Financial needs of Iowa's County Roads

Assessment and prediction

TR-608

Technical brief

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The TR-608 project was undertaken to seek answers to key questions regarding Iowa's county road needs: how much is being invested in the system today, how much ought to be invested, what is the system's role in the rural economy, is the system – as it now is – adequate to serve the traffic it carries, and how will all these things trend in the future. The goal was to develop means by which county engineers and supervisors can accurately inform the public of the financial resources required to provide an adequate rural road network.

The work was performed in three major phases. The first objective was to develop a process for determination of current needs and expenditures. In the second part, the research team created a Trend Projection Engine capable of estimating future revenues, needs and condition outcomes for up to fifteen years ahead. Last, tools were built to enable selection, analysis and graphing of Phase 2 results.

PHASE 1 – CARRYING COSTS

In this section, an effort was made to determine how much money ought to be spent per year to preserve the roads and bridges for the long term. The number sought was named the "Carrying Cost" of the system and was defined as follows:

"The CARRYING COST of a road system is the amount that needs to be spent, per year, to operate, maintain, extend and renew the roads and bridges, keeping them in the exact same extent, configuration and condition as they are today – for a very long time into the future."

To accomplish the task, methods were developed to determine how much counties expend per year, adjusted for inflation, (based on the most recent eight years on record). This provides a smoothed picture of how counties allocate their resources and incorporates costs from items that don't occur every single year. To do this, data was taken from county engineer annual reports, project completion tabulations and GASB-34 records, inflated and averaged. The final results were broken down into the following grid of asset classes (road or bridge), surface types (earth, granular, hard surfaced, and paved) and purpose of expenditure (operations, maintenance, extension of service life, and full renewal):

Cost Breakdown	Roads				Bridges			
	Earth	Granular	Hard Sfc	Paved	Earth	Granular	Hard Sfc	Paved
Operations	$	$	$	$	$	$	$	$
Maintenance	$	$	$	$	$	$	$	$
Extension	$	$	$	$	$	$	$	$
Renewal	$	$	$	$	$	$	$	$

	ROADS	Typical expenditures per year			Bridges	Inflation Adjusted 8 year avg.		
Actual	Earth	Granular	Hd Surface	Paved	Earth	Granular	Hd Surface	Paved
Operate	1.5	81.4	5.2	68.7	0.2	9.0	0.6	7.5
Maintain	1.5	66.8	4.3	39.1	0.1	4.3	0.3	3.8
Extend	0.9	49.7	4.6	68.7	0.3	8.6	0.6	8.9
Renew	0.5	81.2	2.7	126.5	0.8	29.7	2.6	53.0
Totals	4.4	279.0	16.8	303.0	1.4	51.6	4.1	73.3
			Roads:	603.2			Bridges	130.4
							Grd Total:	**733.6**

Each cost element was then evaluated to determine if the amount being expended was sufficient to sustain the system in acceptable condition. If not, work was performed to determine the degree of short fall and product factors that, when multiplied times actual expenditures, equal actual needs. The Asset Class – Surface Type – Expenditure purpose break down allowed factors to vary according to shortfall, different inflation rates and condition states.

Ultimately, the following factors resulted:

	ROADS	2012 'tuned' TR-608 factors			Bridges			
Factors	Earth	Granular	Hd Surface	Paved	Earth	Granular	Hd Surface	Paved
Operate	1.00	1.05	1.05	1.05	1.00	1.00	1.00	1.00
Maintain	1.00	1.10	1.15	1.15	1.00	1.00	1.00	1.00
Extend	1.00	1.10	1.65	1.05	3.00	1.80	0.90	0.90
Renew	1.00	1.10	1.90	1.15	3.85	2.42	0.80	0.85

These multipliers, based on condition trend analysis, life cycle support cycles and engineering judgment of costs, indicate the adequacy of investment: a one indicates that current expenditures match needs, a larger factor indicates that more funding is needed; a factor less than one appear where conditions appear to be improving.

When multiplied times the eight year averages costs, the factors help determine the amounts that ought to be spent to sustain the system long term:

	ROADS				Bridges			
Need	Earth	Granular	Hd Surface	Paved	Earth	Granular	Hd Surface	Paved
Operate	1.5	85.4	5.5	72.1	0.2	9.0	0.6	7.5
Maintain	1.5	73.5	5.0	45.0	0.1	4.3	0.3	3.8
Extend	0.9	54.6	7.6	72.1	1.0	15.4	0.6	8.0
Renew	0.5	89.3	5.1	145.4	3.1	71.9	2.1	45.1
Totals	4.4	302.9	23.1	334.7	4.4	100.6	3.5	64.4
			Roads:	665.1			Bridges	173.0
							Total:	**838.1**

These results can be updated annually, to reflect changes in inflation rates, condition and system configuration changes.

For 2012, the areas in greatest need of more investment were Hard Surface roads and Earth/Granular Road Bridges. Overall, roads appear to need 10.3 percent more funding, while bridges would require 32.7 percent more to achieve sustainability. A total revenue increase of around $105 million per year (roughly $1M per county) is needed to preserve the network at its current extent, configuration and quality.

The research next explored to what degree the system might warrant being upgraded (distinct from preservation) in order to improve utility or decrease accident costs incurred by the public.   This effort compared road geometry to design aids and showed that the mix of road types that exists is a good fit for the level of traffic using each route. Nonetheless, a small percentage of the mileage is under-designed for the current AADT load and warrants being upgraded: about 388 miles of the total 89,965 mile system.   The estimated cost to upgrade would be around $325 million, or $32.5 million per year for 10 years, if spread over time.

PHASE II - TREND PROJECTION ENGINE

Although knowledge of current need is of greatest utility, there is value in being able to look ahead to see where continuation of current trends may take us and how various alternate scenarios might turn out. This assists with planning for the future and advising society's elected leaders on the pros and cons of different approaches to road funding.

To be able to credibly, and with maximum possible accuracy, extrapolate how things will turn out ten or fifteen years from the present, one needs a) a solid picture of the present, b) reasonably valid determinations/assumptions as to future trend rates, and c) a simulation model that can deal with the interconnections that exist between system extent, configuration, condition and costs. To that end, TR-608 used a multiple step model. It started from the basic drivers of population and land use, then progressed through need, cost, revenues and outcomes on a year by year basis. The following summary outlines the basic process.

Step	Item modeled (for Y_X = 1 to 15)	Comments
0	Acquire / set up base year (Y_0) data	Start with the data from the Phase I calculations
1	Project Y_X population, land use and rural economy outputs	Start with fundamental economic drivers
2	Estimate Yx road revenues and the allocations to Road/Bridge – Surface Type – Expenditure purpose	Estimate probable revenues –either as will occur absent a change in funding or with possible new fund mechanisms. (Factor in probable growth rates)
3	Starting from Step 1 results, project Yx VMT, VPD, Trucks and ESALs	Use Trip and VMT per trip factors to estimate traffic volumes from Step 1 outcomes. Allocate VMT to the surface classes, then determine estimated VPD. Calculate total and percent trucks. Calculate ESALs per lane for each surface class.
4	Calculate probable costs that road users will incur while utilizing the network: vehicle operations costs, service interruption costs and accident costs	Use Step 3 data to forecast what it will cost drivers to operate their vehicles upon the roads. This is computed for comparison to the costs of providing the roads.
5	Estimate the Carrying Cost needs for Yx, based on inflation adjusted costs, and the adjusted extent, configuration and condition of the system	Determine inflated costs for the Operation, Maintenance, Extension and Renewal of roads and bridges under each surface class.
6	Estimate Yx Upgrade needs. Identify and prioritize all segments that warrant upgrade. Estimate a cost per segment for each eligible piece.	Recalculate upgrade needs based on adjusted VPD's, determine eligible segments, cost them out and prioritize. Then tally the need as it happens to fall in mid-Yx
7	Conduct a Revenue vs. Needs analysis to determine how well (or poorly) the revenues cover costs. Express the outcome in percentage covered for each Road/Bridge – Surface Type – Expenditure purpose combination. Also determine how much upgrade work could likely be done.	This process is the core of the model. Implicit within the process is the assumption that if revenues are sub-adequate, system condition will decline and vice versa. This is important because user costs and road system costs vary inversely with condition – and constitution a powerful positive or negative feedback mechanism.
8	Using the results of Step 7, model condition adjustments for Granular, Hard surface and Paved surfaces.	Model the deleterious effects of one year's traffic, then restore as much lost serviceability as the results of Step 7 will allow.
9	Using the results of Step 7, model how many structures can be rehabilitated or replaced in Yx	Model, in the abstract, how many structures can be rehabbed or restored per year, given the results of Step 7
10	Combine data from Steps 7 (Upgrades) and 8 to determine extent, configuration and condition status to be used in Yx+1. Adjust traffic flows to account for bridge closures (if any). Update bridge records and recomputed priority points	While Step 8 computes net changes in condition, the results are for the system as it was at the beginning of the year. If any upgrades have taken place, the mix of surface miles will shift and the average condition of certain surface classes will be raised.

10b and 11	Compute feedback factors to be used in Yx+1. Road surface condition factors for granular, hard surface and paved routes. Impacts on cost levels, future rate of decay, traffic flows	This section models how changes in condition can affect costs, traffic and future rates of change.
12	Note and record impacts of urban growth where it is taking place: Loss of rural land area, population and route miles; decrease in agricultural outputs.	This information is recorded to note that urbanization can change the character, usage and layout of the county road system.

PHASE III – Results extraction and graphing

The Trend Project Engine was designed to produce AND save a very large selection of variables, with the idea that one can then pick and choose which items to extract, depending on the nature of the story to be told. One could compare road user costs to the cost of providing the system, or compare road conditions to cost coverage, or contrast the outcome of the status quo with an enhanced revenue option, etc. In order to permit this type of flexibility, a detailed data selection and graphing panel was set up.

The panel affords choice of data items, scenario (up to three), time basis, counties and consolidation level, then outputs data in tabular, line graph or bar graph format.

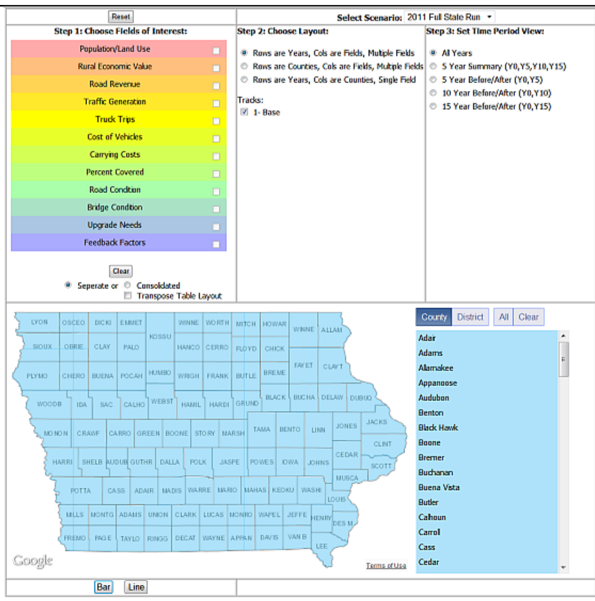
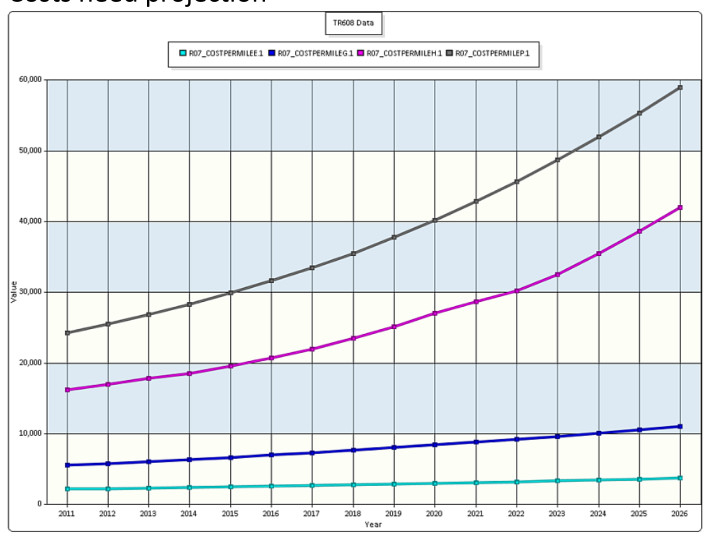


Figure 12 : Earth, Granular, Hard Sfc and Paved Carrying Costs need projection



Conclusion

TR-608 was developed to enable counties to better determine and articulate the financial needs of the system they are responsible for and to enable analysis of future outcomes. Both the Carrying Cost and Trend Projection Engine (TPE) modules are housed at the Iowa County Engineers Associate Service Bureau. The Carrying Costs will be updated annually; the TPE will be operated on an 'as requested' basis – whenever a single county or the state association requests exploration of possible future outcomes. Some of the condition modeling techniques developed in the course of building the TPE could lend themselves to use in Asset Management activities, and the traffic prediction model provides a good way to compare counties' rural road usage potentials.