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**Traveling Toward Health:
The Marriage of Transportation and Public Health**

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Thank you so much, Katie, for that wonderful introduction. Thank you also for letting my mother write it for you. Wonderful to be here today. This is such a rich area in the country, between UNC, NC State and Duke that the resources here intellectually and idealistically probably aren't parallel to anywhere. I've had a wonderful morning so far, thanks to the arrangements that Katie made, visiting with folks from the Design School, and a luncheon that involved people from four or five of the sponsoring organizations that Katie mentioned. So it's a real pleasure to be here.

And it's a pleasure to talk with you about this interface between transportation and public health. It's an interface that lots of us are thinking about these days and I think we can benefit from the interchange that Dr. Routhail [director of the Institute for Transportation Research and Education, NC State University] so eloquently described and acknowledged.

I want to start by telling you a story. This is a story of a little village that was perched on the banks of a fast flowing river in a far away place, long ago. The people in the village were accustomed to living near this river—after all, they'd been living there for generations—and they were accustomed to doing what you had to do when you lived by a fast flowing river: some fishing, but mostly some rescues. Because when people would be swept down the river, they needed to be pulled out quickly and expeditiously. The people in this village were very good at that. But one day as they lounged around the town square, they noticed somebody being swept down the river, and so they leaped into action as was their habit. They grabbed tackle and gear and jumped into the river and pulled the poor victim out, got him to the shore and all sat down to rest.

Well, not a minute went by when they noticed the next person being swept down the river, and they jumped back in the river and saved the next person, too. As soon as they got the second person out, they saw a third person being swept down the river, and jumped in and saved that person too. In fact, this went on all day. Every five minutes, somebody was being swept down the river, and everybody in the village came together and joined in the rescue effort, until by the end of the day, they were completely exhausted and depleted, lying on the town square, panting, hoping that nobody else would be swept downstream.

And sure enough, the flow of people stopped. So they laid there and huffed and puffed, and tried to regain their energy.

Well, a few minutes later, one of the townspeople ambled onto the town square, completely dry, looking relaxed, as if he hadn't done a bit of work all day. He had not been there for the rescues. And as you can imagine, his townspeople turned on him and said, "Where were you? You were supposed to be here helping us. We spent the whole day almost killing ourselves doing rescues."

And he said, "Well, when I saw that there was a flow of people coming down the river, I just walked up a mile and I fixed the hole in the bridge so they would stop falling through."

So this is an apocryphal story in public health. It's a story that reminds us that we need to do upstream thinking. And this is a refrain for public health.

Now I mention that because when you think of public health, if you're not from the public health field, this is probably what you think of. You may think of vaccination programs where children are immunized, especially in those years when we have vaccines to give out. You may think of interventions like the ones you see here: restaurant inspections, hand wash reminders. You may think of venereal disease clinics—for which, I'm glad to say, I will not show you a picture.

But you may not think of the things that you see here and these are also public health. This is the upstream part of public health. The woman on the bicycle wearing a helmet, that helmet is a piece of public health intervention. The fact that the road is banked and has a railing is a public health intervention. The fact that lead was removed from gasoline. The fact that we have water treatment plants. These are all public health as well. In fact, it's no mistake that several of these are in the transportation sector, because again, as Dr. Roupail reminded us, transportation is one of the upstream determinants of public health. And it's the basis for talking about the links between the two fields.

That's the reason that this talk is subtitled *The Marriage of Transportation and Public Health*. And this picture symbolizes that marriage. It says there, "A lifetime of love begins with one exquisite moment." And that is not exactly how it worked out in my case. I don't know about your marriage; I didn't go ahead and put on stockings and shiny shoes and a large white bowtie and assure my would-be wife that a lifetime of love would begin with one exquisite moment, but in reality, it looked more like this. I made my pitch and she needed to be convinced. So I'm here to make a pitch today, and I'll try to convince you that in fact there are important reasons for us to work together between the public health field and the

transportation field and that together we can benefit society in very important ways that will gratify both fields.

Let me start by turning to public health, and let me make it very personal by talking about newborn children here in North Carolina. I went to the census and found out that last year 118,300 children were born in North Carolina. That reduces to 13.5 children every hour. Now assuming that this session will go until 4:15, a little more than an hour, that means that while we sit here together, 16 children will be born around the state. I want to keep our mind on those 16 children for the next few minutes, because they can be the yardstick of whether we're doing a good job for public health and welfare. If we think about what those children need—we'll call them This Afternoon's Children—it will serve to tell us that we're either building the world in a good, healthy, sustainable way or that we're making some mistakes and we'd better change course.

What lies in store for the 16 children who are being born as we sit here? Fortunately, we can be fairly sure that they will all survive the neonatal period, because infant mortality rates are very low in North Carolina, as they are throughout the country. During their childhood, probably none of them will die, but one may die, statistically. And if that one dies it will almost certainly be in a car crash. That's the major killer of children in this country. During their childhood, three out of the 16 children being born now will be overweight. One or two will have asthma, and one will have Attention Deficit Hyperactivity Disorder.

When they reach adulthood, out of those 16 children, who are now adults, 10 will be overweight, of whom half will be downright obese, as defined by CDC criteria. Three will have high blood pressure. Each year, two of them will be depressed, and cumulatively four or five of them will have suffered depression over the course of a lifetime. At least five will suffer from arthritis. One will have diabetes.

What else will they face as they grow into adulthood and live out their lives? Well, the US Census Bureau tells us that the U.S. population will reach 571 million—that's the midrange estimate, between the extremes that you see up there—by the year 2100. So they will see an enormous increase in population. North Carolina's increase will be larger than the average, because this is a fast-growing state. So we're looking at something like a doubling of population over the next hundred years. We have more people to put in good homes and to take care of in every way. The global temperature will be several degrees warmer by the end of the century than it is now, according to best estimates. Petroleum will become increasingly scarce and expensive; the projections are that we will peak out on petroleum discovery, and demand and supply will separate from each other in dramatic ways sometime during the next few decades. Water will become increasingly scarce in many parts of the country. So the children who are

being born now will face very serious challenges, and will be growing up and reaching adulthood in a world that's substantially different than the one in which we grew up.

How long will they live? Well, the life expectancy of a child being born now is about 77 years. As you can see there, you can also see when you stratify by gender and by race that we have substantial disparities in this country. Assuming the average of 77 years, the children that are being born now will on average live until December 2081. But that's only an average. We know that some will die earlier, and we know that a substantial number of them will live until the year 2100. In fact, the over 100 age group is the fastest growing age category in our society.

Let's diverge from talking about their lives to talking about their children. The children that are being born now, this afternoon's children, will start to have their children in something like 14 or 15 years, and they'll probably finish having their children in about 40 or 45 years, if current trends hold true. The first born of this afternoon's grandchildren will survive until the very end of this century, and the last born will survive on average until well into the 22nd century. This is a reminder to us that we need to be thinking on a very long timeframe. And when we make decisions, be they environmental decisions, transportation decisions or healthcare decisions, we need to put in place infrastructure and procedures that will last for and take care of people who will be around for a very long time.

When this afternoon's children finally die, five of them will die of heart attacks, four will die of cancers, there will be a stroke death, there will probably be an injury death—which may have occurred early in life—there will be a chronic lung disease death, there will be a number of deaths from relatively more minor causes as you see here. The only real unknown in this equation is the infectious disease burden, because with climate change progressing, with the mean temperature rising by several degrees, it's projected that infectious diseases will expand their range, and those may add to the profile of mortality well beyond what we currently know.

So as we think about the lives of the children who are being born now, the health challenges that they'll face and the larger environmental and system challenges that they'll face, I think we would all agree that we want to hold them in the front of our radar screen and build a world that will do the best that it possibly can to take care of them, and in which they can thrive and be well.

Let's talk about what they need. On what needs should we build the communities, the transportation systems and so on, that we design? Well, my theoretical model for thinking about this question is pictured here. Is everybody familiar with this model? This is motherhood and apple pie. It's not a very

complicated model. I would maintain as a pediatrician, as a parent, and as a general public health physician that children need places to explore and grow. Children need places to dream and have reveries. They need regular physical activity. They need to be protected from injuries. They need clean air and clean water, strong communities and the promise of a sustainable future. Is there anybody here who disagrees with any of those needs for children? This is really a consensus-based issue, and it's something around which a lot of public policy may well be built.

Are we designing and building communities these days that serve those needs of children as we know them to exist? Well, let me give you a doctor's-eye view of land use and transportation decisions that go into the kinds of communities we now build, and let's evaluate together the extent to which they serve the needs of children and everybody else.

The pattern of development that I want to talk about is urban sprawl. It's familiar to everybody here, I think. It begins definitionally with the vast geographic expansion of cities over large areas. This is Denver. And as you can see it looks as though it wants to continue expanding until it hits the natural barrier of the Rocky Mountains. I come from Atlanta, which is another sprawling city. We don't have an ocean or a mountain range to stop us from expanding, so Ted Turner has commented that there's nothing that prevents Atlanta to continue to grow until it finally hits the Pacific Ocean, and it seems as though it's doing that. What we do now is recognize the existence of a megalopolis called Charlantingham, which is our regional version of Bosnywash, one continuous city from Charlotte all they way down to Birmingham, with Macon, Georgia, and Chattanooga, Tennessee, fixing to glom onto it.

In addition to the geographic spread of metro areas, we see changes in land use, where land that's traditionally been farmland or forest becomes converted to residential land as you see here. For some people this is a triumph. In fact, there is a sense of progress about this. Here are some developers. This is the modern version of *veni, vidi, vici*, they're saying, "I came, I bought, I subdivided," feeling pretty good about the land use change patterns. One of the unfortunate aspects of this pattern is that back in the central city, perfectly good infrastructure, as you see here, is left vacant in what become large pockets of poverty. This is not a new pattern, of course; this has been recognized for 50 years. From the environmental point of view, this is especially interesting, because these buildings have perfectly good electricity, plumbing supplies, sewage lines and so on. So it would be very efficient, wouldn't it, to develop in areas like this, rather than to build from scratch in green fields far from the city's center?

I'm not going to focus on the health consequences of urban poverty, that's another big part of the sprawl and health story. I want to focus more on the suburbs themselves, because now more than half of the

country lives in suburbs, and this is the trend that we continue to see: expansion of cities, changes in land use. The next feature that I'll mention is low density land use. Here is an extreme picture, these are houses that are probably on an acre or two acres each. The density isn't always that low, but sometimes it's lower than that. And now we get directly from the land use side to the transportation side, because you can be sure that the people who live in these homes rely very heavily on this road to get anyplace, and they're unlikely to ever get anyplace by transit or by foot or by bicycle, because the density simply is too low to support that. And so hand in hand with the land use changes that I've mentioned, we are required to commit ungodly acts of civil engineering like you see here, putting resources and talent into building road systems. My favorite example of this kind of construction is this interchange. This is serious; it's not a Rube Goldberg contraption. This is an interchange on Route 128 in Waltham outside of Boston, Massachusetts. But despite the extensive road construction that goes hand in hand with the expansion of cities and sprawling areas, we see a pattern like this in almost every major city, every morning and every afternoon.

Now you can paint it in pastel colors, but the fact is that it's a fairly unpleasant experience for many people and in fact, in my own city, in Atlanta, people talk constantly about the hassles with traffic. It's become a major feature of the quality of life that people perceive. This cartoon is from the *Baltimore Sun*, and it reflects the Baltimore view of the same phenomenon. This is the Baltimore beltway in the year 2025, after it's been newly widened to 1,472 lanes. So this is the extreme version of today's patterns. Now, just to orient those who are not from Baltimore, up here to the northeast is the New York beltway, which was formerly known as the state of New Jersey. And down here is the Washington beltway; here is I-95, signifying 95 yards between the two beltways. The human impact, the impact on one of the 16 kids who's being born as we sit here today can be seen over here: "Mommy, when are we going to be home?" And Mommy says, "We spend 60 hours a week in the car, honey. *This* is our home." So the transportation decisions that we end up assuming, along with land use decisions, certainly have impacts on quality of life, and, as I'll submit in a few minutes, on health as well.

Moving from the regional scale down to the neighborhood scale, we see neighborhoods that look like this: single-use land use. That is, we see purely residential spreads like this. In a picture like this, you won't see schools or stores or theaters or restaurants or libraries or churches, because we tend to segregate different land uses. This has been a zoning tradition in this country for about 80 years, and it reaches full bloom in developments like this. As we move in a little closer on a spatial scale, we notice that the roads are 30 feet wide and are curved. Very good to permit the unimpeded movement of cars. Not so good if you're a child who wants to go out and play on the road in front of the house, because these are cars that

are used to traveling at pretty good clips along the roads, and may not be used to sharing the roads with children. It's called the loop-and-lollipop development for the reasons that you see here. The cul-de-sac, which is the paradigmatic sprawling road arrangement, is very nice in some ways, and we'll talk about it a little bit later. Not so good in other ways. What you do see in arrangements like this is low connectivity, making it difficult for the people who live here to get over here. There's no direct path. There's a circuitous path to get over there, implying fairly long trips for fairly short distances.

For the transportation folks in the audience, this is old hat. And for the public health people, this may be a different way than you've viewed neighborhoods previously. Here it is schematically: an older, pre-automobile, grid-like neighborhood down here, and a more modern, suburban style development up above. Each parcel of land developed distinctly and kept separate up above. So here is the school, here are the single-family houses, here are the apartments, some retail stores and the mall, all spread along this feeder road. In the more grid-like arrangement down below—you see exactly that, a grid—more connectivity, more options from getting from point A to point B. Almost certainly sidewalks on these streets, because this was almost certainly built before the second World War, when walking was built into the neighborhoods, and a mixture of uses: single family close to the store, close to apartments, and walkable access to the school as well.

Does anybody know what these are? Multiple choice: UFOs, factories or schools? Well, these are schools. And as we move down in spatial scales from the region to the neighborhood and now to the school, we reach a very interesting phenomenon. It's hard to know what these are, but the fact that schools are put so far away from where people live has been the subject of increasing attention and Jeff Tsai [chair of TRB's Joint Subcommittee on School Transportation] has been one of the leaders in thinking about that. This is *Governing Magazine*, a magazine read by elected officials, and it recently did a cover story called "Edge-ucation," subtitled, "The Compulsion to Build Schools in the Middle of Nowhere." This is an increasingly common trend. So we see, for example, the Marshall High School in Marshall, Minnesota, way out in the middle of the fields. This is from their website; it's due to open next year. Another example, and my favorite, is the Hubbard Lake Elementary School in Michigan, whose motto is—I kid you not—Outstanding in its Field. Now from a health point of view, this is significant, because no child will ever walk or bike to these schools. These are schools that are completely dependent on motorized transportation for the extent of their useful life and, as we'll see in a just a few minutes, that has important health implications.

We do know how to do better. We know how to build schools that are embedded in neighborhoods. Many of us, who are old enough—myself included—went to schools that looked something like this, and we got there by foot or by bicycle, but that’s an increasingly rare opportunity.

Now coming down to the streetscape, we see streets that look like this very commonly. This is a perfectly good street for moving a lot of traffic, but not a very inviting street for being a pedestrian or a bicyclist. In fact, you can imagine that as much as you want that piece of Domino’s pizza, you’re very unlikely to walk across the street. This is really a system that engineers out pedestrians in favor of motor vehicle traffic. It allows us to play a fun game called “Find the Victim,” so that in a picture like this, there’s the victim. Or for a picture like this, easier to see, there’s the victim. People truly don’t look like they belong in scenes like this. So transportation has become very heavily focused on automobiles because that’s what we need to travel around spread out sprawling areas. We know from the transportation literature—and this has really informed us well in the public health field—that there is a relationship between the density of development and the mode of travel. So what you see here on the X axis is density measured in households per acre. The Y axis shows annual vehicle miles traveled per household. And, no surprise, you can notice that as the density increases, moving from very sparse rural or suburban areas to urban areas, the amount of time spent in cars and the amount of miles traveled by automobile decreases.

Moving down to the sidewalk scale, we can ask the question: do we encourage or even permit walking? And the answer is not as much as we might be able to. Here is a street where a sidewalk didn’t even get built. You can see that the folk process has imposed a sidewalk there, but that was only because some intrepid or desperate people had no choice but to walk. Sometimes we build sidewalks. Sometimes we’re required to. But we make them very unappealing and unappetizing like this one: no shade, no buffer from the traffic, nothing interesting to look at as you walk along the sidewalk, certainly not something liable to encourage people to walk. Sometimes we allow sidewalks to fall apart. Sometimes we send clear signals to pedestrians by blocking sidewalks as you see here. This is a nice example of the blocking strategy. This was a tree that fell down in a recent hurricane not too far from my home in Atlanta, and the county DOT, God bless them, came right out with their chainsaws, and they immediately cut off the tree at this point so that the cars could move unimpeded, sending a clear signal to anybody who wanted to walk that they were not nearly as important.

Sometimes we just build sidewalks, but we let them end in the middle of nowhere—I call it *sidewalkus interruptus*—also sending a clear signal to would-be pedestrians. And sometimes we are very creative in our design. It’s very easy to find examples like this, of scenes that discourage walking, crosswalks that

go nowhere, sidewalks that end in obstructions—combining two different techniques for discouraging pedestrians. This is a nice example: the gated community is one of the fastest growing residential motifs in the country, and this is a gated community that actually just says it, “No Pedestrians,” so you’re only allowed to arrive here by car. More and more anecdotal examples of systematically building walking and biking out of the equation.

Not only that, we have built a drive-thru culture that enshrines the way we travel everywhere. We have drive-thru pharmacies. And we spell drive-thru, by the way, always t-h-r-u, never t-h-r-o-u-g-h, because a busy driver has better things to do than deal with o-u-g-h. We have drive-thru cleaners. We have drive-thru liquor stores. We have drive-thru bakeries. We have drive-thru automobile service. We have drive-thru food, where all of food that we like to eat can be had. We have drive-thru coffee to drink afterwards. We have drive-thru banking; this is an especially eager attempt to get people to drive, because the thoughtful designer of this bank has even put Braille buttons for those who drive up and are blind. We have drive-thru mailboxes. In Alabama, you can even pay your child support at a drive-in window after your divorce. And finally, being that this is America, we’ve taken it to the natural setting and we have drive-thru trees. You would be not far from the truth if you concluded that we’ve really gone to great lengths to build a society where you never have to get out of your car.

Well, the result, as noted by *USA Today*, is that we really discourage walking, and people don’t walk very much. The way cities and suburbs are developed could be bad for your health, according to this headline from a couple of years ago. And we have some good evidence now from the public health literature about some of the dimensions of not walking very much, the direct consequence of the transportation and land-use decisions that I’ve talked about. This is a study of children aged 5-15 who live within a mile of school in Georgia, asking the question: how many walk to school? So this is presumably a walkable distance. It’s about a 20-minute walk. And what you can see here is that across demographic and age groups, across locations and across ethnicity, really no more than about one in five children are walking to school. When parents are asked, “Why don’t your children walk to school?” the answers that they give are shown here. The most common barrier cited is distance. And the next most common barrier cited is traffic. Crime is way up there, and so is weather. These two [distance and weather] are certainly design issues, because if we designed communities such that schools were relatively close to homes, and traffic relatively contained and separated from where people walked, parents might be much less concerned about these two barriers. Not only that, the crime concern might be mitigated if lots of kids were walking, because all parents feel that there is safety in numbers.

So, if we were going to design transportation and land-use decisions with the health of this afternoon's children in mind, if just for a moment we stopped and erased everything that we have built up until now—this is not to ignore the importance of getting people where they need to go efficiently—but let's put health first, just as a mental exercise. What kinds of places would we design? What kinds of impacts would we try to reduce in the design that we undertook?

Well, let's talk about how transportation might either undermine or advance the needs of children that I mentioned before. I am going to go through each of these for just a few minutes and then talk about some overall solutions. As I go through these, I will share with you some current data from the research literature about the impacts of transportation on the extent to which we meet these needs. Let me start with places to explore and grow, and for here I am going to refer to some child development literature that Bronfenbrenner and other writers have been writing for years, about what sort of context children benefit from as they explore and grow. In particular, I want to call your attention to what has been labeled the cradle-room-house-doorstep-neighborhood sequence. It is a real mouthful. What it refers to is the fact that our universes expand as we grow. When you are an infant, a newborn, this is your universe: it is the crib. When you are a toddler, your universe expands and may become as big as your bedroom or maybe down to the living room of the house. When you are a little bit older, say you are four or five years old, you are going out into the backyard, maybe to the next door neighbor's house—your universe is bigger still. At this point, living on a cul-de-sac is terrific. The absence of through traffic and the insularity of the neighborhood help to add to security for a child. Then when you are seven or eight you may be ready to head all the way to the end of the block or the next block over to a little park or a schoolyard if there is one nearby. Now comes the rub.

You are 10 or 11 or 12, and you are ready to travel a few blocks away under your own steam, explore the rest of the neighborhood, maybe go to little stores here and buy some toys for your collection or try to make a little money if you want to wash cars—the kinds of exploration that comes next. And then when you are 13 or 14 or 15, you may be ready to explore on the scale of the entire town. But at this point your options to go to those places are severely limited, because if we build communities that don't allow children to locomote independently, then they are left sitting in the house dependant on Mom or Dad for a ride to get everywhere, exactly the kind of dependence that they are trying to outgrow and that they may resent if they continue to feel it. Now we don't have a lot of data on this connection, but there is a longstanding body of psychological and developmental theory that would suggest that the child's range needs to expand in ways that current communities don't allow.

The neighborhood above, which I showed you earlier, and the neighborhood below both have children living in them. Let's identify two homes equidistant from their respective schools. The child up above, if he or she wants to take a trip over to the school to play some sports, has to take a fairly long trip out to the feeder road, a trip that his or her parents probably wouldn't permit for safety reasons. The child down below, on the other hand, has a shorter trip, probably on a sidewalk. That is a trip that a parent might be prepared to allow the child to take. It is clear which child gets to explore the environment more. Could that be a part of the contribution to the by-now iconic image of the bored, alienated suburban teenager? Could it contribute to what seems to be a growing prevalence of teen depression? Again, no evidence for this, so I really raise these as questions. There will be some links to health that are strongly based in evidence, and this one is not. But it is a question that really hasn't been asked, and I suggest it as food for thought and as a possible research direction.

Kids also need places for dreams and reveries, and that means places that are peaceful and quiet. One of the impacts of transportation is noise, defined as unwanted sound. We know that traffic is a major source of ambient noise in many of our communities, from the urban scale down to the small town scale. We know a lot of the determinants of noise, and the transportation engineers that are here are very familiar with this work. We know that noise has effects on health, hearing loss, sleep disturbance. Noise is a major source of stress. It may contribute to mental health effects such as depression, and it contributes to high blood pressure, certainly temporarily. It is much less clear that it does so permanently. So transportation decisions that would minimize noise could help with all of these health outcomes. Now the standard approach has been to build very expensive barriers along roadways to try to separate the traffic noise from where people live, but other design approaches, in particular minimizing the need for travel by co-locating origins and destinations of trips as mixed land use would have us do, may be an important part of the story of diminishing our ambient exposure to noise.

The third need that we talked about for children is physical activity. This is a very widely discussed set of concerns now. The story that is hypothesized is that a non-walkable environment leads to sedentary lifestyles. There is truth to that, because we know that the main form of physical activity for most adults is walking. Take away walking and the adults become more sedentary. The sedentary lifestyle increases the risk of being overweight, and being overweight in turn leads to adverse health outcomes. Not only that, there is a little bit more to the story, because being sedentary, separate and apart from being overweight, leads to adverse outcomes, in fact many of the same adverse health outcomes flow from both of these risk factors. Being sedentary increases the risk of mortality, increases cardiovascular disease. In fact, not being physically active, being sedentary, is a cardiovascular risk factor approximately as potent

as untreated hypertension, high cholesterol levels, diabetes and even smoking. It is a very serious risk factor. We know a lot, both from public health literature and from transportation literature, about what kinds of environmental conditions get people out and walking. Some of them are listed here, both positive and negative. If there are good trails, if there are good destinations nearby, if there are other people out on the trails or sidewalks, if you have aesthetically pleasing scenes including natural scenes, people are more likely to get out and walk. On the other hand, if there is hilly terrain, if people feel like they are too busy or too tired, then they are less likely to walk. So this body of research offers a series of design guidelines that can be designed into communities to help us be more physically active.

So in addition to the effects of being sedentary on health, being sedentary increases the risk of being overweight. This is a widely discussed trend as well, as this cover of *Newsweek* illustrates. Many people have noticed the problems of [being] overweight. Here it is being noticed in the workplace. Here it is in a coffin manufacturing company. This was an interesting story in the *New York Times* recently describing the growth of the triple-wide coffin segment of the coffin industry, because many people are too big to go to their maker in conventional coffins. And even witches have noticed the growth in obesity. The witches [in this cartoon] say, “Remember when we used to have to fatten the kids up first?”

Let me show you the CDC maps of obesity in the U.S. for those who haven't seen these. This is the obesity pattern in 1989. And you can see the code down here to what the color coding means. 10 to 14% prevalence corresponds to the darker blue. Here is 1990, '91, '92. You can see the epidemic marching over the last decade or so. Here is '96, '97, '98. Very rapidly advancing epidemic across the country. And if you just go a couple more to 2002, you can see that this has really advanced quite fast. A little bit slower in the Rocky Mountain region, but fairly consistent across most of the country.

Those were adult data. But we see a very similar trend in kids who are—between 15 and 20% of children are now considered to be overweight. This is probably a better image to capture that trend than the *Newsweek* cover of the young man with the ice cream cone. This guy is pigging out on junk food, certainly part of the equation, but he's also sitting there sedentarily, enjoying what's called screen time. This was a nice paper from the *British Medical Journal* investigating whether gluttony or sloth is behind the obesity epidemic. And what it shows is two identical pictures of the obesity curve in Britain. The heavy line zigzagging up across the screen. On the left, we superimpose gluttony. Gluttony as measured by energy intake and fat intake. That's basically the fish and chips index in Britain. And you can see that it peaked in about 1970 and declined, even as the obesity epidemic continued to march upward. On the right you see the sloth curves that are superimposed on obesity, as measured by cars per household and

television viewing, and the track along very closely. This is what's called an ecological study; it's not the strongest epidemiologic design because we don't have individual data for participants here. But it does highlight the fact and remind us that gaining weight is a simple algebraic proposition: more calories in than out. So the super-sized portions and the junk foods certainly are a part of the story, but, just as certainly, diminished physical activity is part of the story as well. Now, the diminished physical activity is only partly environmental.

We'll talk about behavioral issues in just a second, but even the data that I've presented so far have been enough to trigger a large body of research looking at the links among sprawl, physical activity and health outcomes. This was a study published by Reed, Ewing and colleagues last year. Sprawl was measured by the sprawl index that includes the dimensions that are listed there. This is a widely used measure of sprawl now. Physical activity was measured by behavioral risk factor surveillance system questionnaire responses. And they looked at whether people got any physical activity, whether they got the recommended levels of physical activity, and how many minutes did they walk. And health outcomes were measured also by the same survey and included weight, hypertension, diabetes and coronary heart disease (CHD).

Over 400 counties and a large number of metropolitan areas were studied, and it turned out that as sprawl decreased, physical activity increased, those who engaged in recommended levels of physical activity increased; obesity, hypertension, diabetes and coronary heart disease all decreased with the decrease in sprawl. So this was one of the first large scale studies that showed a link completely through the chain from the design features to the physical activity patterns to the health outcomes that we know to be linked with those physical activities.

Now, as I mentioned, behavior is also part of the story. We've all heard of new urbanist communities where sidewalks are put in and where people still choose to drive rather than to take the sidewalks. You can even imagine a scene like this—in fact, next time you go to the airport, stand at the bottom of the escalator and look at the staircase next to it and watch what people choose. Given the opportunity to be active, people won't necessarily do it. But it's equally true that without the opportunity to be physically active, people certainly won't do it. So we probably need to think about environmental cues to facilitate and encourage physical activity together with programs of social marketing like we've mounted to get people to quit smoking and stop littering that we know can be effective in the difficult challenge of behavior change.

Diabetes is one of the diseases that we know to be linked to overweight. And as overweight is increasing across the country, so is diabetes. Here is the 1990 diabetes map from CDC. The blue is the highest of the prevalences shown there. This is 1991-92. Here's '93-94. And here's '95. And '97-98, and the last one is '99, showing that diabetes is moving along as a linked epidemic together with the epidemic of obesity.

Kids need protection from injuries. This is a serious concern to all parents, and it's a well-justified concern. Traffic crashes are the leading cause of death for young people in the country and, across the entire age span, cause untold suffering, costs and large numbers of deaths every year. Now, traffic fatality rates are declining, and that is a great thing from a public health point of view. We can attribute that to better automobile design, better road design, better use of protective devices like airbags, enforcement of drunk driving laws and so on. But still, the toll is enormous.

I'm going to show a little bit of data on the links between design and motor vehicle fatality rates. This array is a number of major cities according to their automobile fatality rates. What's interesting is that the older pre-automobile cities tend to have substantially lower rates than the more recently developed sunbelt cities that are very automobile dependent and sprawling. A more sophisticated display of the same data is shown here; this uses the sprawl index that I've referred to earlier, but now, instead of cardiovascular disease, we're looking at traffic fatalities. And you can see a fairly good relationship between the level of traffic fatalities and the level of sprawl. More sprawl means a higher risk of dying in a car crash. Simple public health principle: the more time at risk, the more likely it is that a bad thing will happen.

Not only do drivers and passengers in cars bear some of that risk but so do pedestrians. Pedestrian injuries and fatalities are disturbingly common in the country. I live in DeKalb County, Georgia, one of the counties in metro Atlanta that begins in the urban core and then rapidly moves out to a suburban expanse. And in our county we have one pedestrian hit every day. The relationship between sprawling design and pedestrian fatalities isn't as tight as is the relationship for motor vehicle fatalities. In fact, the pedestrian fatality story is a complex one. Pedestrian fatality rates are also coming down and probably the principal reason is that people are walking much less. So this is good from an injury prevention point of view and regrettable from a physical activity point of view, especially at a time when obesity is expanding.

It doesn't have to be that way. We've got some very nice comparative data from the U.S. and Europe to illustrate how and why. What we see here is the proportion of urban trips that are taken on foot, the gray

areas here; and on bicycles, the white area here. So, in the U.S., 6% and 1%, respectively. At the other end of the diagram, the Netherlands, 18% of urban trips are on foot and 28% on bicycles. Denmark is in the same range, Germany is in the same range and so on. Now, given that more people are on foot and on bikes, we might expect that in those countries pedestrian and bicyclist fatality rates would be higher. What we see in fact is a different pattern. Here is the U.S., here is Germany, and here is the Netherlands. And this shows a range of outcomes: pedestrian fatality rates per trips, bicycle fatality rates per trips, and then we have per distances traveled. So no matter how you measure it, the U.S. rates are substantially higher than those in Germany and the Netherlands.

In fact, the decrease that we have seen the U.S. over time has been exceeded by the decreases recently noted in Germany and the Netherlands. So there's an irony here. The fewer people that walk and bike in this country, the lower our pedestrian fatality rates. But the more people that walk and bike in the European setting, the lower and lower the pedestrian fatality rates, suggesting that good infrastructure and the habitual encounters of drivers with pedestrians and bicyclists create a safer situation for the pedestrians and bicyclists. This is really a mandate for a different kind of design than we now have.

This was an article from the *Journal-Constitution*, the Atlanta paper, last year. It says, "The Department of Transportation is to look at the risks and benefits of tree-lined sidewalks." Now the tree advocates and the environmentalists have been pushing to put more trees along the roads because they beautify the city, they help with air pollution, they help to cool the city and they make walking much more attractive for pedestrians. The DOT doesn't like that. And the DOT doesn't like that because as the newspaper reports, to a traffic engineer's way of thinking, sidewalks are auto recovery zones, roadside areas where drivers have space to correct course if they've veered off. Trees would ensure the driver came to an abrupt end before getting the car back on the road. So the pedestrian advocates—as you might expect—thought this was an outrage. The reporter apparently did, too; this isn't the most balanced writing. But it's an illustration of the idea that we need to consider both the health benefits of getting more people out and walking and the safety liabilities of putting trees by roads as we make decisions about design.

Air pollution is the next issue to talk about because we know that kids need clean air. All of the things that are listed up there are components of air pollution. The ones on the left come from motor vehicles. In fact, it's no surprise to anybody here that motor vehicles are an important source of air pollutants in the country. In general, something like one third of the major air pollutants come from motor vehicles, less for the oxides of sulfur, more for carbon monoxide. But for the big ones, like particulates and

hydrocarbons, about a third comes from motor vehicles. In very automobile-dependent and relatively non-industrial areas, like, say, Atlanta, the proportion is closer to one half.

Let's talk about ozone. Ozone is the most important of the transportation-related air pollutants. Ozone doesn't come directly from tailpipes and smokestacks, but instead it's formed secondarily in the atmosphere by the interaction of hydrocarbons and oxides of nitrogen, which do come from tailpipes and smokestacks. Here is a tracing of ozone levels in Atlanta during a typical summer day. You can see that we start off the day with relatively low levels of ozone. We then have our first rush hour, loading the local air shed with oxides of nitrogen and hydrocarbons, the precursors of ozone. Under the influence of sunlight and heat, those react to form ozone and the level climbs. We then reload the atmosphere with the afternoon rush hour and the level peaks out soon after that and then as the sun goes down and the day cools, the ozone levels fall.

Now imagine that you are a doctor and imagine that you have got a patient who really needs to be more physically active and you say to the patient, "I want you to be walking or jogging." The patient says, "Okay, Doc, I'll do it. I've got to do it after work, that's the only time I can." Well, it's quite a dilemma for you isn't it? If you want to tell the patient to get out there and jog at exactly the time of day when ozone levels are highest, you're trading off your patient's respiratory health with cardiovascular health. It's a dilemma that doesn't have a good answer except for primary prevention of the pollution levels, or exercising indoors, which is a real limitation. The high levels of ozone aggravate asthma. The effects of ozone include diminished airflow in the airways, cardiovascular effects and probably immune system suppression as well. Not only does ozone trigger attacks of asthma in people who have established asthma, but we've got some recent evidence that ozone may help to induce new cases of asthma in people that are previously free of the disease. We're not all equally susceptible to the effects of ozone. In particular, people with asthma, people that are elderly, people with underlying diseases are especially susceptible.

We did an experiment in Atlanta almost 10 years ago. We invited the Olympics to come to Atlanta, and we did that because we wanted to get everybody to stop driving for a couple of weeks in the summertime, and this was the only way we could think of to do it. So the Olympics came. During those couple of weeks when the Olympics were in town, the peak morning traffic levels decreased by 23%. Peak ozone levels decreased by 28%. And when we tracked pediatric emergency visits for asthma, depending on whether we looked at emergency rooms, HMOs or clinics, the number of visits decreased by between 11

and 42%, a direct suggestion that if we change transportation patterns, we can improve air quality and within days improve children's health.

Strong communities are another thing that children need. I'm going to start off by talking about road rage. Road rage can be defined as an event in which an angry or impatient driver tries to kill or injure another driver after a traffic dispute. Nobody really tracks road rage. There's one study that was published by the AAA Foundation for Traffic Safety that seemed to show that incidents of road rage were increasing over time. But it was methodologically kind of weak. I think we really don't know, except that anecdotally they seem to be quite common. Fortunately, most of us don't commit acts of road rage. We may feel like it, but we mostly restrain ourselves.

There is an annual—or, I guess, an every two-year—survey from Mississippi State University asking people about driving behavior and driving attitudes, and it reveals a little bit of the iceberg that must be under the tip represented by road rage. Let's look at the iceberg. People are asked in the survey, "Within the last year has another driver made an obscene gesture at you?" And 50% of Americans say, yes. "Within the last year has another driver tried to intimidate you with a sudden or threatening move?" A total of 28% say, yes, and so on. You see a lot of evidence of uncivil behavior here. But this is not as interesting as what people report about *their own* driving behavior. How often do you _____(blank)? That's what this part of the questionnaire's about. And let's focus our attention on the "sometimes" and "often" responses. "How often do you say bad things to yourself about other drivers?" More than 60% of us admit that sometimes or often we do it. "How often do you complain or yell about other drivers to a passenger in your vehicle?" More than 50% of us admit that sometimes or often is the answer. Now probably we underreport things like this in the context of interviews, so it may even be worse than this. Here's my favorite. "How often do you think about physically hurting another driver?" Well that's just over 5%, 1 in 20 drivers.

Think about that as you leave the reception today and get in your car to drive home. You're going to pass many more than 20 cars, and it may be that 1 out of 20 of those drivers is feeling so hostile that he or she is willing to admit to thinking about hurting you. Now this is a bad situation, isn't it? This is not a very civic and happy society that we've created. Imagine what happens when these drivers get home? Maybe they haven't committed an act of road rage, but if they're hostile and fed up and angry, are they going to be the best parents, the best spouses they could be? Are they going to be likely to go out to a PTA meeting or a neighborhood group and contribute to their community, or are they more likely, as I would

do, to kick back, have a couple of beers, eat some potato chips and try to get over the lousy commute? That bears directly on this issue of good communities for kids.

This is a picture of “sidewalk rage.” This was a cut at Mayor Giuliani in New York when he was still mayor. What was funny about it is that nobody’s ever heard of sidewalk rage because it’s a form of transportation that doesn’t regularly tend to get us all angry at each other. It induces an entirely different kind of interaction among people. And that leads to the concept of social capital, part of this community concept. Social capital is the glue that binds us together as a society, the trust and reciprocity that holds us together and helps us function well. The suggestion is that urban sprawl may undermine that sense of community and social capital that are so important. In fact, a lot of the literature that’s come out lately reports that social capital is on the decline. There are many reasons for that, but sprawl may be one of them.

How could that happen? There’s an algebraic reality. More time commuting means less time available to do things like visit friends, participate in church, whatever. This is where social capital comes from. In suburban areas with single-use zoning, we build fewer so-called third places. *Third place*—the first is home; the second is work; and the third is the other things like parks and cafes where people gather and have casual interactions that really lubricate our society’s bonds with each other. We privatize the public domain. Part and parcel of sprawling development tends to be individualizing our homes, individualizing our recreation, individualizing our transportation, and that may undermine the sense of collectivity that is important to social capital.

The need for elders to change neighborhoods is important. Imagine you buy that four-bedroom house on an acre-and-a-half lot, raise your children there, things go pretty well, but the children grow up and move out. And then it is time to downsize. Well, you may have been in the neighborhood for 20 years, but if you need a smaller home, and it is a neighborhood of homogeneous homes, you don’t have an option within your neighborhood, and you have no choice but to move. So the inability to remain in place, so called aging-in-place across the lifespan, is an important piece of this story of undermining the sense of community.

We know a lot from the sociology literature about what it takes to build a sense of community, and some of the features that encourage a sense of community interestingly are some of the same features that encourage walking. In fact, the two of them have a lot to do with each other, as you can see here. Again, a set of design mandates, or at least guidelines, that we might keep in mind if we were going to engage in land use and transportation decisions that would be good for health and well-being.

Why health and well-being in connection with a sense of community? Because, remarkably, social capital is very good for health. This is kind of a counterintuitive finding that has turned up across many, many studies. Here is just one example. On the X-axis we see the percentage of people in each state who respond positively to the statement, “Most people would try to take advantage of you if they got the chance.” So this is a measure of mistrust. The more trusting states here to the left, and then the more mistrustful states here to the right. I don’t know if anybody can see North Carolina, but it is in here somewhere. Up here [in the top right]. This is mortality on the Y-axis. In study after study, you see a close relationship between mortality and measures of social capital or lack of social capital as you see here.

I am not going to talk about climate change. Just to mention that one of the last things that I think children need is the promise of a sustainable future. I grew up under the threat of nuclear war, and I remember, as many of you may, fleeing with my class in elementary school down to the basement of our school where we were told to sit on the ground and tuck our head between our knees and prepare for the bomb to drop. That was not a cheerful way to be a child. It undermined the certainty that children ought to have that the world is going to be there for them. Today’s children are growing up under a similar shadow, and that is the shadow of climate change.

Let me just point out here that the greenhouse gases that are the culprit in climate change come from a variety of sources. Transportation is not the major source, but the transportation sector accounts for about one quarter of greenhouse gas emissions in this country. If we made transportation decisions that diminished the emission of greenhouse gases by diminishing the demand to burn fossil fuels, then we would diminish our contribution to climate change.

Now I care a lot about that as a doctor because climate change is projected to have a lot of impacts on health, many of which you see listed here. Heat causes morbidity and mortality directly, as we saw directly during heat waves in Europe this past summer. Vector biology—the changes in the life cycles of creatures like mosquitoes. As tropical climate expands its range, tropical diseases will expand their range. We expect that diseases like dengue fever and malaria will become more prevalent in places like this, or like Georgia where I live. That is why we should be very interested in doing what we can to minimize climate change. And the transportation piece is a part of that story. If we want to give the children who are being born now the promise of a sustainable future, that ought to be part of what we are thinking about.

Well, I have listed all of these needs that I propose to you that children have, and I have listed some of the ways in which transportation and its twin, land use, may affect our success in fulfilling those needs. And I have talked about some of the ways in which design can help us do better. Let me finish by talking a little bit more about solutions, and then we will turn the lights on and talk.

To summarize the health effects I have put them all in a chart here, and what you can see is the issue of a child having a range to explore, noise, physical inactivity, motor vehicle accidents, air pollution. All of these outcomes of transportation or transportation-related decisions having effects on health outcomes like child development, hypertension, obesity, diabetes and so on. I have put X's to mark where the intersections occur, as a summary reminder that there are many ways in which transportation may potentially affect health, and offer us opportunities to plan for healthier ways of doing things.

Well, as we think about solutions, the first thing we have to get over—and we are doing it all by being here today—is thinking in silos. Transportation people and public health people need to learn to think together and get over the typical tendency to think in siloed ways that characterize so many of our fields. The solutions are generally lumped under the title “smart growth” or “new urbanism” or “neo-traditional development.” There are lots of terms that are thrown around, and they need precise definition, and that takes time that we don't have today. But some of the features of smart growth are familiar to all of us who have thought through these issues, and I think everybody here has. We are looking at higher density, more contiguous development, balanced by preserved green spaces, both for ecological reasons and to give people access to parks, so that they won't require individual large yards themselves as much. Mixed land use instead of the single land-use pattern that typifies a lot of modern development, with walkable neighborhoods. Road construction needs to continue. Cars aren't going away any time soon, but we need to balance road construction with transportation alternatives, both for non-motorized transportation and for transit.

So we have examples of this kind of thing in Europe. People come back to Atlanta from visiting European cities like this all the time, and they have what I call the “Back-From-Europe Syndrome,” where they say something like this: “It was great! It was beautiful! I walked every place. I ate like a pig, and you know what? I lost weight! How could that be? I wish I could walk like that in Atlanta. Then I could eat that much and still be healthier.” People kind of like that opportunity. They take advantage of it when they go on vacation. We have survey data suggesting that Americans really do want to walk more. Now, surveys can say lots of things. You really need to examine the wording of the survey to satisfy yourself that it does show what it purports to show. The question here was—this is a 2003

survey—“Please tell me which of the following statements describes you more: if it were possible, I would like to walk more throughout the day, either to get to specific places or for exercise; or, I prefer to drive my car wherever I go.” And you can see that a pretty good majority votes for walking more.

Similarly, “Which of the following proposals is the best long-term solution to reducing traffic in your state: build new roads; improve public transportation, such as trains, buses and light rail; or develop communities where people do not have to drive long distances to work or shop?” And what you can see is that the combination of walkable communities and public transportation accounts for about two-thirds of respondents. Now this is just what people say. It is not clear that this is what they do. In fact, we know that many people are moving to suburban locations. But it does suggest that there is an unmet need out there for walkable neighborhoods, and there is at least some willingness on the part of the public to entertain measures that would get us in that direction.

What we need to do—those of us who are in the fields that are working on these areas need to remember that the way things are is not the way things have to be. Things can change, and we need to envision that change to persuade ourselves and then others that it is possible. We might take a streetscape like this, and envision how it would look if we widened the sidewalks and put, say, an island down the middle of the street. It looks a little bit better. And then if we put some trees in and maybe some transit and a bicycle lane, it would look like this, and now suddenly instead of a barren place where you wouldn't let your children go unsupervised, it's a place that you might like to let them explore a little bit. You might take a pretty bad-looking corner like this, begin to fill it in, this is in-fill growth or densification, and then we might go an extra step, improve the crosswalks, widen the sidewalks, put in some trees, and it's a better looking place. And now there's life on the streets.

We might take an old shopping center that looks like this—and these are great opportunities for in-fill development, the mixed-use kind of communities to get people walking and out of cars. So we can fill it in like this. We can also add residential to the commercial by putting apartments up above. It is especially important to build in affordable housing such as apartments as we revive our urban areas, so that the people who work in stores like this can be close to where they work and not have to drive long distances to get to work.

We can take a pretty bad looking underpass like this, fill it in with crosswalks. Put some English ivy or other invasive species on the pillar and have a decent-looking neighborhood, or we can take a fairly low density neighborhood like this and send this signal to pedestrians and bicyclists that they have a role there, by putting in some traffic-calming measures, sidewalks, big crosswalks and trees.

We can take another one like this, and do just the kinds of things that I've been talking about. So what do we all do together, public health people and transportation people, if we're to get married? Well, first we need some joint training. We on the public health side need to learn a lot more about transportation—the terms, the concepts, the strategies that are available to you all—and I would submit that you on the transportation side would really enjoy learning some public health as well. We can blend training programs by having joint courses or joint degree programs, especially at institutions like ours in Emory, where we're right next to Georgia Tech and can do this, or like yours here where you've got both faculties close to each other.

We need joint research to fill in some of the questions that I raised as I went through the possible links between transportation and health, and we're seeing some of that emerging now with joint committees between the Institute of Medicine and the Transportation Research Board, I'm pleased to report.

We need systematically to evaluate what are the health impacts of decisions we make in transportation and land use. We have a set of methods called Health Impact Assessment that require input and participation from transportation planners, land use planners and others, as well as health people. This is like the environmental impact assessment that's a little bit unpopular because it's regulatory. These aren't regulatory...they theoretically could be, but that's not going to happen anytime soon. But simply to undertake a careful accounting of the health impacts of transportation projects before we start them would be enormously useful at making explicit our goals and objectives.

We need to make decisions jointly. Having gathered data, having made studies, having trained each other to talk with each other, we need to make decisions jointly about the way we will spend transportation funds and the way we'll monitor the outcomes of our transportation investments.

And finally, I want to end with a couple of suggestions that I had the chance to offer to the Institute of Transportation Engineers when I spoke there not long ago. The canon of ethics of the ITE offers guidelines for professional ethics in the transportation profession. It calls for professionals to work toward health, safety and welfare. But there is no clause like the one that I suggest here, that professionals should assess the health impact of transportation alternatives and strive to choose the alternative that best protects and promotes health, building health promotion in as an ethical precept of the transportation field. I respectfully submit that as a part of the ethical code that would fit very nicely. I also learned, when I spoke with the ITE, that the ITE does a lot of its work through councils, and all of the councils listed there are the ones that comprise ITE's work. But how about a transportation and health

council? So those of you that are active in the field might want to consider moving efforts like that forward to begin to advance the marriage of health and transportation.

Finally, I want to close by urging all of us to remember and celebrate the concept of synergy. The kinds of design decisions that I've talked about offer benefits across a range of outcomes. This is a vaccine that treats many diseases, something that we never have the chance to enjoy in healthcare but we can in this aspect of public health. This is a picture of a woman walking her children to school in the year 1956, the last known time such a sighting was reported in the U.S. What's nice about this is that they're getting physical activity. What's also nice about this is that they're diminishing air pollution and improving respiratory and cardiovascular health by not putting pollutants into the air.

Physical activity is a very effective treatment for depression. They are not contributing carbon dioxide emissions to the climate change cycle that will have all of the health outcomes I mentioned. Osteoporosis is prevented by regular physical activity in women. Social capital increases as they meet and greet neighbors on the street, on the sidewalk, instead of shaking their fists at their fellow citizens through the windshields of their cars. And by the way, if more people are doing this, we need to spend less money repairing and upgrading roads. And that leaves public funds available for things like education, healthcare, and law enforcement, which are also worthy and sometimes competing goals, but it would free us up to use funds for those purposes as well, something that those of us in the public health side think a worthwhile goal.

Well, we'll know that we're doing well when this picture is replaced by the next one and when we see children walking to school, about five or six years from now when this afternoon's children are ready to start kindergarten.

Thank you all for your attention and thank you for all that you do to advance both good transportation and good public health for the people of our country. Thank you.

[END OF PRESENTATION]