

# **How Smooth Are New York City's Streets?**

*Results of a Study Conducted by the  
Fund for the City of New York  
Center on Municipal Government Performance*

## **HOW SMOOTH ARE NEW YORK CITY'S STREETS?**

### **Introduction and Background of this Study**

In 1995 the Fund for the City of New York initiated research to determine how New York City residents and owners of small businesses go about assessing the performance of city government agencies. It may be surprising to some that this undertaking is novel in city government, since private sector businesses have been asking their customers about how they evaluate services and products for decades. Most measurements and reports of government performance, however, are created by government managers consulting among themselves and are often designed to help them manage the resources for which they are responsible.

Our initial objective was to find out if the public uses performance indicators and standards for some critically important services that are different from what government applies as it allocates and manages its resources. If, indeed, the public identified indicators that are not being used, our plan has been to then create, apply and disseminate some of the new measurements. This new information can be used by government to align or realign its activities, when necessary, so that they are more responsive to people's expectations and/or engage the people in discussions that can help them understand why performance is at the level reflected by these measurements.

Our standards for the new measures are stringent in that they must be objective, valid and replicable. The data must be systematically and consistently gathered, using the appropriate scientific methods whenever possible. When complex, technical data are involved, we are making every effort to produce reports that are understandable and useful to the public as well as to government. We are doing this work because we know that it is important for the public to have access to reliable information about how their government is doing on subjects that matter to them.

In the course of our research we found that the public considers the maintenance of New York City's streets to be a critically important service. They said that the presence (or absence) of irregularities and bumps that cause discomfort and damage while driving over them are the indicators that they use to rate the city's performance. Currently, street conditions are not systematically evaluated in this manner.

This report describes the work we have done to develop and produce, reliable, unbiased and objective measurements of the smoothness of New York City's streets, using the two indicators people identified -- smoothness and significant jolts. We have sought to apply the best technologies to this task. We hope that this study and future ones will encourage government and the public to discuss resources allocated to this service, monitor changes in performance, and communicate constructively with one another about ways in which city services can improve. Data were obtained and are presented here for

each of the city's 59 community districts, thereby enabling local residents and leaders to see how their districts were rated.

We are doing this work with the support and strong interest of the Alfred P. Sloan Foundation which inaugurated its national Assessment of Government Performance Program in 1995 by naming the Fund for the City of New York as its first grantee. Their assistance has enabled us to establish our Center on Municipal Government Performance and encouraged us to continue innovations in performance measurement.

## **Who We Are and Why We Conducted this Study**

The Fund for the City of New York is an independent, private operating foundation established by the Ford Foundation in 1968. Its mandate is to be responsive to the problems of New York City and to opportunities to improve the quality of life of its citizens. The Fund seeks to improve the functioning of government agencies and nonprofit organizations by introducing and helping implement innovative programs, technologies, and methodologies.

In 1973 we introduced Scorecard projects -- projects that have advanced the art of performance measurement in government. These projects consist of rating scales, guidelines, trained observers and reporting systems to provide government with the knowledge it requires to assess, monitor, report on, adjust and improve core services. A Scorecard system provides quantifiable, accurate and reliable information about the outcome of service delivery.

Sanitation Scorecard, our first scorecard project, is still in effect and is a key indicator of the Department of Sanitation's performance. It is a systematic way of assessing and reporting about the cleanliness of the city's streets and comparing data over time for the city as a whole and for all community districts. Since its inception in 1977, the Mayor's Management Report, which is published twice a year, has included the results of Sanitation Scorecard surveys. The results are also reported monthly to all Community Boards and are used by the Department of Sanitation to monitor and allocate resources. Over the years we created other Scorecards for city agencies. Then, as agencies became accustomed to creating their own performance measures in order to comply with New York City Charter revision provisions, our work in this field continued on an advisory and consultant basis.

### **Our Center on Municipal Government Performance**

Our current work builds on the Fund's previous experiences with Scorecards, but adds a new emphasis. We now wish to build the voices of the public into performance measurement systems. We think this new emphasis needs to be embodied in the next generation of government performance measurement.

To that end, we have created a Center on Municipal Government Performance. The mission of the Center is to produce reliable, non-partisan, objective information about the effectiveness of municipal government services that reflect the people's perspectives. We are producing measures that reflect the way people see, feel and otherwise experience and talk about city services. The maintenance of the city's streets is one such service.

We hope that these neutrally-produced data will enable the public and government

together to fairly and accurately monitor, assess and/or measure, using standards that the public considers relevant, the performance of certain governmental functions that people consider critically important. We hope that the substance and manner of the communications between the public and government will be constructive and instructive to both parties and lead to improvements in government performance.

In doing this work the Center introduces, applies and fosters the development of new technologies and methodologies. We review relevant approaches that are used in other sectors and other places as we formulate new measures and assessment techniques to apply here. Our relationships with many municipalities around the world help us to be informed about relevant developments elsewhere.

## Focus Group Research

We started our work by listening to what a diverse group of citizens who live and work in New York City know and think about the wide range of services delivered by their municipal government. We determined that the best way to get at the information was through focus groups sessions. We worked with DYG, Inc., a social science research firm founded by Daniel Yankelovich\* and Madelyn Hochstein in the design and implementation of the focus group sessions.

### Focus Group Requirements

Our requirements were that

- the participants should reflect the diversity of New York City to the maximum extent possible;
- the selection of participants should be systematic and avoid bias, and
- the groups should be designed to encourage full and free discussion.

As a first step, neighborhoods were selected from which participants would be recruited -- the neighborhoods serving to insure representation of two critical elements: socio-economic status and ethnicity. Respondents were drawn from all five boroughs in New York City. The recruiting was designed to insure that men and women would be represented as well as members of each important age cohort.

In all, 15 focus group sessions were held. We listened to the views of 151 people from 29 different community districts. They were from various generations: Generation X'ers, Baby Boomers, Seniors, and others. We heard from people with low, middle, and upper household incomes; men and women of African American, Caribbean American, Hispanic, Asian, Native American, and European descent. DYG's professional moderators led the focus group discussions. They covered 33 different service categories performed by New York City's government including sanitation, health, public safety, parks, housing, city planning, social services, regulation of taxis, provision of business services, assistance to seniors, transportation and many others.

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\* Daniel Yankelovich is a pioneer in the field of public opinion research and social trend analysis. He is the author of many books and articles on the subject of public engagement in social and policy issues. He founded, with Cyrus Vance, the Public Agenda Foundation. Madelyn Hochstein is a leader in the field of market and opinion research. She directs, designs, conducts, and oversees the implementation of innovative studies throughout the world that identify and track opinions on social trends and consumer preferences.

## Focus Groups' Comments About the City's Streets

One service category covered in the group discussions was "Transportation: Traffic, Roads, etc." This municipal service was described to the participants in the following way: "Manage traffic; maintain roads and highways; street paving and repair; traffic signs; signals and lights; maintenance of bridges and tunnels; highway graffiti; safeguard pedestrians." This description is excerpted from the City Charter and the Mayor's Management Reports that describe the major functions of each agency. People's comments about this service revealed:

- Sixty-five percent of all the participants said that they considered these transportation functions to be critically important, and eight focus groups discussed them for a considerable period of time.
- Clearly, one reason that so many people rate street conditions to be so important is that, as they tell it, poor street conditions disrupt their daily life. Street impediments cause them delays and discomfort in getting to and from work, school, shops and other destinations.

For the most part, people were dissatisfied with this service. Their own personal experiences formed the basis for their judgments (rather than media reports or hearsay). They judge the condition of the streets and the quality of maintenance by the presence of potholes and bumpy streets and what results from them: vehicle damage and palpable discomfort.

There were frequent comments about how difficult it is to drive around holes and other impediments in order to avoid damage and discomfort. People described vehicle damage they had incurred (lost suspensions, shocks, hubcaps, broken axles). And there was dissatisfaction with the timeliness of street repairs and even more distress about the quality of repairs ("the same pothole gets repaired over and over again;" "tell me why this pothole hasn't been fixed -- it's been there for months;" "repairs are either concave or convex, never smooth"). People were seeking answers to questions they posed about why these problems exist.

## Why Measure and Report on the Condition of the City's Streets?

In addition to the focus groups affirming the value of having well maintained streets, there are a number of other compelling reasons to produce information on the condition of the streets.

- **Everyone experiences the streets.** Virtually everyone -- residents, visitors, pedestrians, passengers, commercial and private car drivers and anyone with a window-view of a blockfront -- experiences the streets and observes their condition. People know that it is city government's responsibility to maintain them. For many, then, the performance of local government itself is evaluated by the condition of the streets.
- **This study provides data for the public and government to use in monitoring service changes.** Regular reporting of purely objective, reliable data about the condition of the streets provides an opportunity for the public and government together to study the findings, engage in conversations about the resources that are allocated to street maintenance and repair, reflect on the relative importance of this governmental service, and then to track, over time, how performance has changed.
- **The public's point of view is needed.** The City does not have a good measure of the condition of its streets, from a user's point of view. Uneven repairs, misaligned utility covers, construction-related roughness and bumpiness and some intersection irregularities are among the conditions that are not captured in the city's surveys and reports.<sup>1</sup>
- **Bumpy, uneven streets can precipitate accidents.** The New York City Comptroller's Office reported that the City paid more than \$16 million in 411 settlements and judgments for roadway related claims in its 1996 fiscal year. Claims include pedestrians, motorists or others injured as a result of defects in a street or roadway, e.g. potholes, cracked roadways, sewer gratings, raised or missing utility covers, roadways under repair, etc. and also includes injuries as a result of wet or

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<sup>1</sup> *The New York City Department of Transportation (DOT) conducts a pavement rating program that started in 1990. Under this program, each street block is visually inspected by trained DOT employees at least every other year for its pavement condition. The raters use reference photographs that represent ten categories of pavement condition. The rating categories were developed by thirteen judges who were employees of the city and state transportation departments. The ratings are one element in DOT's process for determining which streets need resurfacing or more extensive rehabilitation.*

snow covered roads.<sup>2</sup> Of course, injuries and accidents that do not result in claims are not reflected in these numbers.

- **Smoother streets mean less fatigue for drivers.** Vibrations that result from driving over uneven, bumpy and rough streets cause driver fatigue faster than when driving over smooth road surfaces. This finding, described by the International Organization for Standardization (ISO), has implications for the safety and health of those who spend a considerable part of their day driving on the city's streets.
- **Smoother streets mean less damage to vehicles.** Bumpy, uneven streets cause damage to vehicles. A recent report on national surface transportation policy found that drivers spend \$4.8 billion a year repairing damage to their cars caused by "crumbling urban highways."<sup>3</sup> People in the Fund's focus groups spoke frequently about the vehicle damage they had experienced from rough streets in New York City ("my hubcaps went flying off," "my axle broke," "my tires were ripped," "my shocks are gone," "I landed in a ditch and couldn't get out").
- **Smoother streets extend the life of vehicles.** Bumpy streets cause vehicles to wear out sooner than if they were driven on smooth streets. ORTECH Corporation, a research and engineering firm based in Ontario, Canada has done structural tests of transit buses for major bus manufacturers and for New York City Transit. They estimate that the roughness of streets in New York City halves the structural life of a transit bus when compared to buses driven on the streets of major Canadian cities.

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<sup>2</sup> *New York City Comptroller's Annual Claims Report, Fiscal Year 1996*

<sup>3</sup> *Potholes and Politics*, Environmental Working Group, Washington D.C. 1997

## What We Did in Response to the Focus Groups to Create New Performance Measures

- **Consulted with Local Government**

Consultations with New York City government confirmed that there were no performance measures in use that reflected the riding experiences of the public and that such measures would be of value and consistent with the administration's emphasis on improving customer service and the overall quality of life in the city.

- **Conducted World-Wide Searches**

We initiated literature and Internet searches and consultations with government officials elsewhere, and with transportation institutes, universities, road and pavement contractors and engineering and scientific companies and consultants from around the world to find technologies and reporting procedures that would produce the accurate, reliable, objective data we were seeking. We found no city that routinely measures and reports to the public about the smoothness and bumpiness of their streets. In 1993 the Government Accounting Standards Board (GASB), a nonprofit organization that establishes standards of financial reporting for state and local governments issued a research report on how state and local governments report on road maintenance. They came to a similar conclusion, and recommended that an "effective set of...indicators for the general public, elected officials, and others be devised and communicated regularly."<sup>4</sup>

- **Identified Highway and Runway Measurement Technology and Methodology That Could Be Adapted To Measure City Streets**

There is a notable lack of published research and experience in applying objective methods to assess city street conditions where, because of traffic lights, stop signs, pedestrians, congestion and other considerations, maintaining constant speed is impossible and street conditions are not homogeneous. We found ourselves, unexpectedly, in the forefront of identifying and applying road roughness measurement technologies that are appropriate for cities.

As for applicable methods to measure the city's street surfaces, we found that considerable work had been done in the past 20 years to create verifiable measures of the surfaces of high-speed highways where one can maintain a constant speed and where surface conditions are reasonably homogeneous. More recently, similar

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<sup>4</sup> William A. Hyman, Roemer M. Alfelore and Joan A. Allen, *Research Report. Service Efforts and Accomplishments Reporting: Its Time Has Come. Road Maintenance*, Government Accounting Standards Board of the Financial Accounting Foundation, 1993

methods have been adapted and applied to measuring airport runway surfaces.

After examining and testing different approaches to measuring New York City's streets we identified one that produces consistently reliable roughness measurements at variable speeds under typical city conditions. The equipment that produced the most reliable measures is called a profilometer. The profilometer uses laser technology to scan the street's surface and then produces a profile of that surface. The profile data is then converted into a roughness index, using a computer simulation standardized by an international research project sponsored by the World Bank. The roughness index is known as the International Roughness Index (IRI) and is used in many places throughout the world.<sup>5</sup> In our test, conducted by Galaxy Scientific Corporation<sup>6</sup>, two profilometers were used, one attached to each side of the test car.

- **Matched Objective Measurements with Citizens' Perceptions**

Since we achieved our goal of finding a method to produce objective, verifiable measurements of the city's streets, we then needed to be sure that the profilometry readings were consistent with the way people in New York City rate the streets' roughness or smoothness. To that end, we asked DYG, Inc., the same firm that conducted our earlier focus group research, to conduct a test to determine if there was a correlation between the objective profilometer measurements and the perceptions of typical New York City drivers. Some of the people in our original focus groups participated in a test that included driving over and then independently rating eleven diverse segments of the city's streets that were measured by Galaxy Scientific the following day. We found that there was, indeed, a high positive correlation which is detailed in our Technical Appendix.

In a focus group discussion that followed immediately after the road test, DYG asked the people who rated the streets to delineate how many categories would be needed to adequately describe the range of street conditions. They identified four categories: "Good," "Fair," "Poor" and "Terrible." They said that streets in the first two categories, although not perfect, were acceptable for city driving. People were unanimous and unequivocal in saying that street conditions that produce severe jolts--holes, ridges, uneven repairs, etc. were totally unacceptable, and that even one severe

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<sup>5</sup> See Technical Appendix for further details on the equipment used, the computation of IRI, preliminary testing and related matters.

<sup>6</sup> Galaxy Scientific Corporation, a ten-year old high technology research and engineering company with offices in 14 cities in the U.S. and in Asia, conducted the profilometry tests. Their engineers and scientists have had extensive experience with highway and runway pavement measurements and pavement maintenance matters. One key member of their staff, Dr. Gordon Hayhoe, transferred to the Federal Aviation Administration (FAA) during the course of our work. The FAA gave permission for Dr. Hayhoe to continue to consult with us on this project.

jolt on an otherwise smooth stretch of street was intolerable. These judgments were consistent with what earlier groups had told us.

We applied the people's ratings to the range of IRI data produced by Galaxy Scientific to establish the beginning and ending points for four categories of IRI that we use later in this report.

- **Created a City Roughness Index**

Since we applied profilometry tests to city streets, not to long distance, high speed highways, and our categories of acceptability are derived from city drivers riding over city streets, we are calling our roughness index a "City Roughness Index," rather than an International Roughness Index (IRI). If other cities adopt this method, eventually we will have reliable comparative information from other major cities.

- **Surveyed the City's Streets**

Galaxy Scientific Corporation was engaged to survey, with the profilometers, a random sample of the city's streets covering all 59 community districts. The sample methodology and selection was designed by the Fund's sampling and statistical consultant, Dr. Martin Frankel. The sample was drawn from a listing of all streets in New York City, including highways, that was produced and provided to us by the New York City Department of Transportation. Further information about the sampling methodology appears in the Technical Appendix.

Our purpose was to measure what it is like to drive once through all sections of the city, randomly selecting the lane of travel.

Over a seven-week period, working six days a week in two seven-hour shifts in October and November 1997, Galaxy surveyed 676 miles of the city's streets, a distance equivalent to driving from New York City to Ft. Wayne, Indiana. In order to accomplish this ambitious task quickly, we utilized a navigational database and software system produced by Navigational Technologies and Lightstone to produce efficient routes for us since they had data on the city's one-way streets and that information is not incorporated into the Department of Transportation's database. A video camera was installed in the test car to visually capture every one of the 8,855 blocks measured. We hired experienced, professional New York City drivers to drive the test car so that we could drive through our routes quickly and safely. At least one engineer from Galaxy Scientific was in the car during the entire test, operating the two laptop computers that recorded the data from the profilometers.

Galaxy Scientific produced well over 5,000 pages of data, including graphs and tables displaying the results of the profilometer readings and listing each severe bump

encountered during their survey.

Galaxy applied a method developed by the Boeing (aircraft) Company to present bump indexes from the profiles produced by the profilometer. Boeing considers bump index measurements of 1.0 and above to be potential causes of aircraft structural damage. However, in this report, we are reporting all bumps that measured 1.5 or more to account for the differences between airplane and automobile stress and to reflect the fact that people in the focus groups said that they expect some bumpiness in the city's streets, but find severe bumps intolerable. We are also using the term "jolt" instead of "bump" because a bump is commonly understood to mean a rise in the surface, and we are, in fact, reporting on significant upward rises as well as significant downward depressions, both of which create the sensation of a jolt and cause riders' discomfort and vehicle stress.

Because of the considerable variation in the length of New York City blocks, statistics describing the percent of "acceptable" blocks are computed on a weighted basis. This means that longer than average block segments have relatively greater impact on the overall percentage of acceptable blocks while shorter than average blocks have relatively less impact.<sup>7</sup>

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<sup>7</sup> See Technical Appendix for further information about the computation of the bump index and about weighting procedures.

## **What is New and Different About this Work**

It identifies what the public considers to be the indicators of good road conditions and maintenance for city streets: smoothness and lack of severe jolts.

It demonstrates that it is possible to measure the smoothness of city streets and we have done it.

The methods used measure these conditions objectively and reliably and we are reporting on them to the public and government in what we hope is an understandable way. No city, to our knowledge is doing this.

Other street and road surveys are typically designed and used by transportation engineers and officials, usually to either comply with state or federal regulations or to plan long-term preventive maintenance programs and capital budgets. Survey results are rarely disseminated to the public at large and are not designed to reflect the public's immediate concerns.

Some cities such as Washington, D.C., New York, Portland, Oregon and San Jose have visual and/or subjective techniques to spot road deterioration. The Washington D.C. Department of Public Works for example, conducts an annual subjective roughness survey in conjunction with a visual road distress survey. The two measures are combined to yield a pavement condition index (PCI). Tacoma and Tallahassee are using profilometers to collect data on cracking and road distress.

Cities that have formal pavement management systems rely on some form of visual inspection. In some cases the visual inspection is formalized and evaluated using a computerized algorithm. One example is a product called MicroPAVER, which has been developed by the U.S. Army Construction Engineering Research Laboratory (USACERL) and the American Public Works Association. MicroPAVER provides an algorithm for producing a pavement condition index (PCI) from 100 (best) to 0 (worst). USACERL engineers inform us that MicroPAVER enables highway engineers to anticipate road repair issues and is not intended to characterize rideability.

To produce reliable, scientific measurements, we adapted laser-scanning profilometry technology to measure city street conditions. And we are reporting the findings using categories that reflect people's judgments about acceptable streets for New York City. To the best of our knowledge, this technology and approach has not been used in this city or other cities for this purpose.

We are reporting street smoothness ratings in all 59 community districts with a new indicator, a City Roughness Index (CRI). And we are reporting the number of significant jolts encountered per mile for all 59 community districts in the city as well.

## What Comes Next

This study will serve as a baseline for future studies of the smoothness of the city's streets. We plan to conduct profilometer surveys again and will work to help assure that these surveys become a continuing and regular source of information so that the public and city government will be able to monitor and measure significant changes, progress and improvements at the citywide, borough and community district levels, over time.

These objective, impartial data can serve as a source for discussion among elected officials, their constituencies and government officials as they review management practices and resources allocated to the maintenance of the city's streets.

This study can be helpful to other cities that need to assess their performance in maintaining their streets. If this method is adopted elsewhere, it will then be possible to conduct intercity comparisons which could be valuable to all municipal transportation officials and to the public in forming realistic expectations of government performance.

It is striking that so little research has been done on measuring the rideability of city streets, as contrasted with the resources that have been directed to highway and runway surface measurements. Perhaps this study will stimulate interest in advancing the art and science of performance measurement of this very important city service.

We are applying the model we have introduced here, of producing replicable performance measures that reflect the citizens' perspectives, to other governmental functions and will be reporting on them in the future.