biggest aid, however, to Street Maintenance and the Street Rehabilitation Program from this system is the ability to graphically show city council members and the administration the condition of our streets. By looking at a plot and showing only the poor or worst streets, the impact is positive for funding purposes. Our rehabilitation budget has increased and we have started to rehabilitate the backlog of poor streets. We have used plots from this graphical system at city council meetings, budget meetings, neighborhood organization meetings, etc.

**Equipment**

We have installed a direct line from the mainframe computer to the street maintenance office. To this line, we have connected an 8-port multiplexer. Currently, we have four terminals, a plotter, and a printer connected to the multiplexer. Three terminals are Textronix 4207 graphical terminals, the other is a Prime PT200 nongraphical. The plotter is a
Calcomp 1023 which plots up to size 24” x 36” graphics. We also use a plotter located downtown for larger plots when needed. The printer is a Prime Printronix 600 dot-matrix printer. We also have two Textronix 4696 color, ink-jet printers connected to the graphical terminals to draw the graphics on the screen on 8-1/2” by 11” hard copy instantly. Overhead projections also can be produced from this printer for presentations.

The cost for this equipment was approximately $25,000. Since we are connected to the city-owned mainframe system, we do not pay time-sharing expenses. The only expenses we have at this time to maintain the system are the costs of maintenance contracts for the equipment and the cost of supplies. Combined, they do not exceed $3,000 per year.

Cost savings from this system are not easily accumulated. Since this system is an in-house innovation, it did not replace an old system but enhanced an inventory system. One direct cost savings from the system is the elimination for the need of a consultant to produce computer reports from the inventory. This was running approximately $15,000 per year. An indirect cost savings from being able to locate streets needing rehabilitation in a vicinity eliminating the contractor’s mobilization costs. However, the biggest benefit from this system is being able to convey a message or information on a plot graphically to large groups, which usually has a much bigger impact than supplying computer printouts.