FHWA Advanced Research Forum

Minneapolis, Minnesota
September 20-21, 2005

Summary Report

1.0 Overview

Moving forward with the Federal Highway Administration's commitment to create a more robust advanced research program, a group of stakeholders in the future of transportation were invited to convene for a 1.5-day think tank forum, the second of three to be held in 2005. Planning support was provided by the Volpe Center and noted futurist Glen Hiemstra of Futurist.com. The intent of the forums is to seek ideas to assist the Agency in establishing a strategic agenda for advanced research.

This second forum was held at the McNamara Alumni Center, University of Minnesota in Minneapolis. About forty participants gathered for this interactive event with expert speakers on breakthrough technologies such as nano, emerging intelligent transportation systems and new vehicles technologies. A sustainable transportation presentation on aligning values and behaviors balanced the forum discussion. Through a series of structured presentations and discussions, the participants explored issues impacting the future of transportation and identified advanced research needs. Then, using a modified version of the nominal group technique for group decision-making, the participants developed a list of suggested research topics, and ranked the priority items.

Next is a summary of the presentations, which framed the participants' discussion and identification of advanced research topics. The summary concludes with participants' impressions and comments on the synergy around the purpose of the forum and possible next steps for an FHWA advanced research agenda and program.

1.1 Forum Purpose

1. Scan across disciplines, within and outside the transportation area, to search for promising research and technology that could fundamentally improve transportation.
2. Develop a set of recommended areas, topics or questions for consideration as part of a strategic agenda for advanced research.

1.2 Recommending Advanced Research Agenda Topics

*Participants convened in four working groups. First, in each group individuals listed their ideas for advanced research. Participants were asked to consider ideas that would be "game changers" by encouraging breakthrough innovation, have high leverage in terms of being high pay-off for high risk, would fit between basic research and applied research, and which would be strategic in terms of seeking outcomes rather than simply being interesting research. In addition, the teams were reminded of the two-part definition of advanced research provided by Dennis Judycki: "*Research that involves and draws upon basic research results to provide a better understanding of phenomena and develop innovative solutions. Sometimes referred to as exploratory research in order to convey its more fundamental character, its broader objectives, and the greater uncertainty in expected outcomes compared to problem-solving research.*"*

When individuals had their personal lists, ideas were shared around the table and a master list was created for the group, eliminating overlapping ideas. These were then discussed at the table, with an emphasis on clarifying the ideas, and on why particular ideas ought to be preferred over others. When called upon, the table groups reported their lists to the entire forum. These small group results are listed in the Appendix.

All participants discussed the lists, noting themes and common ideas. Among the themes that were obvious were the following:

Themes from discussion following group brainstorms

- Some research topics deal with things to do or to build
- Other research topics deal with ways to change fundamental assumptions, approaches – to change the transportation game
- Perhaps we need a category for "what we have not thought of"
- New materials development is assumed
- Improving, even revolutionizing the driver – vehicle – environment – technology interface
- How to increase pedestrian-based transportation
- How to leverage resources via inter-agency research – e.g. switch grass energy – rivers – environmental protection

Each working group went back to their group list, clarified their opinions, and then used nominal group technique to indicate their preference for the top research ideas. Each working group reported the top 3 to 4 priorities to all participants.

After discussion of the resulting list of 15 items, participants expressed their preference in one more round of voting, using a weighted voting process. The results below fell into three basic tiers, with the vote total for each item noted.

2.0 Recommended Advanced Research Agenda Topics

Tier 1

- Use of nanotech and smart structures for enhanced performance; from nano-structure to infrastructure (32)
- Innovative transportation pricing; full accounting of system structures and environment (24)
- Land-use and transportation interaction (23)
- Social, political issues, concerns that affect these breakthrough ideas (21)
- New ways to collect better data (21)
- Transportation effect on Public Health (19)

Tier 2

- Scouting, tracking research in other areas to make linkages (11)
- Human-vehicle interfaces for enhanced safety (11)
- Extreme materials, methods for construction (11)
- Fuel tax alternatives (9)

Tier 3

- Effects of automated vehicle systems on driver behavior (7)
- Governance structures (6)
- Achieving significant pedestrian travel (4)
- Long distance personal travel, multimodal – who provides and how (4)
- Develop regionally-scaled institutional design (3)

3.0 Forum Framework: Summary of Presentations and Discussion

Each presentation will be included on the final CD as PowerPoint slides in PDF format.

Day 1, September 20, 2005

3.1 Welcome: Denny Judycki and J. Richard Capka

Denny Judycki, Associate Administrator for Research, Development and Technology, personally welcomed the attendees and provided background on the advanced research initiative. The FHWA mission includes enhancing mobility through innovation, leadership and public service. The role of FHWA's research and technology activities cover the innovation process, developing and deploying new products and services, education and training. This workshop is the second of three to be held this year. TRB's Research and Technology Coordinating Committee (RTCC), which serves FHWA in an advisory capacity, will be briefed on the outcomes of these workshops on November 1-2, 2005.

As part of Denny's welcome, in a video presentation J. Richard Capka, FHWA Acting Administrator, emphasized the value of this activity to the FHWA and stressed 1) the need to raise awareness of what is going on in advanced research, 2) the need to reward partnerships with funding, and 3) the need to encourage innovation and move ideas into practice.

Denny provided an overview of the FHWA's definition of advanced research and strategic vision as outlined in the agency's Corporate Master Plan. He emphasized the FHWA's strong interest in enabling innovations for a better transportation future. *He defined advanced research as exploratory research designed to develop a better understanding of phenomena, and to develop innovative solutions.* He hopes that these forums will identify advanced research theme clusters, with an emphasis on higher risk and long term issues. In addition, he provided a brief overview of the recently passed SAFETEA-LU legislation.

3.2 Table Exercise: What is your image of the future?

Glen Hiemstra asked participants, "What words or pictures come to mind when thinking about the future?" This warm-up exercise works with the idea that our images of the future play a powerful role in shaping our present actions. Change the image of the future, and you begin to change how we behave in the present day. Individuals at tables shared their images, and examples were cited for everyone to hear.

Sample images of the future articulated by participants include:

- Automated
- Increase personal mobility
- Non-obtrusive technology
- Greater cost sharing
- Balkanization and limited affordability
- U.S. decrease personal mobility hubs
- Affordable for all
- Info teach – choice – pricing
- Who is driving
- Greater choices
- Privatization
- Environmental consciousness
- Higher cost
- Virtual businesses
- Easier to co-exist passenger & freight
- Strong multi-modal
- Separate facilities for freight
- New mind-set-freight

3.3 Presentations: The World and Transportation in 2050

Glen outlined key lessons from the future:

1. The future creates the present.
2. Breakthroughs must be compelling.
3. People you see in 2050 will be different.
4. Energy Tipping Point is approaching.
5. Great technology revolutions to come.
6. The way it is, is not the way it will be, economically, environmentally.
7. Travel – vehicles, roads, systems will evolve or change fundamentally.
8. Systems should be integrated.
9. Every impossible thing may someday be possible.

Glen reviewed broad trends shaping the world of transportation. Highlights included:

- Some parts of the world will shrink in population while the U.S. will grow, by as many as 100 million by 2050, depending on immigration policies. At the same time, US growth may slow much sooner if fertility rates continue downward trend.
- Most population growth concentrated in mega-cities.
- Transportation and related businesses have become global.
- Economic growth looks uncertain and full of discontinuities, although the developing world anticipates robust growth (with resulting demands for transportation).
- Energy outlook is for plentiful supplies of carbon but not of cheap oil, and decreasing supply leads us to use expensive dirty carbon. Thus the next 50 years will see an energy transition, sooner rather than later.

Glen asked questions about:

- U.S. population growth projections, which seem exaggerated in light of global dynamics.
- Impact of the aging population, which is underestimated.
- Millenials or, “digital natives” are the largest population cohort since the baby boomers.
- Impact of the first “digital native” generation coming of age, and taking information technology beyond what we “digital immigrants” imagine.
- How do we maintain economic growth and robustness with a declining population?
- Are we at an energy tipping point – i.e., of cheap oil? What happens if the end of oil comes sooner than expected? Will use of alternative fuels increase/decrease health problems?
- Impact of new technologies, primarily vastly improved telecommunications, next energy wave technologies, and nanotechnologies.
- A greater technology revolution yet to come.

3.4 Physical Performance, Infrastructure & Materials: Roundtable 1

Dr. James S. Murday, Executive Secretary to the U.S. National Science and Technology Council’s Subcommittee on Nanometer Science Engineering and Technology (NSET) and former Director, National Nanotechnology Coordination Office: *"Nanotechnology - Hype and Hope as it Relates to Transportation"*

- Nanotechnology is a buzzword.
- At the nanoscale, things behave differently.
- In the “old” atomic world, limited by 100 elements.

- In the new nano world, an unlimited variety of building blocks exist.
- Assembly rules in the nano world include atomic bonding plus Van der Waal forces, Coulomb forces, magnetic & molecular recognition, and many others yet to be uncovered.
- Nano products are beginning to come on-line in electronics and IT, in both healthcare and the life sciences, and in manufacturing and materials.
- Nano products in transportation include the use of higher performance composites such as new coatings developed for the marine environment, higher performance metals, improved catalysis, energy alternatives, reduced materials failures.
- The National Nanotechnology Initiative (NNI) includes $230 million for fundamental research through 2006.
- NNI includes efforts in Aerospace, Defense and Security, Energy, environmental, Information – in both memory and logic, and in Medicine and Health.
- NNI transportation affords the transportation enterprise the opportunity to steer investment through collaboration and in identifying the most promising areas for advanced research.
- Vehicles with nanotechnology will become lightweight, multi-purpose, intelligently guided, comfortable, and be low energy users.

Table Discussion: *Following each speaker, table groups discussed their impressions, and then general comments were made to the whole group. A sample of questions and comments…*

- Is there a shelf life to nano-structures? There is no shelf life until a nanostructure is stuck to something and degradation occurs – i.e., anything air sensitive will be reactive and "spoil".
- Is there a role for motor vehicle emissions control? DOE is looking into this.
- We are spending too much money on nano technology research. How do we weigh how much we invest in one basic research area versus another? Nano research amounts to less than 1% of the $120 billion total in technology research investment, i.e., not very much relatively speaking.
- Is there a way to convert carbon nano-tubes into a 150-year bridge design? Many problems/issues arise including nomenclature itself, quality control, dispersion, how to couple nanotubes into a composite. As computer technology improves, our understanding at the nano scale improves, which in turn leads to even better computing.

3.5 Operations, Technical Performance and Mobility Roundtable 2

Professor Max Donath, Director, Intelligent Transportation Systems Institute and Professor of Mechanical Engineering University of Minnesota: *"Reducing Fatalities and Managing Congestion: Emerging Technologies Enabling 'Outside the Box' Solutions"*

- New and fundamental is the role of China as it emerges as a major player in all economic sectors, including transportation.
- China is building roads faster and concomitantly increasing fatalities to 100,000 per year.
- Our vision and focus must be to save lives.
- More fatalities occur as a result of lane departures.
- More fatalities occur in rural rather than in urban areas – esp. high in FL, NJ, and TX.
- Despite teens making up only 7% of all licensed drivers, they represent 14% of those who die on the road (i.e., teens are overrepresented among road fatalities.)

- Teenagers do not use seatbelts – in MN, 60% of teenage fatalities were not wearing seatbelts.
- Need interlock seatbelts and biometrics.
- We must reduce driver error and improve dramatically communication to the driver.
- We need to focus on a human-centered approach with detection/prediction capabilities as well as corrective action.
- Managing congestion may be a more reachable goal than reducing congestion.
- Reliable travel times can reduce crashes.
- Congestion pricing can reduce travel times and congestion.
- Use narrower vehicles and narrower road lanes.
- We must adapt technology to the user – not the reverse.
- The grand challenge is in how to deploy technology to manage congestion.
- Technology can inform, advise, warn, and teach.
- Must detect and predict when a vehicle is leaving a lane and map feedback to where it does the most good.
- Must detect when a driver is driving inappropriately.
- Use of GPS and augmented reality is a solution. High accuracy GPS maps can be used for sensor applications.
- Who will set GPS standards?
- Who will be responsible for digital maps?
- How does one best signal the driver?
- We must look at driving simulators as a tool to examine unintended consequences of novel driver assistance technologies.
- We must have a better driver reporting system – what is normal driving behavior?
- A virtual Reference Station Network (VRS) using GPS/DGPS can add capacity with narrower road lanes and/or narrower vehicles.
- Bus rapid transit using highway shoulder as a lane using sensors has been proven. We must pursue many approaches.
- Need new Vehicle Positioning Systems that overcome limitations of GPS.

Table Discussion: *Table groups discussed their impressions, and then general comments were made to the whole group. A sample of questions and comments…*

- What is the percentage of speeding accidents? One half of speeding accidents are the result of drivers under the influence of drugs/alcohol. One third of fatal accidents are due to speeding and/or the influence of alcohol or drugs.
- Is it feasible to automate highways? There are funding problems; the necessary redundancy is too costly; re-engaging the driver to react accordingly takes too long.
- Do we want to take the human out of the system? Should we?
- We must look at behaviors and road design. Note: the Department of Homeland Security is funding research on detection of suspicious behavior. How can this be applied to solve transportation problems?
- What is the role of combining high-tech with low-tech solutions such as the rumble strip?
- We must get the drunk driver off the road. Just as important is the enforcement of cell phone use while driving, which is more distracting and dangerous than drunk driving.
- We must leverage the military's research and use of UAVs to transportation for the public.
- The human-in-the-loop is more difficult to solve than the human-out-of-the-loop; we must keep the human in control with system backups.

- Litigation is a problem. The one time something doesn't work can stop a technology cold – i.e., 1 death versus saving 1,000 lives.

3.6 Sustainable Transportation for Sustainable Community Roundtable 3

Jean Brittingham, Vice President Global Technology and Solutions, CH2M HILL: *"Tipping Communities Towards Sustainable Transportation: Aligning Values and Behaviors"*

- Technology alone cannot let us live our lives, maintain our health, sustain our economy and allow us to pass it on to later generations.
- We must have genuine political leadership and societal changes.
- Focus on language, as language "frames" behavior. In this regard, marketing research is genuine research and should be treated as such.
- The current frame for privately owned vehicles:
    - Cars are safe.
    - Cars are inherently more convenient.
    - People won't leave their cars.
    - Cars aren't that bad for the environment.
- Current frame for public transit:
    - Available to anyone, so it's unsafe.
    - Suggests I am dependent.
    - It's noisy and not secure – i.e., private.
    - It's focused on the needs of others, not me.
- Words matter – we must find new frames.
- People pay attention to facts.
- In spite of a strong belief to the contrary, people do not act in their own best interests.
- People respond to and make choices aligning with their own identity.
- We must focus on finding and refining frames that put values people want in their lives back into play.
- Re-shape the language and re-frame conversation.
- Transportation choices are not just about transportation – they are about personal health, community vitality, societal vitality, fairness.
- People are out of touch with the effects of individual choices – language can bring it back.
- Don't frame transportation in terms of "highway" or "road" – frame as "surface transportation".
- Use scenario planning to bring the future into play.
- Expand existing toolkit to become robust by including shared databases to satisfy the engineer and planners.
- Add elements that access values as well as facts.
- Tools must not draw conclusions.
- Seek new audiences and players such as magnet schools, I-Max, futurist games for the Gen Y set.
- Market results of research and re-framing evaluations.
- Innovation for tipping points:
    - Changes in culture spread in patterns similar to diseases
    - There must be a disruption in normal patterns to bring about change.

    - There are particular roles that are played in the spread and these roles can be manipulated.
- Give alternatives a competitive chance with:
    - New Public-Private Partnerships.
    - Added services and benefits
- Be honest about the role of policy:
    - Vested interests exist including past investments and the marketing machine.
    - There is resistance to change even when it is good
    - Entropy exists in the face of complexity.
    - The re-frame of political will and the role of policy makers now and in the future are critical.

Table Discussion: *Table groups discussed their impressions, and then general comments were made to the whole group. A sample of questions and comments…*

- Technologists do not feel comfortable in an advocacy position although framing an argument is valuable.
- We need a pilot project at the TRB similar to the Public Involvement committee.
- A re-frame might be income/poverty.
- Talk about schools and location.
- What if we didn't have a Highway trust Fund?
- Transportation and land-use is an area to explore – what are the dynamics? What are the state and local issues?
- The Number 1 Red Flag – increased land use for transportation takes away freedom to use land any way you want.
- There is a "disconnect" between land use and public transit. Why aren't developers demanding more transit?
- In Europe and the UK incentives to change are a bit easier for them to do.
- We hope that a percentage of FHWA Advanced Research funds will go into systems approach topics.

3.7 Vehicles, Technology, and Energy: Roundtable 4

Amory Lovins, Co-Founder & CEO, Rocky Mountain Institute, Author, *Winning the Oil End Game*, "Advanced Lightweight Vehicles: Key to the Oil Endgame"

- Advanced, light-weight vehicles are the key to the oil endgame.
- We can get off oil use within 10 years led by for-profit industry. Energy future is a choice, not fate.
- Oil insecurity, geopolitical rivalry, price volatility, climate stability, and depletion demand that we care.
- Economic pressures are putting our core sectors at risk – Japan, Europe and China will eat Detroit for lunch. National security and national competitiveness are at risk.
- How do we win?
    - Efficient end-use can save half the oil @ $12/bbl.
    - Bio-fuels can replace another 5th @ $18/bbl.
    - Saved natural gas can displace the rest @ $18/bbl.
- How do we capture the prize:
    - Invest $90 billion in equipment and industry.
    - Invest another $90 billion to advance the biofuel industry

- Capturing the prize:
    - Creates 1 million jobs
    - Preserves 1 million existing jobs
    - Restores $150 billion/year
- Use ultra-light composites for vehicles that absorb 6-12 times as much energy as steel.
- Migrate this ultra light technology from the military skunk-works to civilian cars.
- Europe already has an ultra-light SUV concept vehicle – the Revolution Ultra-Light.
- New bio fuel technology such as ligrocellulosic technology is showing returns: Brazil has replaced ¼ of its gasoline with sugar cane ethanol without subsidy and already exports it to China and Japan.
- Europe, in 2003, made 17 times as much bio fuel as the US.
- Saving 1% of electricity would save 2% of natural gas consumption – why aren't we doing this?
- Forty-eight states currently reward electric companies for selling you more energy – NOT for lowering your bills. This is a fundamental public policy issue.
- Oil will probably become uncompetitive even at low prices before we run out of it and it becomes unavailable at higher prices.
- DARPA and DoD investment in ultra-light vehicles could transform the US economy as profoundly as the internet and GPS.
- Government can help by:
    - Stimulating the demand for very efficient vehicles with "freebates" which are revenue and size neutral.
    - Create a new million-car a year market through leasing to low income customers thereby forcing scrappage of fuel-inefficient clunkers and increasing the economic viability of the poor. Rural areas are more likely to have access to biofuels.
    - Smart market and government fleet procurement incentives like X-Prize – a "Golden Carrot".
    - Heavy truck buyer information, leadership, and loan guarantees.
    - Build vibrant 21st century industries by sharing R&D efforts/costs.
- Research issues/areas:
    - Ultra-light, ultra-strong structures, materials, and manufacturing. 3 technical paths: aluminum, light steel and carbon composites (the lightest and strongest).
    - Innovative policies – esp. for extreme vehicles. Fuel efficiency will dry up fuel taxes, therefore a shift of taxes to roads and miles is necessary.
    - Heavy trucks – allow an extra axel; more 2/3 combos but fewer hauls.
    - Substantially increase the use of bio fuels in ultra-lights and in hybrids.
    - Utilize parked Hybrids as plug-in power plants on wheels.
- What if we stopped mandating and subsidizing sprawl? Policy research?
- What if drivers got what they paid for and paid for what they got?
- Cybertran (www.cybertran.com) is a novel, ultra-light rail with a system cost of approximately $4/mile or $15K per seat. It's being tested at the Alameda Naval Air Station and promises great social, political and technical potential. (In 2002 dollars, the cost of a traditional light-rail system was about $72/mile.)

Table Discussion: *Table groups discussed their impressions, and then general comments were made to the whole group. A sample of questions and comments…*

- Has the cost of hydrogen fuel been figured in? Yes, $400 - $600/per car cheaper from a systems perspective. It is cheaper to build a hydrogen fueling station structure than a gasoline station structure.

- What about Hydrogen safety?
  Contrary to popular thought, hydrogen actually burns safer than fuel. (Video demonstration showing the two types of explosions illustrates his point.)
- Can you break down hydrocarbon to hydrogen for fuel?
  Yes, but it takes a lot of energy.
- What about dynamics – stability, high wind conditions, etc.?
  Advanced light-weight vehicles have been aerodynamically designed to auto-correct for cross winds. They are wire controlled.
- What about institutional dynamics?
  U.S. auto makers do not have the financial/political strength that Honda and Toyota, for example, do. Many know that business-as-usual is not the way to go, and that the industry is classically over-mature.
- Cybertran – a concept vehicle? Yes. Nobody is buying it because nobody is making it. Cybertran is not light rail, not transit, consequently no one seems interested.
    - Non-material infrastructure, or the 'transportation governance systems' – institutions, laws, regulations, business systems and recent policy innovations such as deregulation, privatization and just-in-time logistics
    - Information capital and infrastructure

4.0 Closing Discussion

Dennis Judycki began the closing session by summarizing his impressions:

- Importance of partnerships.
- There is an opportunity to take the agenda beyond FHWA's core mission.
- We need to find out what is out there already and what is underway, and then identify and fill the gaps in that picture. Fortunately, FHWA has developed 60 R&T roadmaps that represent this.
- 80% of the $30 billion/year in Highway Trust Fund spending is on infrastructure and operations, yet many of the ideas we discussed at this workshop transcend these areas.
- SAFETEA-LU funding is complicated. It provides for areas of advanced research many of which are earmarked and designated.
- Linkages must be made – the Research and Innovative Technology Administration (RITA) is the organization to accomplish this. FHWA will encourage RITA to do so.
- A great deal will depend on the advanced research agenda and on the '06 budget process.
- What is the best way for us to take this to the next step?

As participants contemplated next steps they made comments such as these:

Monique Evans, Ohio DOT, noted that, "We should not lose sight of the fact that we are going to make recommendations to FHWA, but we should fill in the gaps and maybe have other (lower priority) ideas get picked up by other organizations." She also stated that advanced research is a good niche for FHWA.

Don Forbes, HNTB, stated that an obvious transportation strategy is: more walking, leads to better health, lowers transportation demand – especially in urban areas. This should be the blueprint.

Jean Brittingham, CH2M Hill, noted that applied research rather than advanced research returns the bang for the buck and return on investment. The problem is that we measure benefit/cost generally in 18-month increments, when advanced research benefits are realized in 20+ years.

Tom Maze, Iowa State University, asked if FHWA was already partnering with other agencies and departments – especially those with larger budgets – to share advanced research costs in areas in which both have a vested interest. Denny replied that such partnerships are on-going strategically and corporately. He provided an example of possible partnership with NSF where FHWA would provide $1.5 million and NSF would provide a match to establish a transportation area for joint research. TFHRC, NSF, and participating universities would share publicity and results.

Victor Li, University of Michigan, commented that advanced materials used in transportation infrastructure will have an environmental impact. He recommended teaming with EPA to explore this area.

Charlie Nemmers, University of MO-Columbia, noted that there was a definite dichotomy in our discussions between "Things" such as infrastructure, vehicles, etc. and "Process" especially government processes at all levels - Federal, state, and local.

5.0 General Observations

- There was agreement that needed advanced research seems to fall into two basic categories. One is research on things to do and build, such as research into new materials including nanostructures. The second is research into social transformation, or what may work at personal, community and institutional levels to shift basic attitudes, assumptions and behaviors regarding transportation.

- Comments were made that FHWA should do more policy research, because no one else will. Recommendations that "advanced research" should be FHWA's niche were also noted.

- There was strong encouragement for FHWA to seek multi-party and inter-agency research opportunities to leverage limited dollars.

- There was encouragement for FHWA to continue to set a strategic agenda for research, rather than merely to solicit random research proposals.

- Data collection was found to be a key area that lends itself to collaboration. "Infomatics" – i.e., strategic data collection needs serious consideration. On this topic, it was noted that the Federal Aviation Administration has won a legal battle and is able to separate critical safety data from Freedom of Information (FOIA) laws.

- The coming decades seem to strongly suggest that business not as usual will be the norm, and all kinds of new thinking is required. We will need new mechanisms to *enable* radically new transportation solutions.

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Appendix

Brainstorming Advanced Research Agenda Ideas – Team Results

Below are the initial results of the four working groups, who produced lists of suggested advanced research topics or issues using a modified nominal group technique. These results formed the material for the final recommendations. Results are listed with score that each item received within the working group when it used the nominal group scoring method .

YELLOW TABLE: Initial Advanced Research Agenda Topics and votes

1. How get into the driver psyche to warn them about imminent collisions (Human/vehicle interactions) (16)
2. More data – more, cheaper, ubiquitous wireless sensors remote and infrared 16)
3. Use of nanotechnologies to improve current ultra high performance construction materials in a significant way (13)
4. Public education, responsible motoring public, conservation of transportation resources (11)

5. What are the future performance measures of the transportation system? (beyond congestion & travel time) (8)
6. Vehicle position sensing – alternatives and augmentations to GPS - link to data (6)
7. Smart structures – notification of maintenance (5)
8. Improvement to soft-side management systems (5)
9. Alternative power on a mass scale (5)
10. Utilization of remote sensing – let satellite do more (4)
11. 100% recycled materials used in construction (4)
12. New processes for making concrete; more environmentally friendly (3)
13. How to create a culture of change with agencies (2)
14. Standardization of freight size and weight regulations (2)
15. Advanced vehicle research transit, passenger cars, trucks (2)
16. Optimization across commercial users of the highway and highway design (2)
17. New models for transit service and vehicles: energy efficient gains, better customer service thru info technology (1)
18. How do we convince the general public that 42,000 fatalities is a health epidemic? What is an acceptable level?
19. Vehicle/road communications interface
20. New materials and methods to ensure long term performance before it is constructed (minimum inspection)

BLUE TABLE: Initial Advanced Research Agenda Topics and votes

1. Achieving significant pedestrian travel (includes land use, choice, mba form, etc.) (13)
2. Nanostructure to infrastructures scale, linkages, long life, ultra-safe, sustainable, smart (12)
3. Scout/track other research (other areas, funders, etc… DOD, Health, etc) (12)
4. Effects of an automated vehicle systems on driver behavior (10)

5. Totally renewable infrastructure (9)
6. Development of self-healing, self-sensing materials in bulk (8)
7. Shaping human behavior to meet societal values (e.g. sustainability) (8)

8. New transportation systems (ultra-light mass transit) (5)
9. Methods for making better decisions (5)
10. System wide collection of real-time traffic data using nanotechnology (4)
11. Integrating research (synergy) (4)
12. Migration of 'best practices' to their use and application (organization, mgmt) (3)
13. Elimination of testing through sensors and smart equipment (3)
14. Pilot bio-fuel plants for high energy grazers (3)
15. Advanced computer applications to transportation (super computer) (3)
16. High performance permeable pavements (2)
17. Market research on how people make transportation choices (2)
18. Methods to adopt 'model city' goals to local tasks and attributions (2)
19. Why things did not happen that we thought would be the future (1)
20. Paperless construction (3D model to field – beyond equipments, testing, P.T., etc
21. Crack-free infrastructure
22. Understand effects of breakthrough automotive technology that may remove capacity banned (e.g. sprawl)
23. Imbedded energy in infrastructure materials
24. Methods to achieve harmony between the built (construction) and natural environment
25. What will people accept re: vehicle controls
26. Dynamic and 'smart' pavement markings
27. Vehicles with voluntary speed controls
28. Dynamics of light-weight passenger cars on ROR crashes (impact, rollover)
29. Zero fatality 'jersey' barriers
30. New business models to deliver innovative services
31. Partnering with parts to identify improvements in operation and emissions
32. Estimated effect of automated lane departure systems on ROR crashes

<u>GREEN TABLE: Initial Advanced Research Agenda Topics and votes</u>

1. Transportation's effect on public health (16)
2. Land use and transportation interactions (accessibility focus) (13)
3. Fuel tax alternatives (12)
4. Social/Political Issues, concerns and barriers that affect the implementation of breakthrough ideas. (10)

5. Vehicle/infrastructure systems to improve safety (8)
6. Better materials using nanotechnology (7)
7. Workforce demographics and future skills required (7)
8. Personal transportation for all that is affordable, convenient, safe, efficient and attractive. (Rural and urban) (5)
9. Completely wireless ITS technology (3)
10. Use satellite imagery to operate real-time traffic control (citywide) (3)
11. Automated highways and smart car interactions (3)
12. Enhance night/poor weather vision (goggle/hud) (3)
13. Real time multi-modal travel info (3)
14. Any fuel, low emission internal combustion engine (3)
15. Better use recycling of vehicles and infrastructure (2)
16. Carbon fiber research for improved vehicles (2)
17. Alternative urban freight delivery (2)
18. Infrastructure (materials and design) (2)

19. Pedestrian issues in urban areas (2)
20. Vertical take off and landing technology (1)
21. Embedded sensors for collection of condition and other data (1)
22. Real-time driver performance and vehicle performance (1)
23. Improved batteries
24. Methods to create seamless multi-modal links
25. Scanning and security of freight
26. Universal real time ride sharing
27. Roadside safety devices that are compatible with changing vehicle fleet
28. Improved sign sheeting (visibility and durability)

RED TABLE Advanced Research Agenda Topics and votes

1. Innovate pricing similar to pollution credits – market for the full costing of transportation cost of ownership (public & private) (15)
2. Governance structures – public/private sector rules (10)
3. Extreme materials and methods of construction (9)

4. Multi-modal, long-distance personal travel – who provides it and how? (8)
5. Changes in man & retail, what are the alternative strategies to moving goods. Serving freight – innovative! (7)
6. Performance assess of systems on time, operation flow and health monitoring (6)
7. National market research, marketing plan (6)
8. Rural road safety – what can be done? More money, technology, design, public education (5)
9. System network and service needs transportation must provide (regional level) (5)
10. Understand transportation land use policy (4)
11. Serving older people (4)
12. Driver automation interface ratio Human factors vs. what we automate (3)
13. Embedded road sensors – feedback to drivers for safety corrections (3)
14. Change mind-set of transportation community – customer vs. partner (3)
15. Greening transportation – avoiding imprints in location design and operations (2)
16. Ways to reduce transportation demand (1)
17. Maintenance-free roads, long-lasting pavements
18. Recycled agriculture. products in pavement design – sustainability
19. Impacting obesity through transportation choices
20. Re-look driver requirements
21. Public expectations vs. minimal eng/safety standards (etc. de-icing of roads impacts on environment)
22. Incentives to lightening the load – (e.g. carbon structures)