STAR *mural* SUPPLEMENT

MAY 16-18, 2022

Atlanta, Georgia

aif STrategic Asphalt Research *symposium*

STRATEGIC ASPHALT RESEARCH SYMPOSIUM
MURAL SUPPLEMENT

May 16-18, 2022
Atlanta, Georgia

The mission of the Asphalt Institute Foundation is to conduct strategic research and educational activities that are designed to advance and improve the liquid asphalt industry.

FOREWORD

As described in the 2022 STAR Symposium Report, breakout sessions were conducted with a focus on four main topics: Human Needs (Workforce Development), Environmental Sustainability, Performance (Durability), and Economics (Infrastructure Policy and Funding). Each of the topics had six subtopics assigned to one of six tables/areas in the breakout session room. Participants discussed problems related to each topic/subtopic and followed those discussions with identification of root causes of those problems, goals to address the identified problems, and strategies to achieve those goals. Goals and strategies were prioritized by the participants, with the top identified priorities making their way into the pages of the STAR Symposium Report.

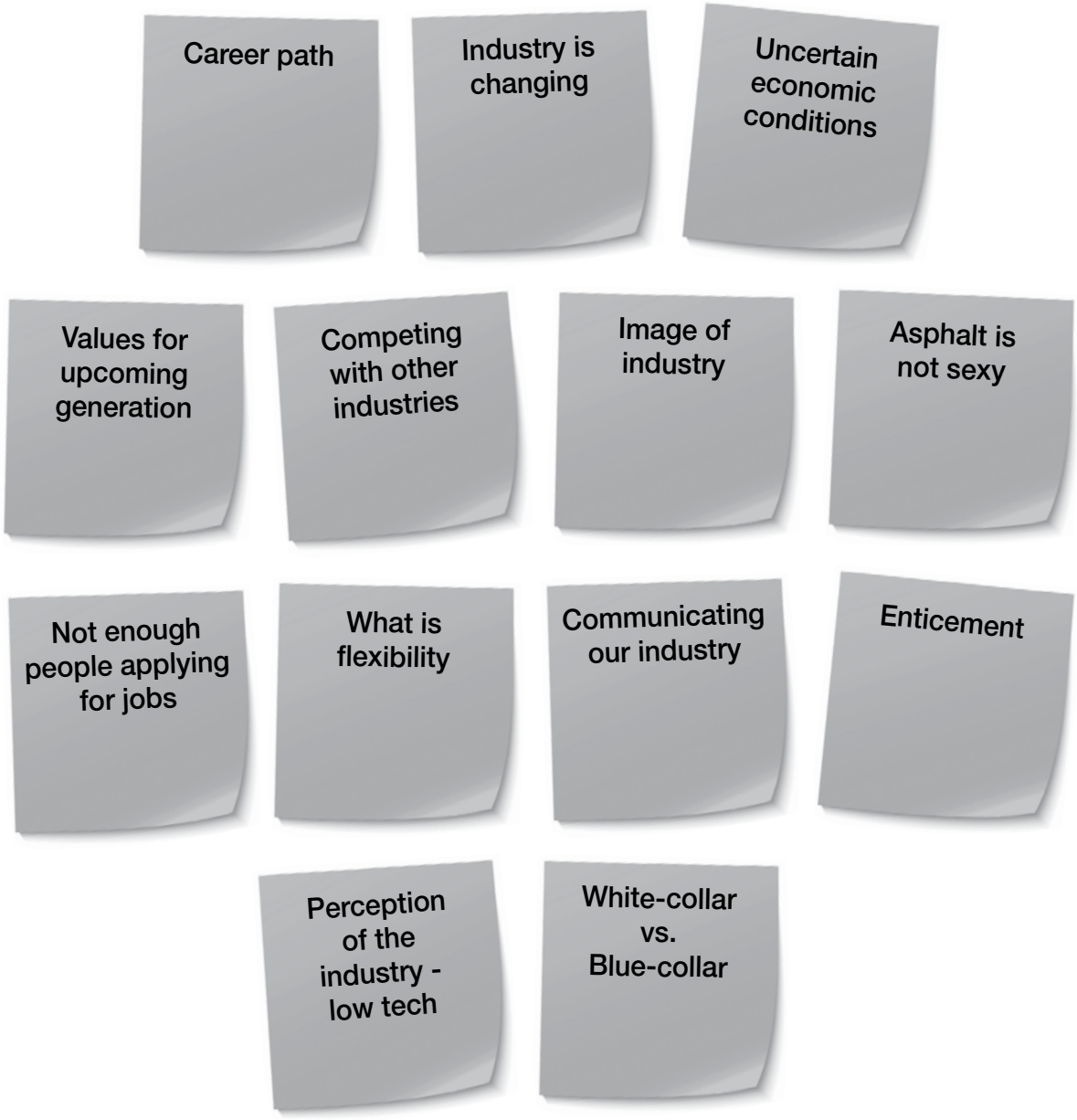
But just because a goal or strategy was not identified as a top priority by the participants does not lessen its potential value. This supplement was assembled to highlight all of the ideas that came from the STAR participants that made it into the Mural whiteboard. All the problems (shown as gray sticky notes), root causes (red), goals (blue), and strategies (orange) are shown by topic/subtopic area. Comments are shown in yellow.

We encourage you to review this supplement to get more of a feel for the thoughts of the STAR participants. You never know what ideas may lead to new strategic research directions!

Ralph Shirts
2022 Strategic Asphalt Research Symposium Chair
ExxonMobil-Retired
Asphalt Institute Emeritus

MURAL SUPPLEMENT

HUMAN NEEDS ADAPTING TO THE WORKFORCE



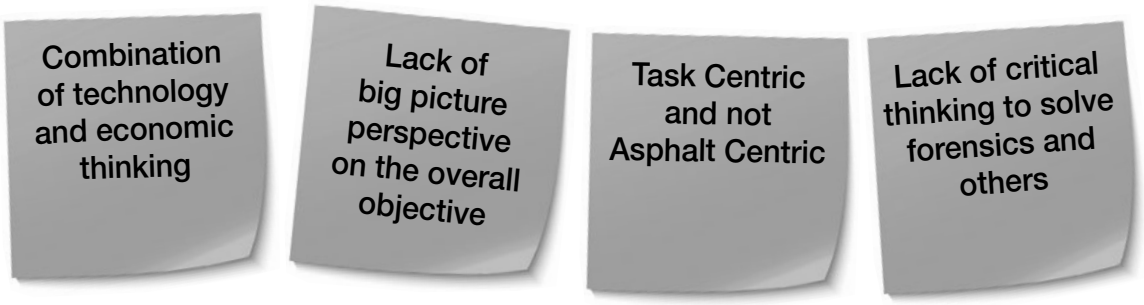

Attracting younger people
Job security/ reluctance to mentor
Poor advertising
Tough/Dirty Jobs
Demands for entry level jobs have increased
Asphalt industry refuses to change the way it does business
Mechanism for knowledge transfer
Lack of truth in advertising
Targeting the right people
Salary - more responsibility


We will tailor our message of our future employees
Show entire picture of industry - be true in advertising
Good collaboration with teachers curriculum
Improve onsite working conditions - heat/exhaustion
Will be known as an industry to take you from entry level to senior management
Workplace that attracts talent - Jobs & Equipment


Recruit IT/ Automation to shift workforce
Share the vision of where they can be in ten years
Implement Employee Recognition to make them feel valued
Offer lifestyle improvements
Implement four-day work week
Global diversity in workforce
Offer case by case evaluation of employee hours
Not a 9-5 job/flexible options
Have a pool of employee's - not running lean
Showcase other people like them i.e. Gen Z
Current employee diversity training
Create support work groups to get current work groups to be more tolerant
Establish and support policies
Create safe places within workforce
Cross generational employee training to create better communication and understanding
Rather than focusing on a specific generation, try focusing on "Next Gen Leaders"
For the next STAR, invite or nominate someone who hasn't attended before

HUMAN NEEDS NEEDED SKILLS

SKILLS AND KNOWLEDGE



EDUCATION AND TRAINING

EMPLOYMENT CULTURE AND WORK ENVIRONMENT

- Non-attractive overall packages (insurance, facilities to family)
- No competitive pay
- Lack of flexible work schedule
- Type of jobs (work requirements, work conditions)
- Profitability prioritized over employee interest

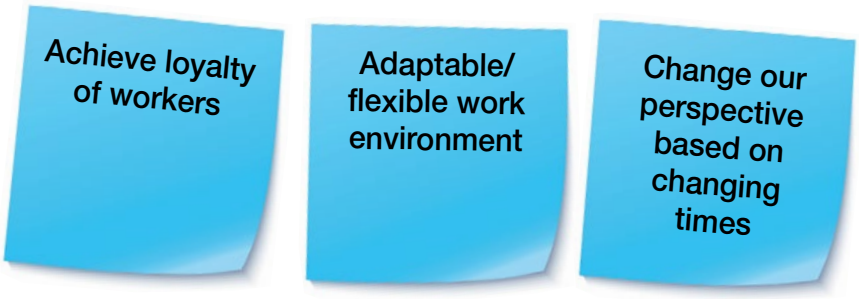
SKILLSET

- Lack of qualified trainers
- Limited knowledge on required skills
- Need interdisciplinary background

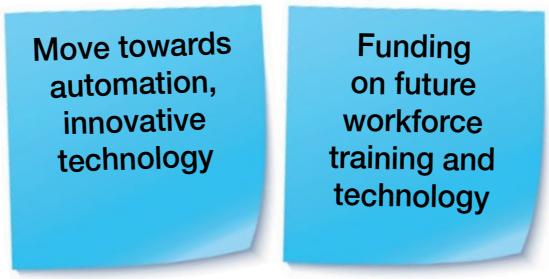
RECRUITMENT PROBLEMS

- Tight labor market, No incentive to get pre-training
- Recruiting from wrong talent pool

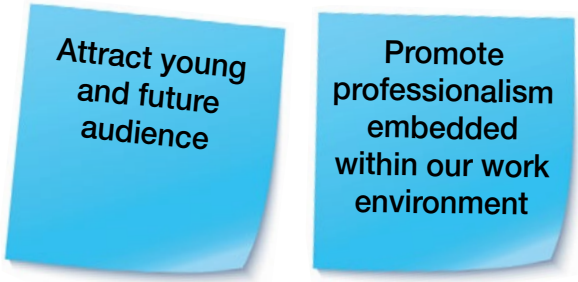
CHANGE IN WORK CULTURE



INNOVATE WITH TIME



INDUSTRY PROMOTION




1. Promote the Big Picture
2. Organize workshops to listen to young audience
3. Campaign to promote diversity and inclusion
4. Train the Trainer
5. Define a career path for more appeal
6. Form a consortium focused on future workforce training with new technology
7. Establish training labs involving industry, academia
8. Seek out external training, pressure local APA to provide quality training
9. Develop a Management Training Program for project managers
10. Develop mentoring program within industry to promote vertical education
11. Open all kinds of jobs and don't be rigid (wider audience and not just specialists)
12. Education program about career starting at a young age
In addition to listing types of jobs, also provide real-life examples of people in those jobs

HUMAN NEEDS WORKPLACE ENVIRONMENT

ACCOMMODATING MODERN FAMILY

- Lack of childcare systems
- Environment not friendly to women (breastfeeding stations, etc.)
- Mobile toilet facilities
- Women - Toilets on worksites
- Rigid timing requirements / lack of flexibility
- Remote work locations/stuck in hotels for long periods
- Long hours
- Night work

WORKPLACE SAFETY

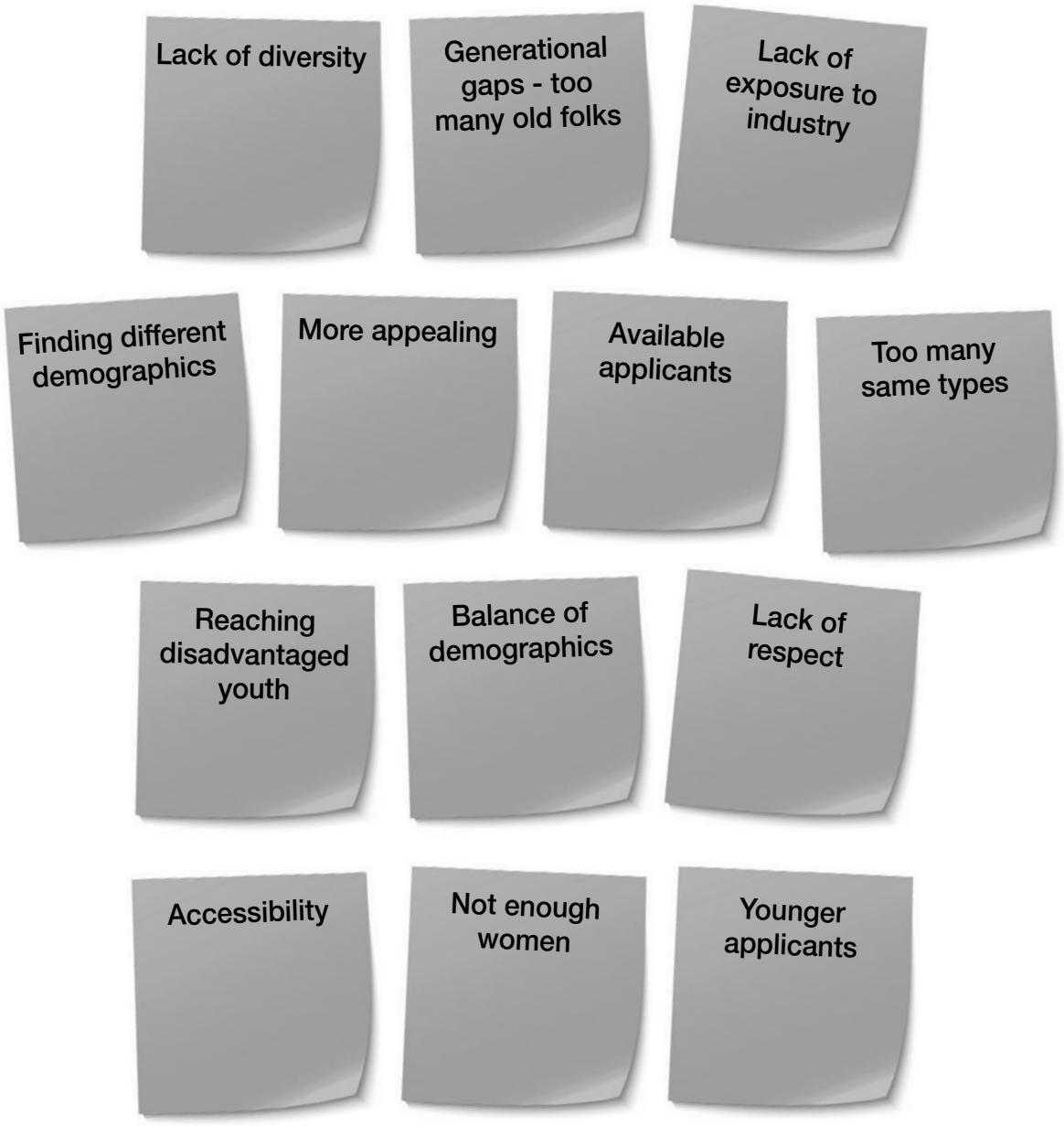
- Skeleton crews / a few people with many jobs
- Remote burn treatment facilities
- Workplace safety
- Perception of unsafe work conditions/ environments
- Hot and fumes
- Educating public about our work zones
- Fatalities in work zones: dangerous

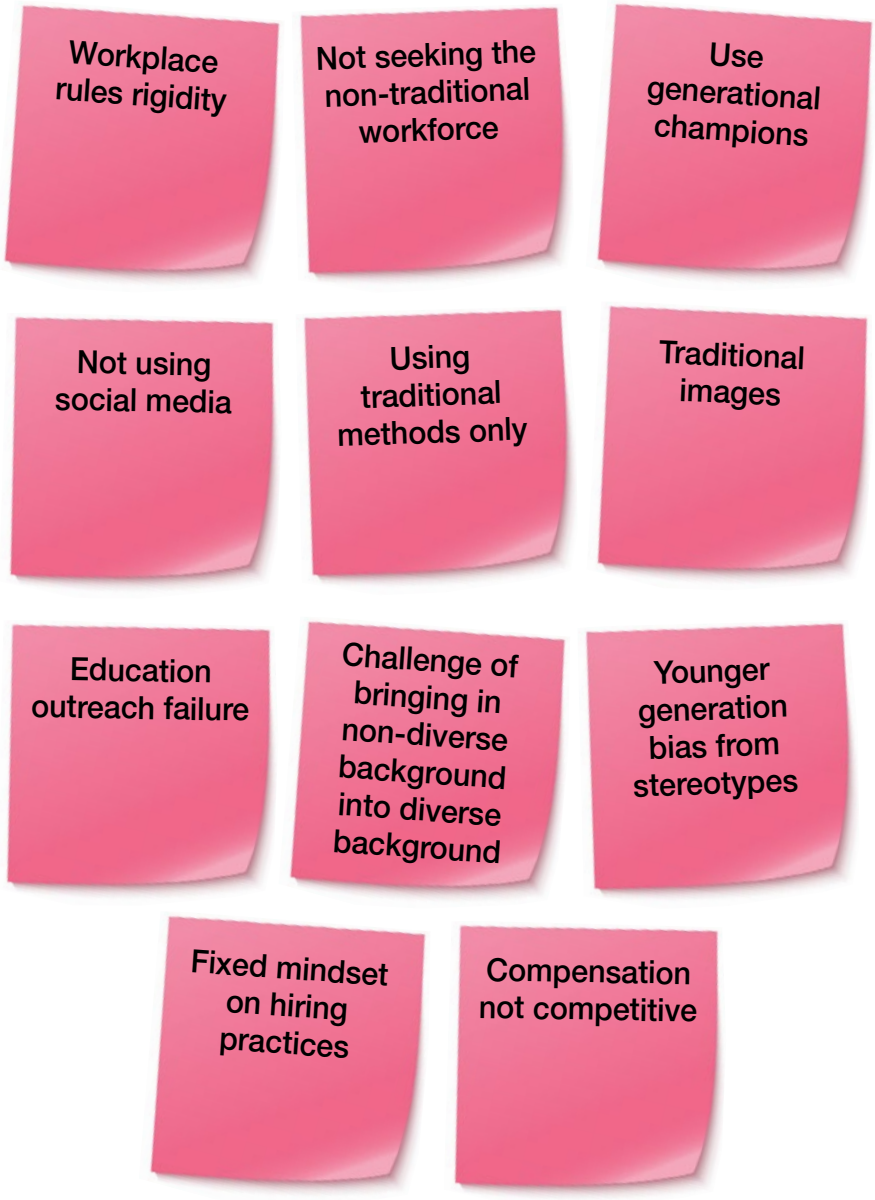
CULTURE

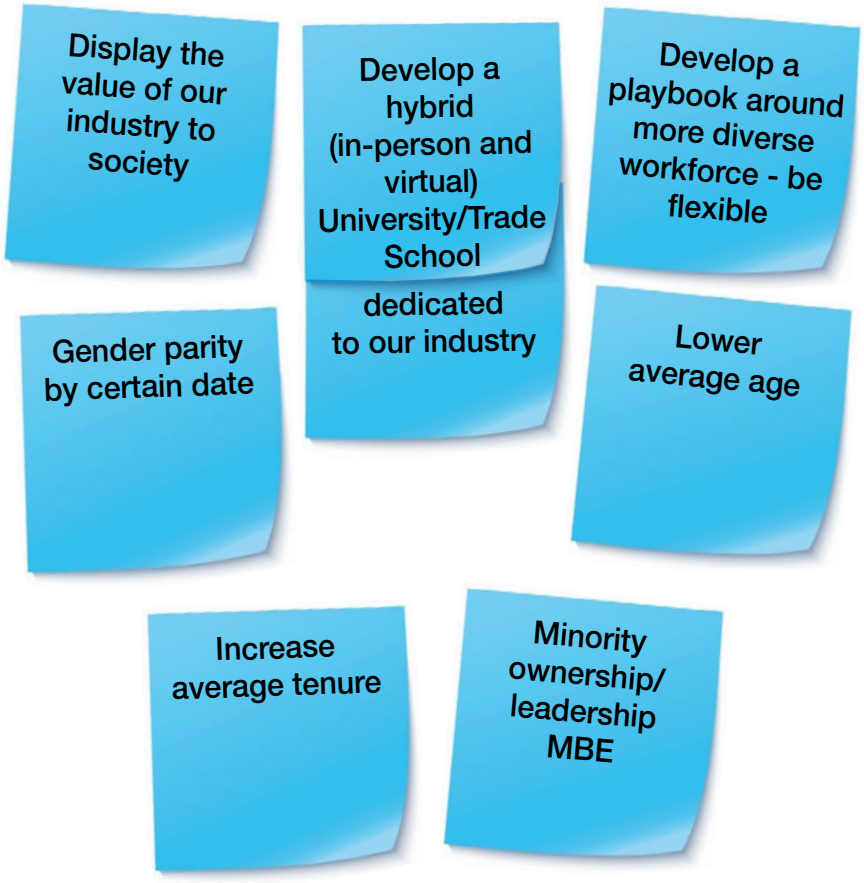
- Work feels old school / low tech
- Language barriers - need signs
- Diversity /inclusion
- Company / industry culture

Note: All Goals and Strategies for this subtopic are identified in the STAR Symposium Report.

HUMAN NEEDS WORKFORCE DIVERSITY




Workplace rules rigidity
Not seeking the non-traditional workforce
Use generational champions
Not using social media
Using traditional methods only
Traditional images
Education outreach failure
Challenge of bringing in non-diverse background into diverse background
Younger generation bias from stereotypes
Fixed mindset on hiring practices
Compensation not competitive


Display the value of our industry to society
Develop a hybrid (in-person and virtual) University/Trade School dedicated to our industry
Develop a playbook around more diverse workforce - be flexible
Gender parity by certain date
Lower average age
Increase average tenure
Minority ownership/ leadership MBE


Benchmark against competing industries so we can poach
Craft a message of value to the community to improve our image
Create both college level and trade level - integrated to reach more people
Train senior employees to understand younger generation
Promote the value of the industry to the community
Reach out to disadvantaged youth (foster kids) to offer a career path
Find trusted messengers to reach target audience
More churn in management for retention
Deploy grass roots efforts to reach the young
Define diversity to understand who we are trying to reach
Develop corporate culture to encourage diverse thinking
Recruit to challenged backgrounds to reach a more diverse audience
Adopt a practical approach to diversity
Match benefits to incoming generation expectations
Internships and active training to build a path forward
Outreach programs
Use all modes (classroom, lab, field)

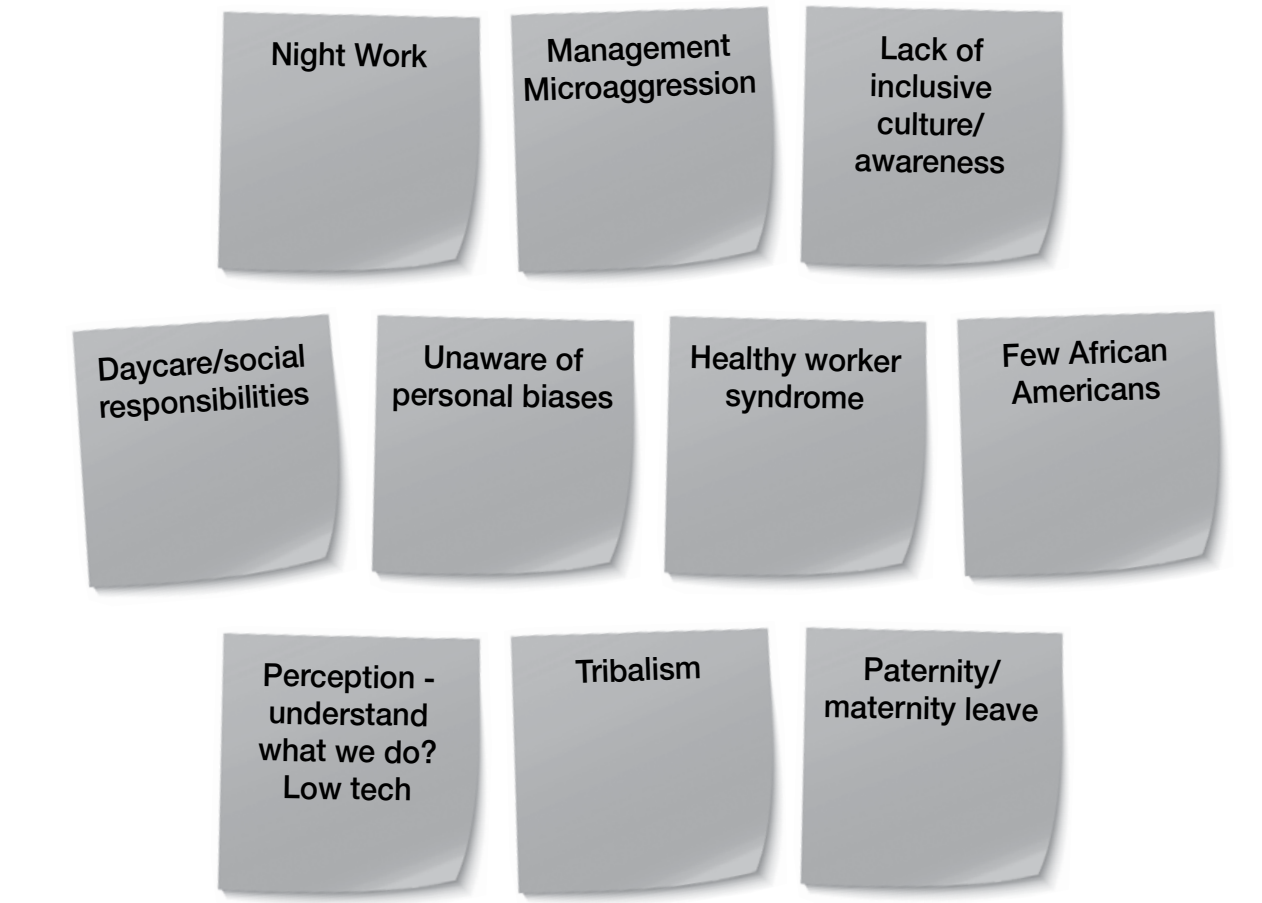
HUMAN NEEDS WORKPLACE AUTOMATION


Integration of other disciplinaries (IT, chemical engineering, robotics, etc.)
New technology. Lack of experience
The technology doesn't exist
Innovation driven by events, not just monetary incentives
The degree/ possibility of automation is bigger than we know
How much automation do we need? Because the technology already exists
Stipulations are inhibiting innovation
How do we incentivize automation?
We don't have a good communication plan (broader industry plan) - it hasn't been a priority
Lack of interdisciplinary approach in communication
How much are we willing to pay for it?


We will know all the jobs that are right for automation
Expand our business through automation
Eliminate employee injuries by using automation
Catch up on maintenance backlog with automation
Predict long term mix performance
Automation to repair roads through communication with maintenance
Use automation to enhance safety, enhance other job functions
Have higher and more consistent quality with automation
More fun at work
More work/ life balance for employees
Expand our community by working with other disciplines
We will be more efficient with automation
Have a skilled labor force to work the automation

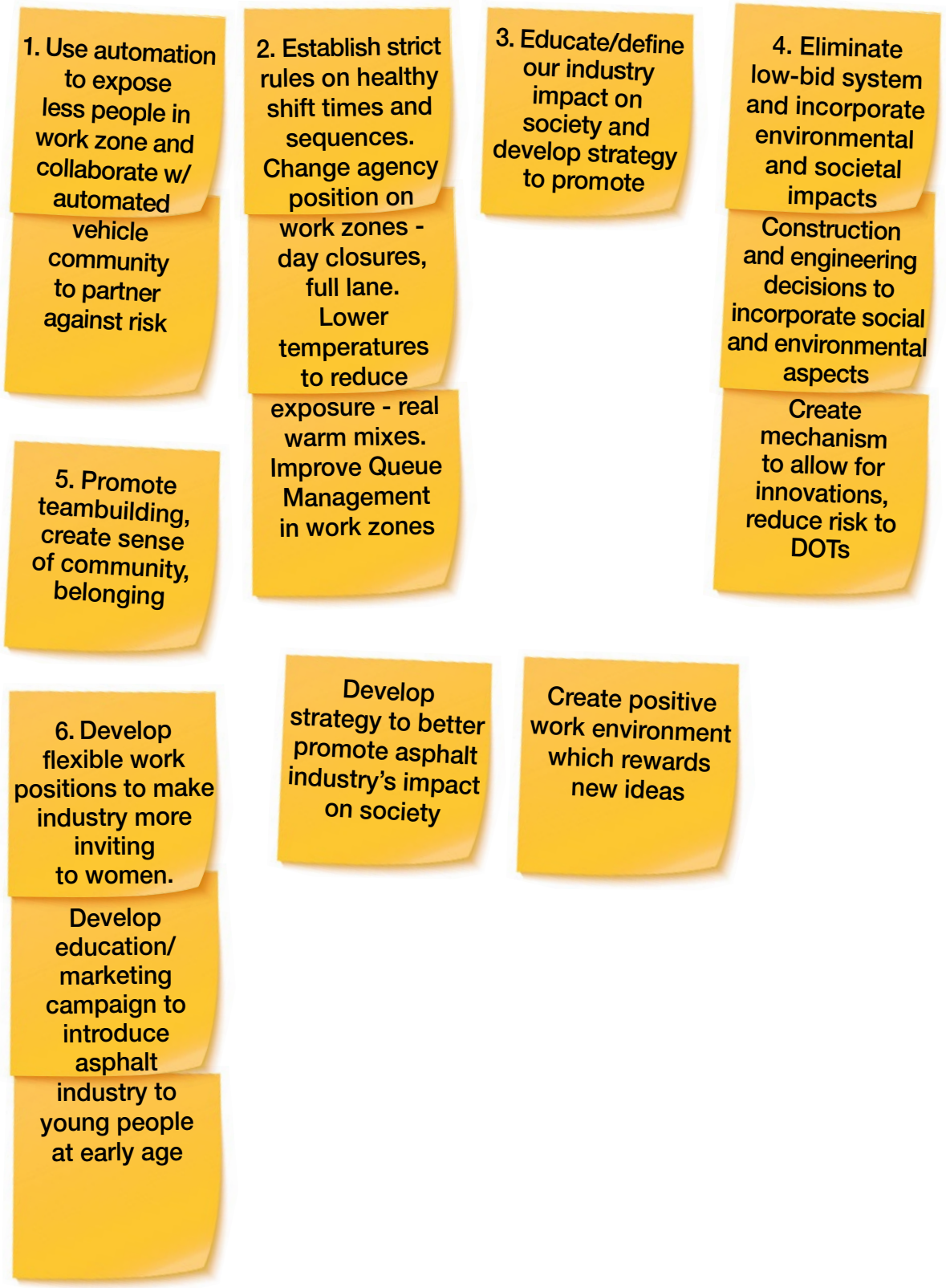

Make asphalt that doesn't require equipment
Develop a paver that extrudes asphalt at the right density
Give the problem to someone who doesn't know our industry
How do other industries solve this problem?
Collaborate with universities to develop and help with costs
Develop an instrument that communicates when road/ roof needs maintenance
Work with government DOTs to reduce barriers in adopting technologies
Run seminars on automation and share that with entire industry
Automate material sampling and testing - QC & QA
Partner with military on full automation.
Implement 100% automated paving project
Rewrite the code to embrace automation
Everything has to connected and communicating with each other. Fully integrated
Have a broader platform that other systems can connect to
Full industry alignment on automation.
Run a competition for students to get new ideas.

HUMAN NEEDS OTHER




Work Zone Traffic Restrictions by Owners
Hostile Workplace - Lack of awareness and hostility
Generational Disconnect creating hostile/toxic workplace
Male dominant industry leads to family responsibility issues
Safety - less cars on road at night
Language Barriers - Monolingualism
Lack of communication leads to HWS perception
Don't know how to recruit against low tech perception
Education affects perception
Unaware of good pay
Managing w/o management training
Monoculture - no opportunity to learn


Less people exposed in Work Zone
Create positive perception of asphalt industry
Create industry that next gen aspires to be part of
Be part of planet solution
Have a vision for how the workplace should be and communicate it
Less toxic culture from office to crew
Safe spaces to discuss challenges
Sell the mission of industry
Understanding the big picture


1. Use automation to expose less people in work zone and collaborate w/ automated vehicle community to partner against risk
2. Establish strict rules on healthy shift times and sequences. Change agency position on work zones - day closures, full lane. Lower temperatures to reduce exposure - real warm mixes. Improve Queue Management in work zones
3. Educate/define our industry impact on society and develop strategy to promote
4. Eliminate low-bid system and incorporate environmental and societal impacts
Construction and engineering decisions to incorporate social and environmental aspects
Create mechanism to allow for innovations, reduce risk to DOTs
5. Promote teambuilding, create sense of community, belonging
6. Develop flexible work positions to make industry more inviting to women.
Develop education/ marketing campaign to introduce asphalt industry to young people at early age
Develop strategy to better promote asphalt industry's impact on society
Create positive work environment which rewards new ideas

MURAL SUPPLEMENT

ENVIRONMENTAL SUSTAINABILITY NET NEUTRAL CARBON

BARRIERS

- Cost/ Technology to shift to renewables
- Lack of technology
- Climate change considered as a political topic and not completely accepted
- Low Bid Environment
- Cost to do it
- Production of asphalt needs intensive energy (specifically from fossil fuels)

BAD PRACTICES

- Different objectives throughout the supply chain irrespective of geography
- Poor management of facilities
- Habits of using cheap fuels/asphalt
- Not being consequential
- Use of non-renewable sources
- Non-effective use of RAP, downstream performance needs to be considered

LACK OF UNDERSTANDING

- Lack of comprehensive scope (e.g., full life cycle of a pavement)
- Lack of standardized definition of Net Neutral Carbon

The low bid system forces industry to innovate in cost reduction, not quality. The agency believes it is getting quality via their specifications.

COMPLEXITY OF THE PROBLEM

- Lack of clear and simple path to Net Zero
- Why and for what Net Zero
- Perception of industry that production requires hydrocarbons
- Lack of education on Net Zero/ Decarbonization terms and rules

ORGANIZATIONAL CHALLENGES

- Sustainability is not a priority for pavement owners and industry
- Different political agenda around Net Zero
- Perception that reducing carbon will affect business
- Rigid government specifications
- Too many chefs in the kitchen (e.g., too many sustainability definitions)
- Low Bid Environment (age old contracting mechanisms)
- Objectives of owners and industry not aligning
- Technology standards change processes are built to go slow and be risk averse
- Use of high carbon energy sources
- Risk of experimentation falls to the bottom of chain

Agencies have different objectives and standards for their programs. Little federal alignment or leadership here.

In the LEEDS building rating system, government agencies will build rather expensive buildings to obtain higher ratings. We have to help agencies understand our industry can do the same with pavements; innovation for performance.

STANDARDS/RULES

Carbon Negative (Carbon Sequestration) and not Net Carbon Neutral

Develop/Adapt "Low-Carbon" commercially viable technologies: path similar to low carbon fuel standards

Implement bio-based technologies

TECHNOLOGY

Create one set of PCRs/carbon accounting rules for our industry

Specifications for performance aligned with specifications for Net Zero: data science integration for scalability

INDUSTRY EFFORTS

Industry-led education efforts

Be an industry leader toward Net Negative Carbon (Cumulative Net Zero)

Make Climate Change approaches/ progress administration agnostic


1. Increase service life of end product
2a. Reduce Energy Consumption through production processes to reduce carbon
2b. FHWA incentives to lower carbon emissions
2c. Innovate and implement cold technology with equal performance
3a. Develop communication/ research documents that will be administrative agnostic
3b. Create sustainability tools to assess and choose best solution
4. Collaborate with Universities/ Research Institutes/External Stakeholders to develop long lasting binders, carbon capture sequestration
5. Develop frameworks for consequential LCA, carbon offset strategies for asphalt, alternative fuels: Engage with external groups
6. Involve with supply chain stakeholders across the globe to develop PCR/carbon accounting standards
7. Develop closed vs open production to eliminate emissions

ENVIRONMENTAL SUSTAINABILITY IMPACT OF ADDITIVES

NEED FOR LCA/EPD

- Proprietary nature
- Lack of full, transparent LCA data
- Lack of maintenance, rehabilitation, and use phase in LCA (performance not part of the picture)
- Lack of product category rules
- Unknown leaching compounds
- Every additive has different upstream process

PERFORMANCE

- Don't understand true overall effects of additives
- Potential impacts on recyclability
- Unintended consequences
- Additives react differently to different asphalt streams
- Not using additives to improve sustainability
- Microplastics

MARKETING / ENGINEERING

- Proprietary nature
- Added initial cost
- Marketing vs. engineering
- Education: Must be comparable (equivalent performance)
- Lack of distinction between what's a modifier and what's an additive

CONSTRUCTION

- Additional storage requirements
- Added complexity

NEED FOR LCA/EPD

- LCA challenge - range of products for same application
- Cost of LCA
- Not looking at cradle to grave
- Lack of coordination between suppliers on PCRs
- Proprietary nature of industry

MARKETING / ENGINEERING

- Bad past experience
- Can be legislative or lobbyist driven instead of engineered
- Lack of education and training
- Proprietary nature
- Lack of trust between supplier and client

PERFORMANCE

- Lack of engineering data
- Standard testing may not capture benefits
- Not quantifying longterm performance
- Previous experience with “Snake Oils”
- No push / incentive from customer
- Not understanding the benefits

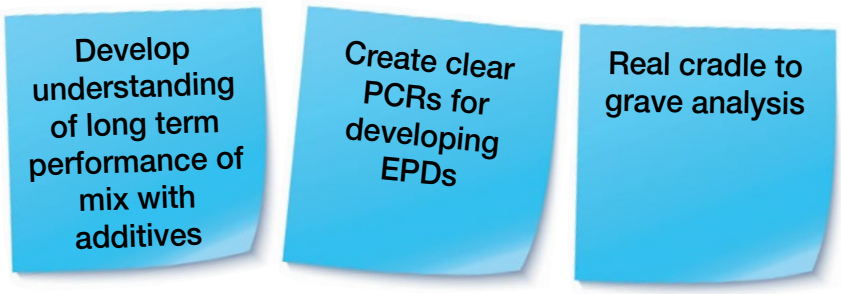
CONSTRUCTION

- Lack of champion to take risk
- Add impacts of emissions & interaction w/temp

TESTING AND PROCEDURES

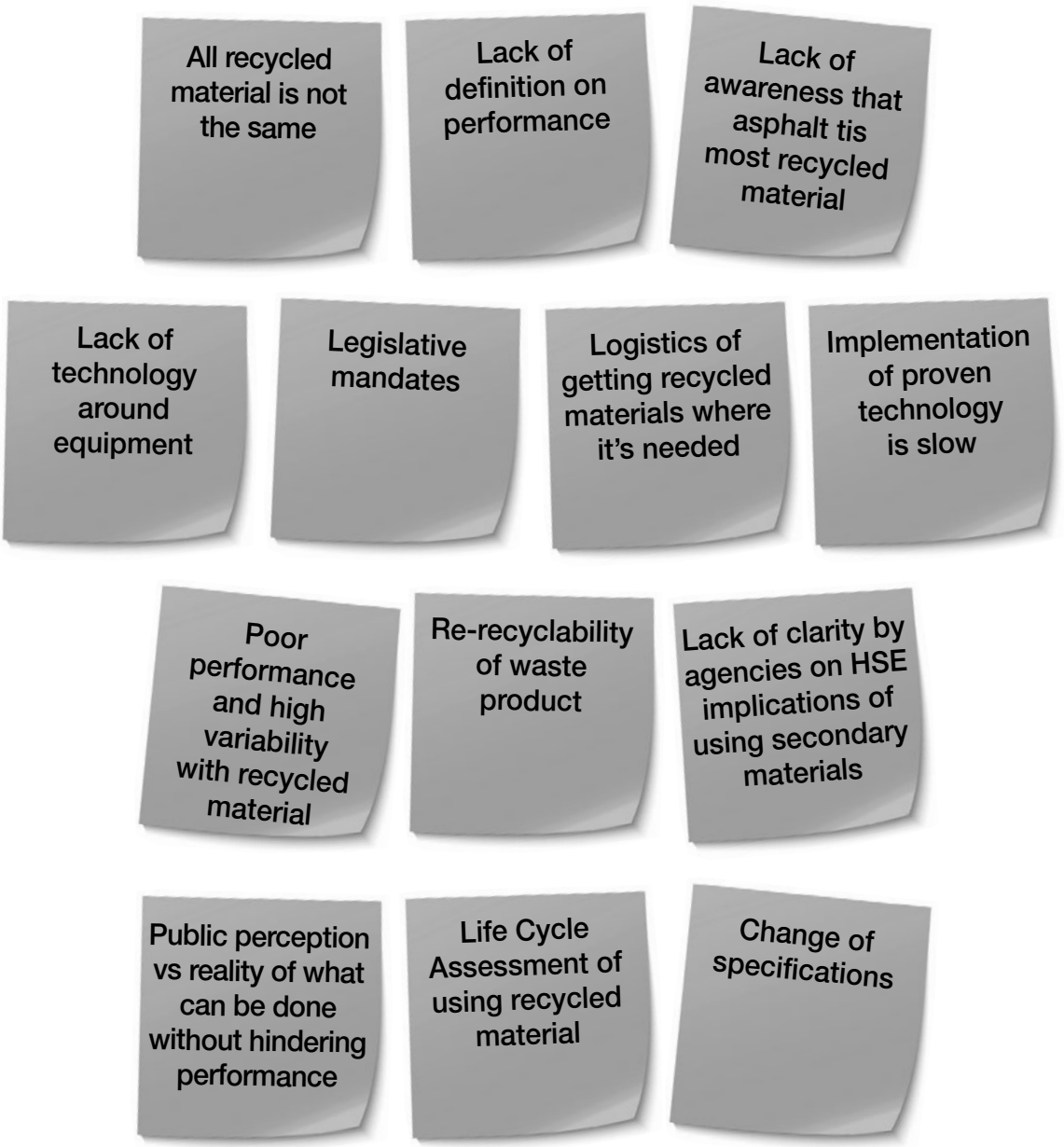
PROCUREMENT METHODS

LCAS AND EPDS



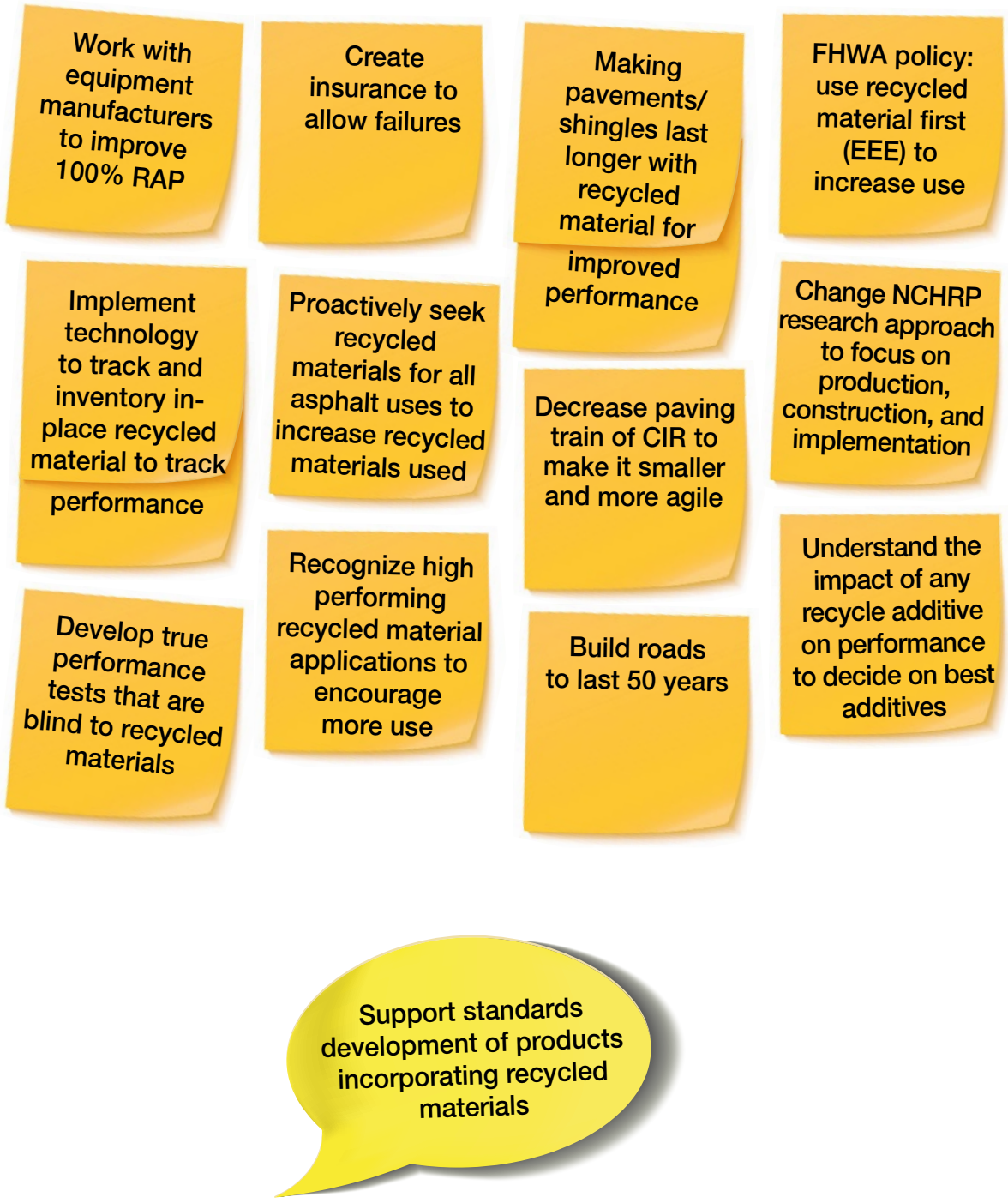
Note: All Strategies for this subtopic are identified in the STAR Symposium Report.

ENVIRONMENTAL SUSTAINABILITY RECYCLED MATERIALS

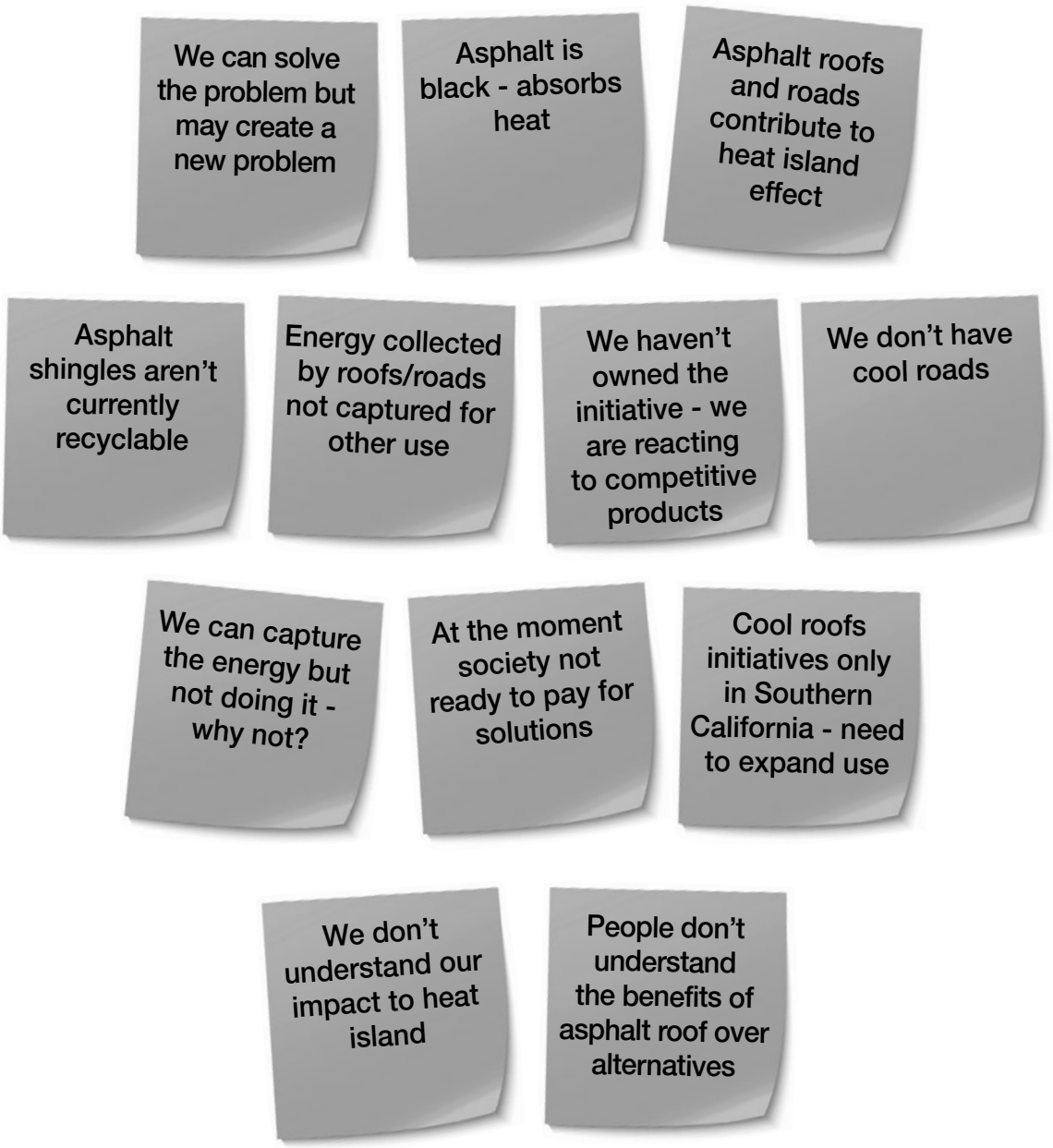


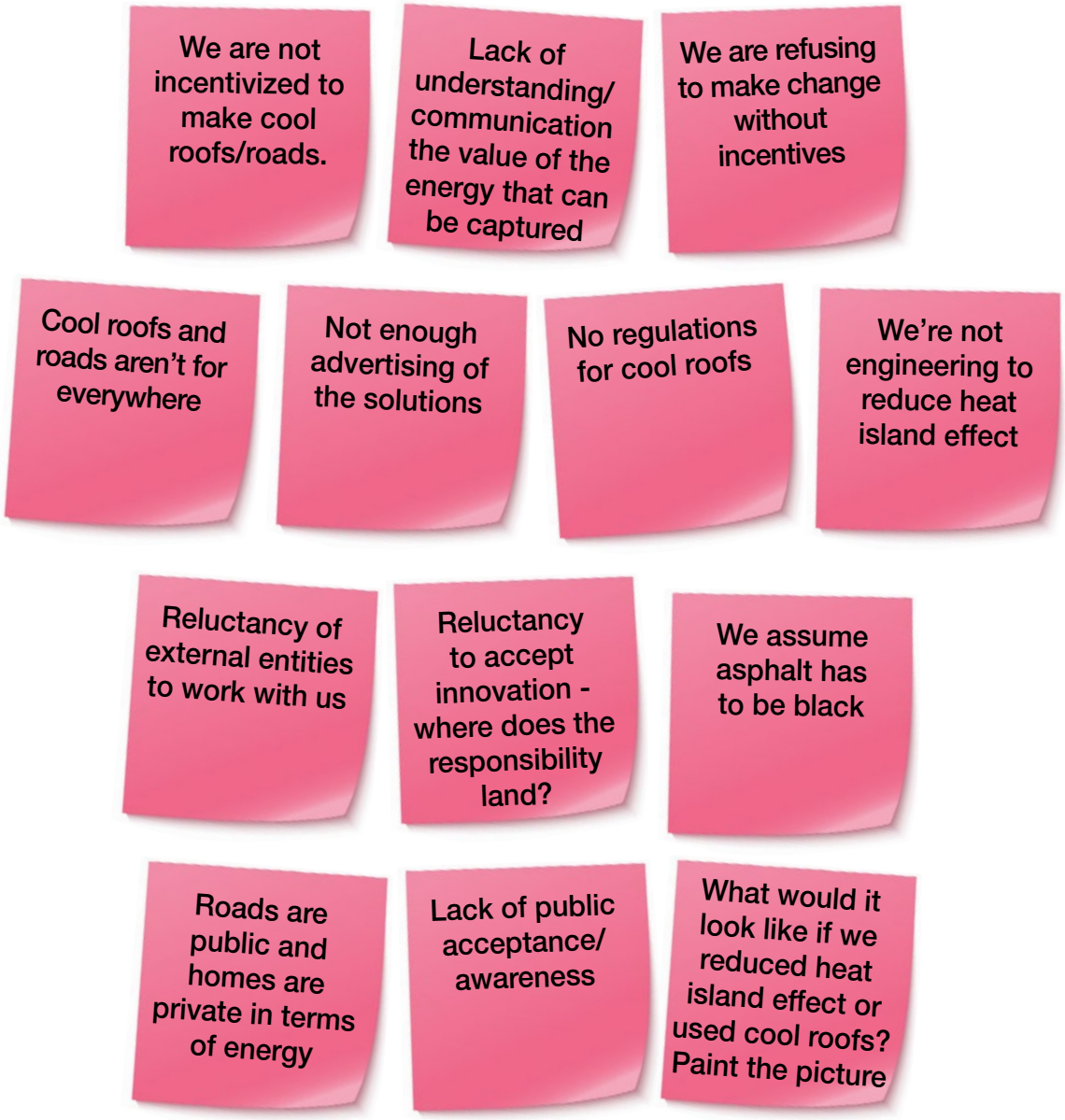

Only one component of entire pavement system
Failed roads with recycled material
Industry is reactionary versus being proactive
Recycling driven by environmental pressures with disregard on performance
No true performance tests that are blind to recycled material
Lack of data and sharing of data
Poor communication between asphalt technologists and legislatures
Fear of change
System should be more innovation friendly and allow failure as means of learning
Using recycled material may not be sustainable

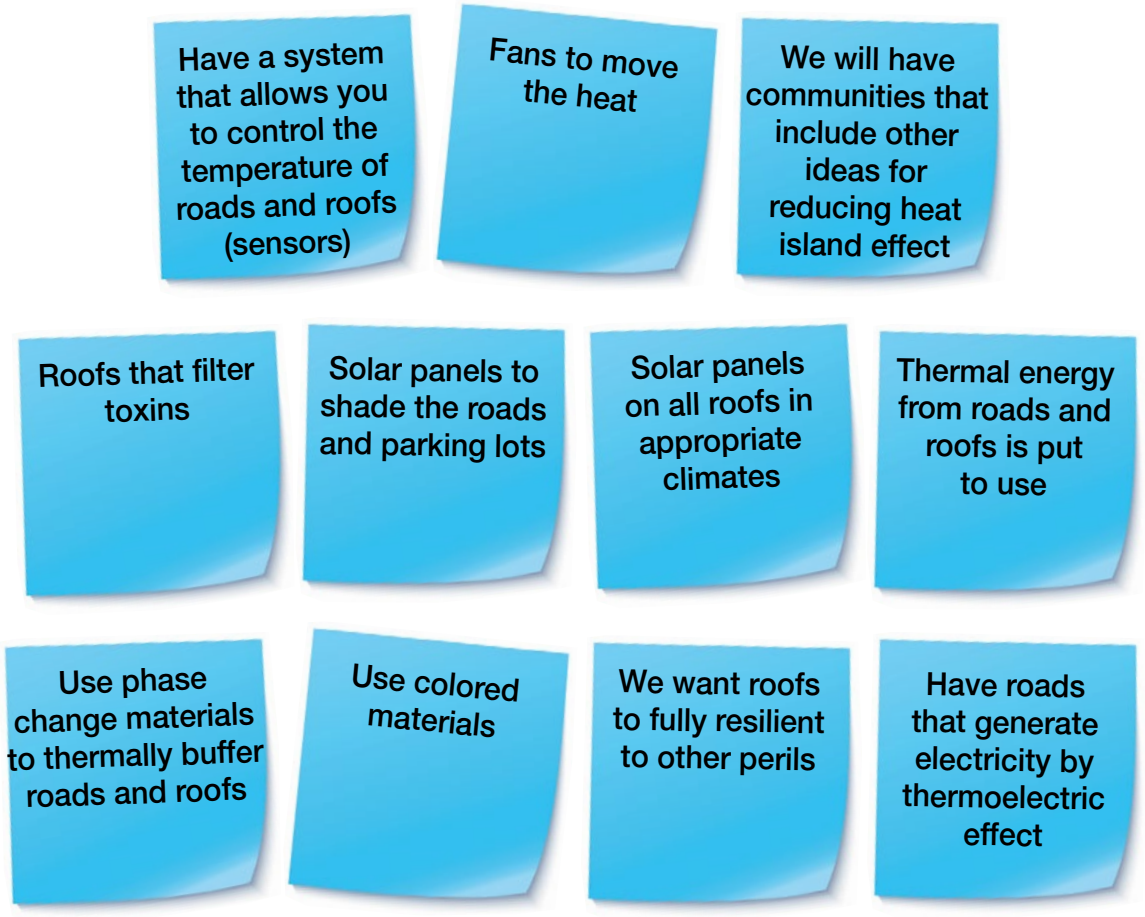

Equal or improved performance with recycled material
Increase use 100% recycled materials where materials never leave jobsite
Establish inventory of road construction, materials etc.
Develop tests, tools, requirements to assess the full life cycle impact with new technologies


Work with equipment manufacturers to improve 100% RAP
Create insurance to allow failures
Making pavements/ shingles last longer with recycled material for improved performance
FHWA policy: use recycled material first (EEE) to increase use
Implement technology to track and inventory in-place recycled material to track performance
Proactively seek recycled materials for all asphalt uses to increase recycled materials used
Decrease paving train of CIR to make it smaller and more agile
Change NCHRP research approach to focus on production, construction, and implementation
Develop true performance tests that are blind to recycled materials
Recognize high performing recycled material applications to encourage more use
Build roads to last 50 years
Understand the impact of any recycle additive on performance to decide on best additives
Support standards development of products incorporating recycled materials

ENVIRONMENTAL SUSTAINABILITY COOL ROOFS/COMMUNITIES



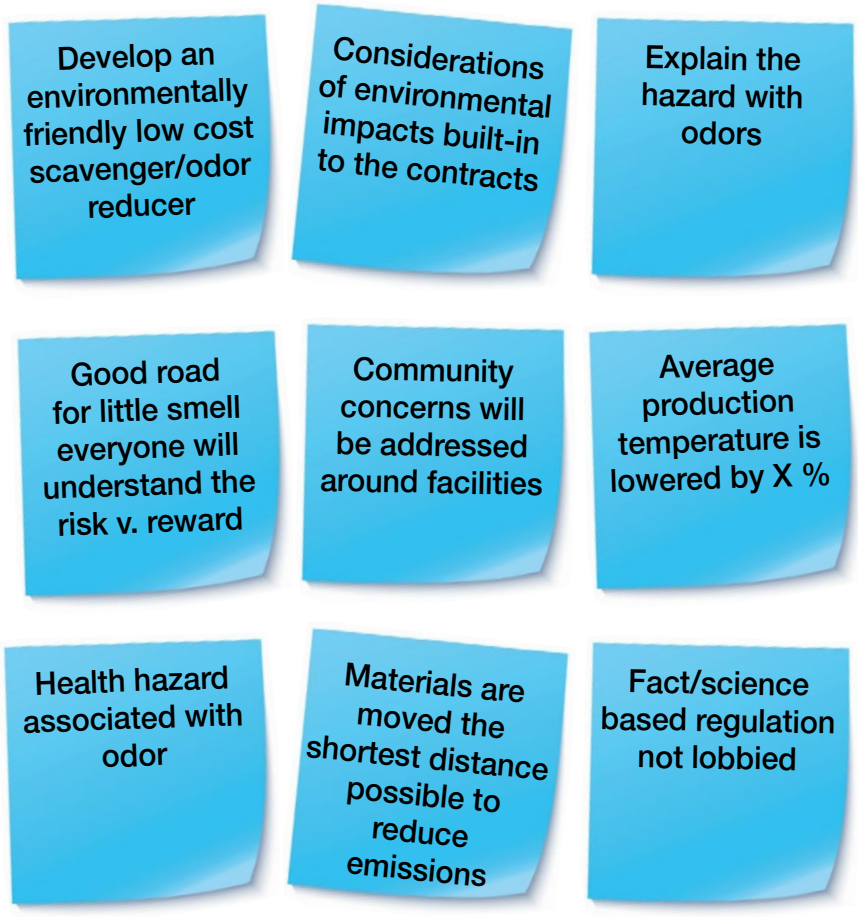

We are not incentivized to make cool roofs/roads.
Lack of understanding/ communication the value of the energy that can be captured
We are refusing to make change without incentives
Cool roofs and roads aren't for everywhere
Not enough advertising of the solutions
No regulations for cool roofs
We're not engineering to reduce heat island effect
Reluctancy of external entities to work with us
Reluctancy to accept innovation - where does the responsibility land?
We assume asphalt has to be black
Roads are public and homes are private in terms of energy
Lack of public acceptance/ awareness
What would it look like if we reduced heat island effect or used cool roofs? Paint the picture


Have a system that allows you to control the temperature of roads and roofs (sensors)
Fans to move the heat
We will have communities that include other ideas for reducing heat island effect
Roofs that filter toxins
Solar panels to shade the roads and parking lots
Solar panels on all roofs in appropriate climates
Thermal energy from roads and roofs is put to use
Use phase change materials to thermally buffer roads and roofs
Use colored materials
We want roofs to fully resilient to other perils
Have roads that generate electricity by thermoelectric effect


Plant more trees & vegetation
Influence policy makers to focus on the bigger community
Develop coatings to restore roofs
Use of highly reflectivity granules for asphalt roofing
Mandate washing of TPO roofs
Change the refining process so that asphalt comes out a different color
Encourage construction practices that lower energy cooling needs (i.e. air gap)
Tax incentive for new construction of green (living) roofs
Use high heat capacity materials in construction
Educate communities on benefits of lighter colored roads and roofs
Use smog reducing coating on roofs/roads
Be an active partner in energy code and key states where these policies are being implemented

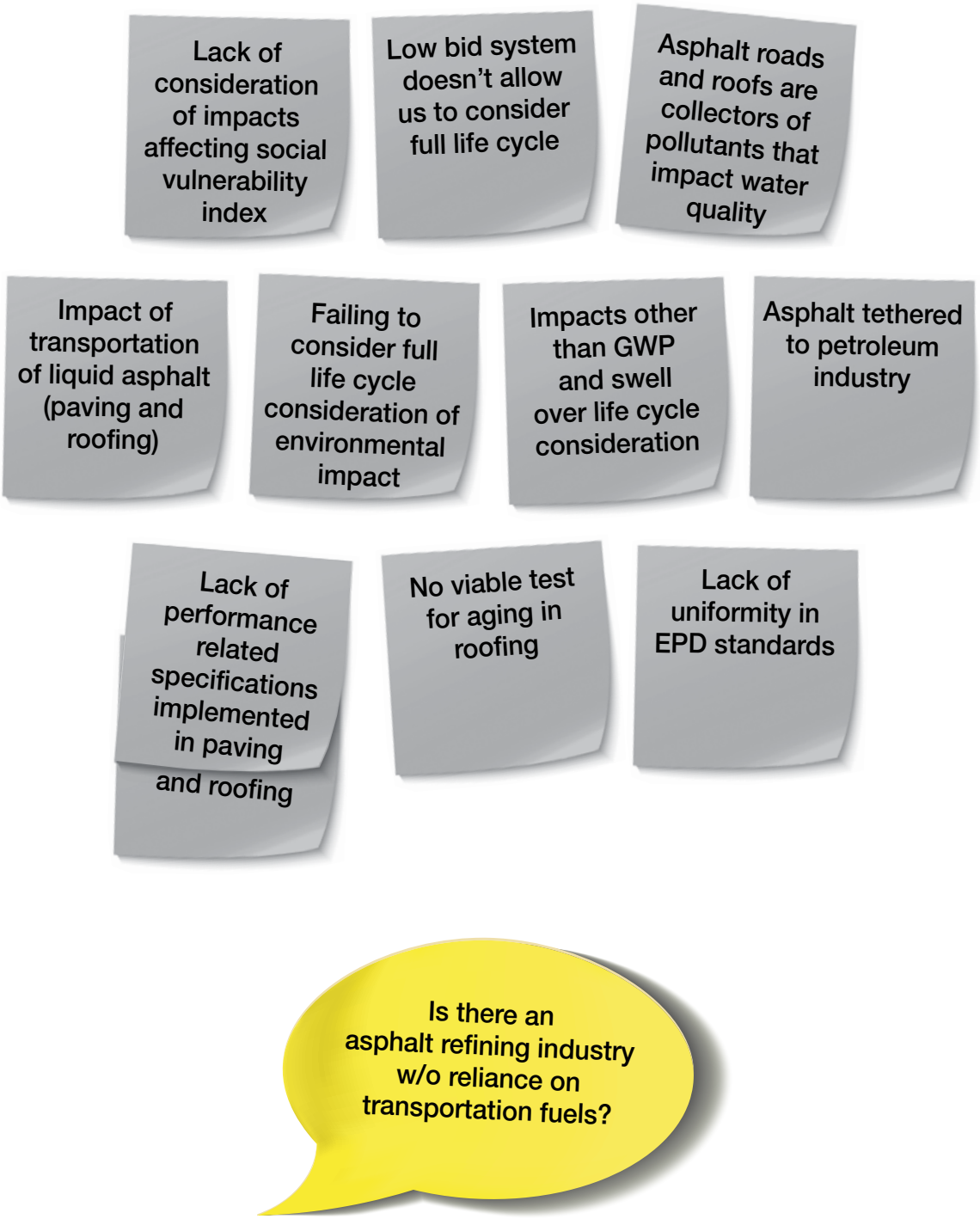
ENVIRONMENTAL SUSTAINABILITY EMISSIONS AND ODORS


Temperature
Chemistry/ Material
Plants run hot which cause emissions
Vapors coming off
Unconfined
Heavy trucks emit emissions which are not associated with asphalt production
Current Specifications cause/allow high temperature
To be competitive companies are continuing to use the same assets
industry habits - outdated perceptions of higher temperatures means better product
Dryer emissions in Europe, additional odors when using RAP
Outdated equipment at plants
We don't know why it smells
Low bid
Emissions capture technology is expensive
Industry asking for high product temperature at delivery

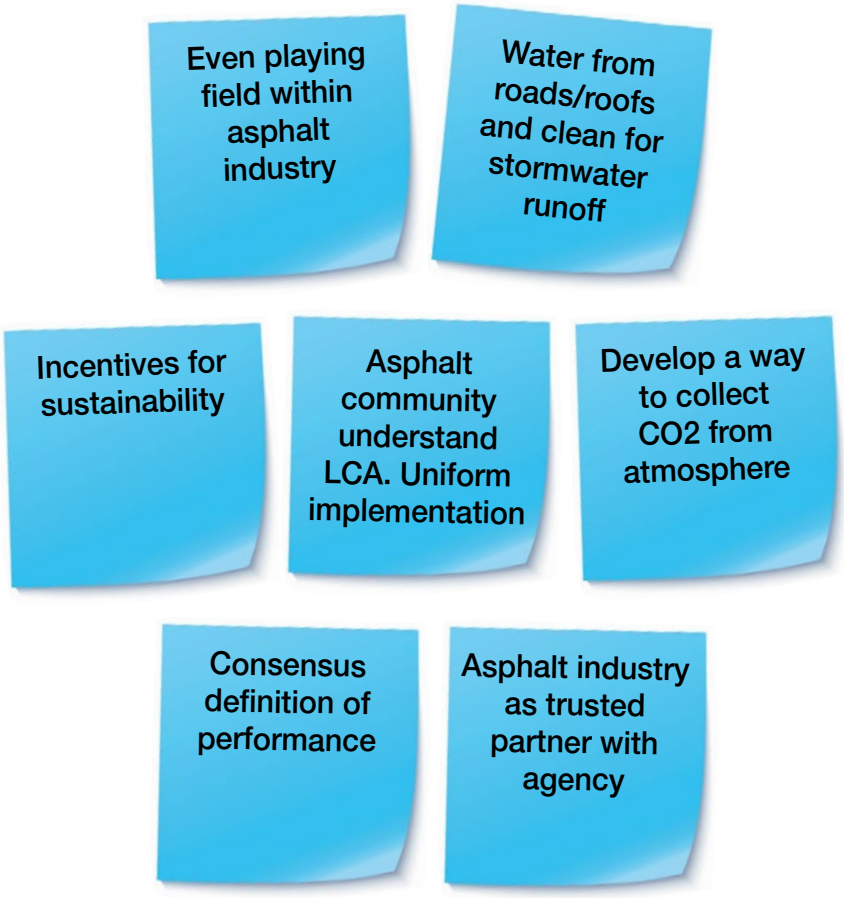

Develop an environmentally friendly low cost scavenger/odor reducer
Considerations of environmental impacts built-in to the contracts
Explain the hazard with odors
Good road for little smell everyone will understand the risk v. reward
Community concerns will be addressed around facilities
Average production temperature is lowered by X %
Health hazard associated with odor
Materials are moved the shortest distance possible to reduce emissions
Fact/science based regulation not lobbied

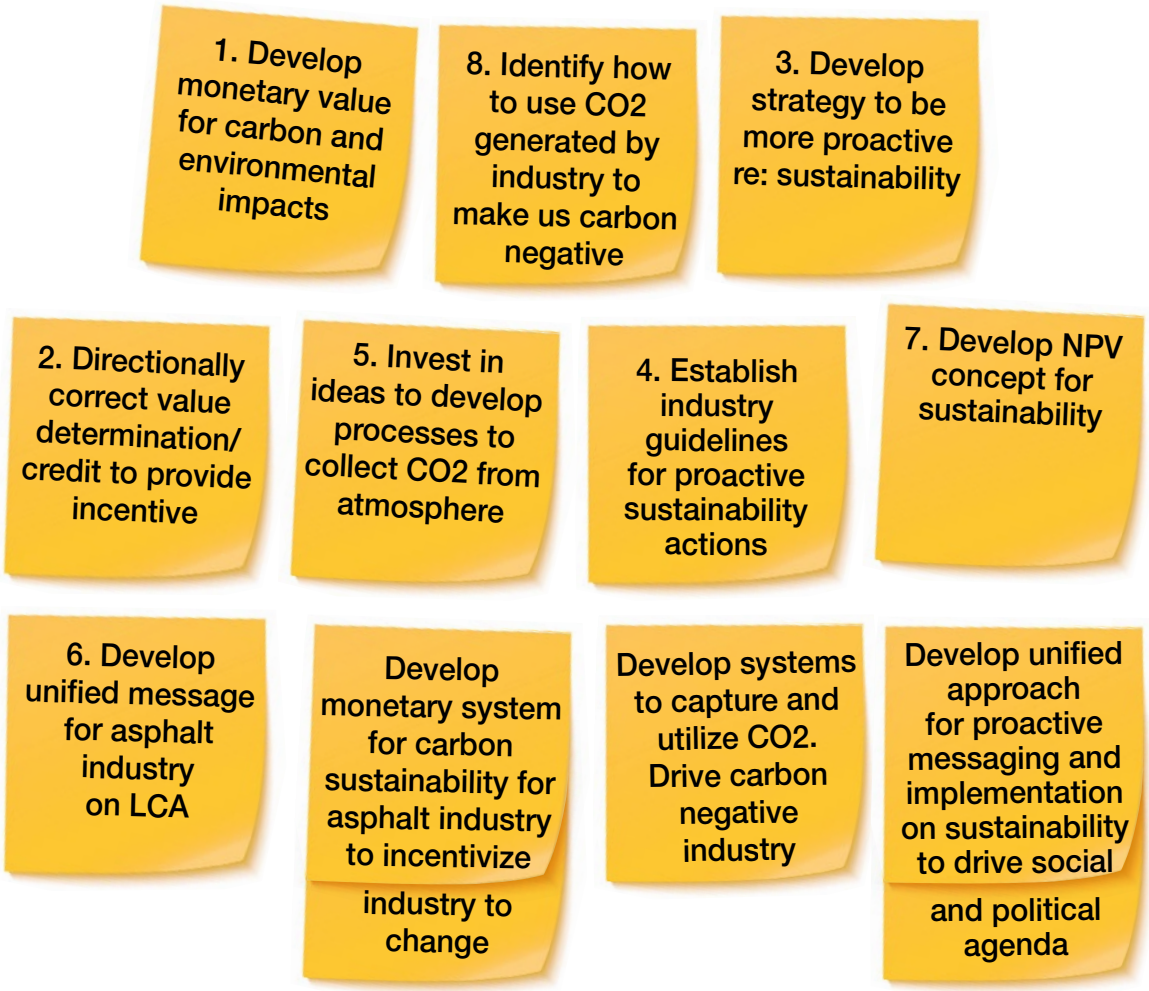

Education of our lobbyist
Comparing to materials that people might be more used to
Using technology from other industries in our industry
Make and maintain good roads
Adding nice smells to our product
Educate them on the real cost
#Hashtag stop to smell the asphalt
Making the industry proactive v. reactive
Incentivize the end user to reduce odor and low temperature
Raise roads higher in the political agenda
Make smaller/ mobile plants in each community
Meets certain emissions standards
Blend and mix material to improve the mixture - helps reducing emissions
Make our industry cleaner/green
Educate communities that we can do less harm
Use alternative energy sources to heat our products
Preheat using solar or infrared

ENVIRONMENTAL SUSTAINABILITY OTHER




Insufficient funding to fix problems
Lack of definition of performance
Asphalt business is S&D balanced. Disruption in refining major effect
Lack of education on PCR, EPD, LCA
Knowing target audience
Impacts other than GWP related to lack of education
Lack of models and data beyond gate for env. consideration
Asphalt (roads and roofs) is efficient collector of air and water pollutants
Defining of functions of asphalt are limited. Uni-tasker
Lack of trust - specifying agency and contracting industry


Even playing field within asphalt industry
Water from roads/roofs and clean for stormwater runoff
Incentives for sustainability
Asphalt community understand LCA. Uniform implementation
Develop a way to collect CO2 from atmosphere
Consensus definition of performance
Asphalt industry as trusted partner with agency


1. Develop monetary value for carbon and environmental impacts
8. Identify how to use CO2 generated by industry to make us carbon negative
3. Develop strategy to be more proactive re: sustainability
2. Directionally correct value determination/ credit to provide incentive
5. Invest in ideas to develop processes to collect CO2 from atmosphere
4. Establish industry guidelines for proactive sustainability actions
7. Develop NPV concept for sustainability
6. Develop unified message for asphalt industry on LCA
Develop monetary system for carbon sustainability for asphalt industry to incentivize industry to change
Develop systems to capture and utilize CO2. Drive carbon negative industry
Develop unified approach for proactive messaging and implementation on sustainability to drive social and political agenda

MURAL SUPPLEMENT

PERFORMANCE (DURABILITY) PERFORMANCE REQUIREMENTS

SPECIFICATIONS

- No performance requirements for asphalt used in roofing
- ASTM specs are prescriptive, not predictive of performance
- Laboratory tests not reflective of field performance
- Most standard pavement design tools do not match current materials performance
- Don't get paid for performance, get paid for meeting specs
- Can meet ASTM, but doesn't correlate with actual performance
- Penalties don't match cost to repair corresponding damage
- Existing specs don't necessarily predict performance
- Specifications don't address performance

ENVIRONMENT

- Geographic variability

CONSTRUCTION

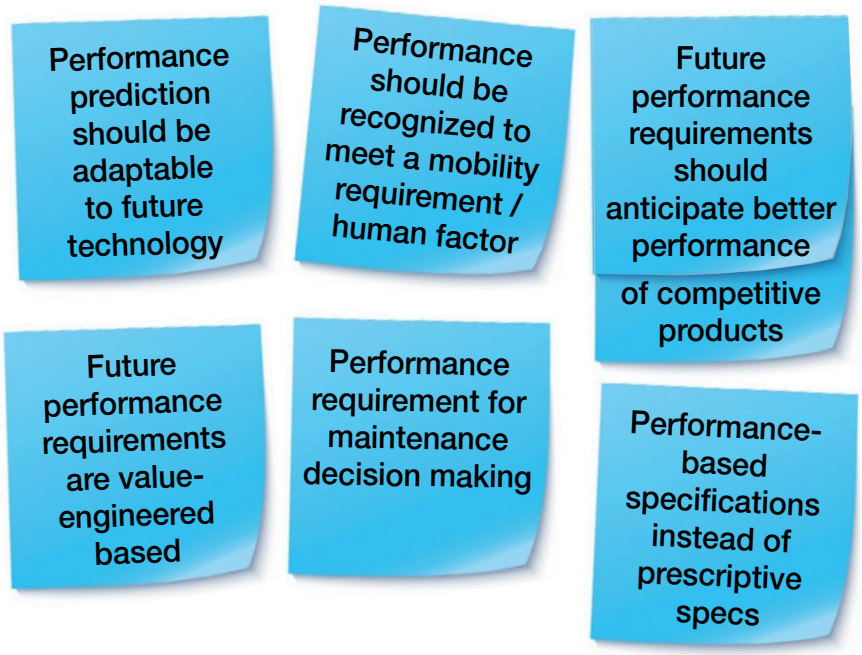
- Need to understand why pavements perform
- No incentive to make products that exceed specifications
- Poor construction practices have greater influence on performance than proper mix design
- Poor performance if poor existing base / structure

OWNER PERCEPTIONS AND PRACTICES

- Lack of data about existing full depth pavement sections / inadequate site investigation
- Road owners set low standards
- Highly varied opinions on optimum preservation treatments / very little performance data
- Owners perceive that the cost of getting good performance specs outweighs benefits
- Limited definition of performance
- Roofing warranty periods do not match actual life cycle

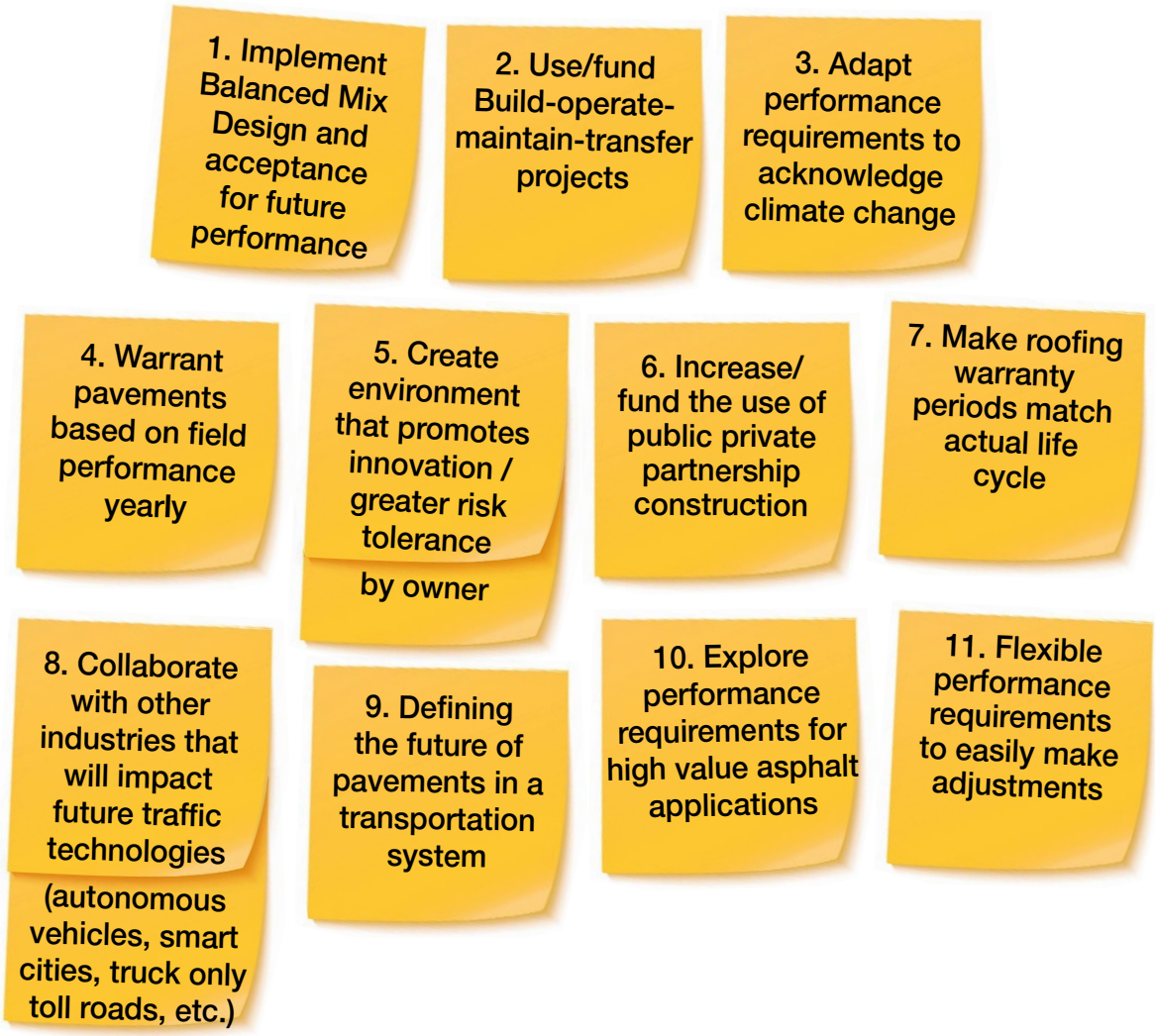

Too many opinions about performance expectations
Outdated specifications
Specification creep
Bureaucracy
Low bid system doesn't prioritize or verify performance
Predictive tests don't relate to performance
Focusing on specifications over finished product
Focusing on cost over finished product performance
Budget-based pavement thickness design
Disconnect between government and Standards bodies (ASTM, AASHTO, etc.)
Market-driven specifications
Wrong design assumptions
Lack of funding

PERFORMANCE REQUIREMENTS

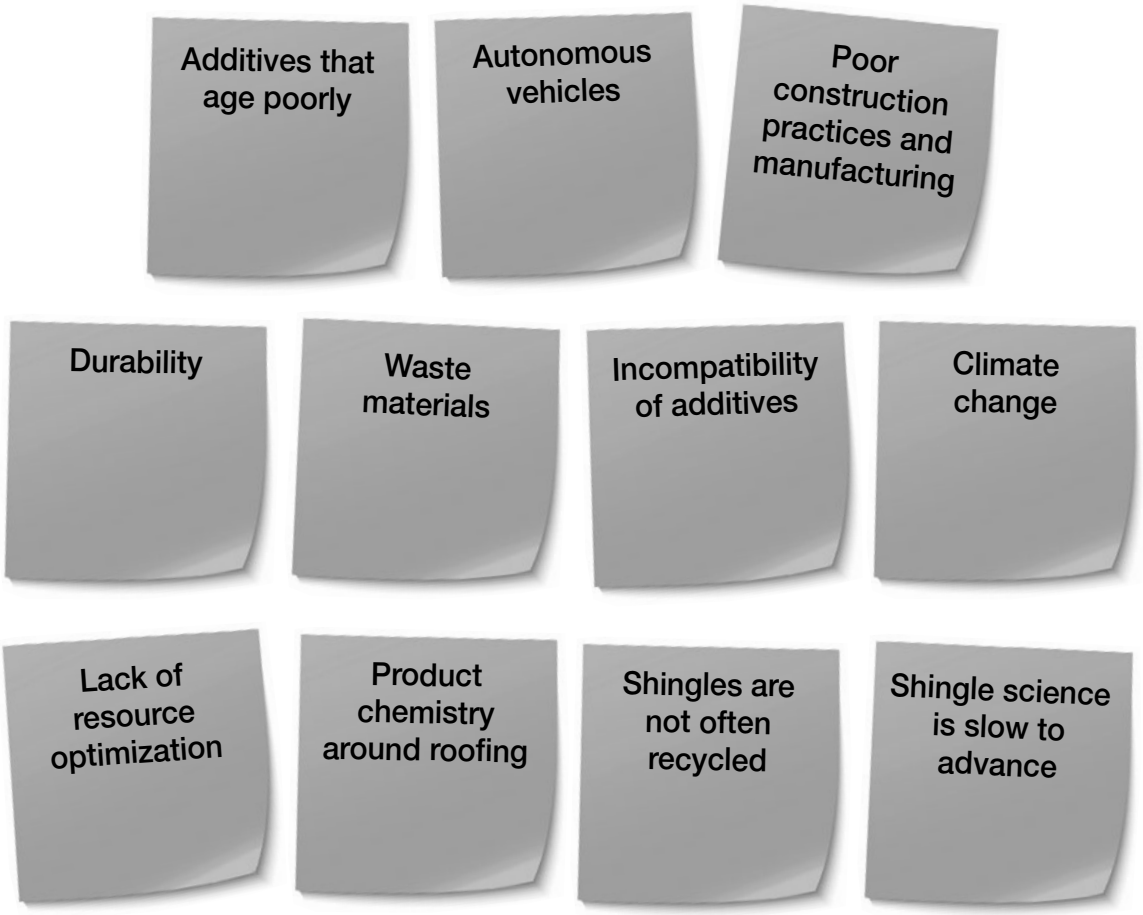


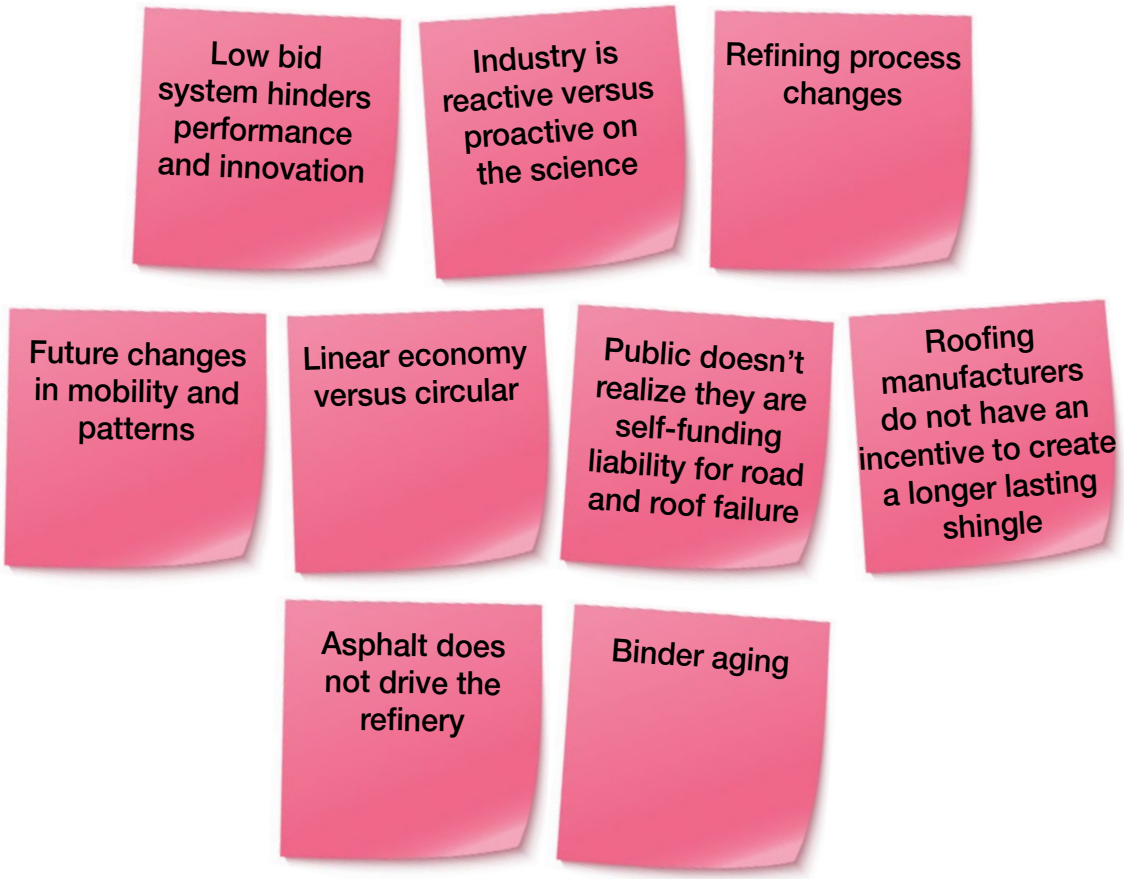
PERFORMANCE-BASED BIDDING

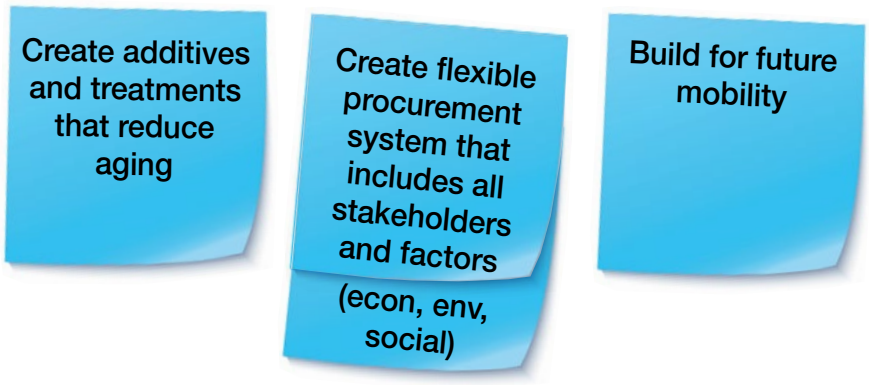
CONSUMER EXPECTATIONS

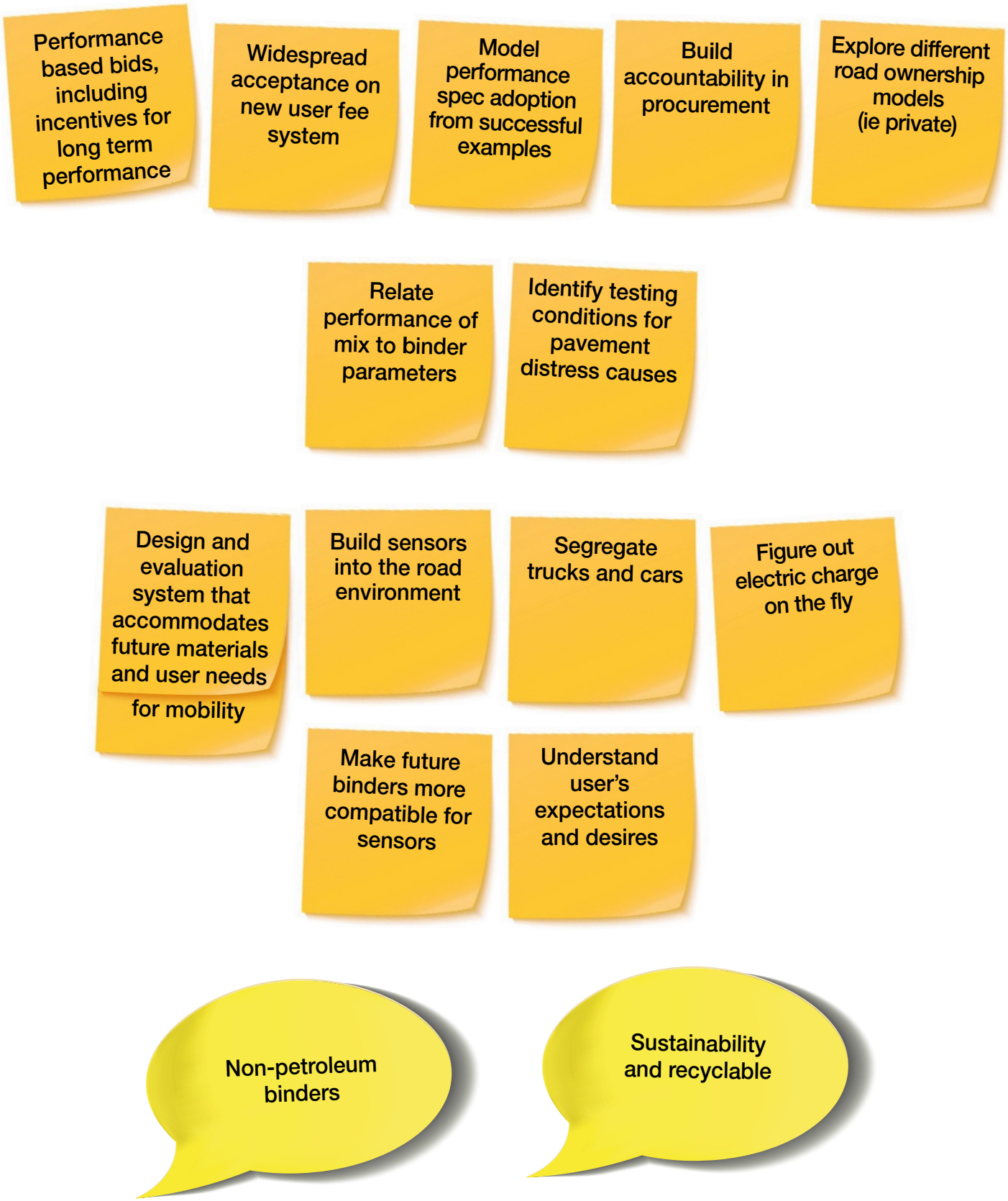

1. Implement Balanced Mix Design and acceptance for future performance
2. Use/fund Build-operate-maintain-transfer projects
3. Adapt performance requirements to acknowledge climate change
4. Warrant pavements based on field performance yearly
5. Create environment that promotes innovation / greater risk tolerance by owner
6. Increase/ fund the use of public private partnership construction
7. Make roofing warranty periods match actual life cycle
8. Collaborate with other industries that will impact future traffic technologies (autonomous vehicles, smart cities, truck only toll roads, etc.)
9. Defining the future of pavements in a transportation system
10. Explore performance requirements for high value asphalt applications
11. Flexible performance requirements to easily make adjustments

PERFORMANCE (DURABILITY) PERFORMANCE DRIVERS




Low bid system hinders performance and innovation
Industry is reactive versus proactive on the science
Refining process changes
Future changes in mobility and patterns
Linear economy versus circular
Public doesn't realize they are self-funding liability for road and roof failure
Roofing manufacturers do not have an incentive to create a longer lasting shingle
Asphalt does not drive the refinery
Binder aging


Create additives and treatments that reduce aging
Create flexible procurement system that includes all stakeholders and factors (econ, env, social)
Build for future mobility


Performance based bids, including incentives for long term performance
Widespread acceptance on new user fee system
Model performance spec adoption from successful examples
Build accountability in procurement
Explore different road ownership models (ie private)
Relate performance of mix to binder parameters
Identify testing conditions for pavement distress causes
Design and evaluation system that accommodates future materials and user needs for mobility
Build sensors into the road environment
Segregate trucks and cars
Figure out electric charge on the fly
Make future binders more compatible for sensors
Understand user's expectations and desires
Non-petroleum binders
Sustainability and recyclable

PERFORMANCE (DURABILITY) RECYCLED MATERIALS

OTHER

- How to enhance in-place recycling technologies?
- DOTs control how much RAP and RAS can be recycled.
- There is a negative perception with recycling RAP or RAS back into roads and roofs.
- How do we optimize our production plants to recycle more?

PERFORMANCE

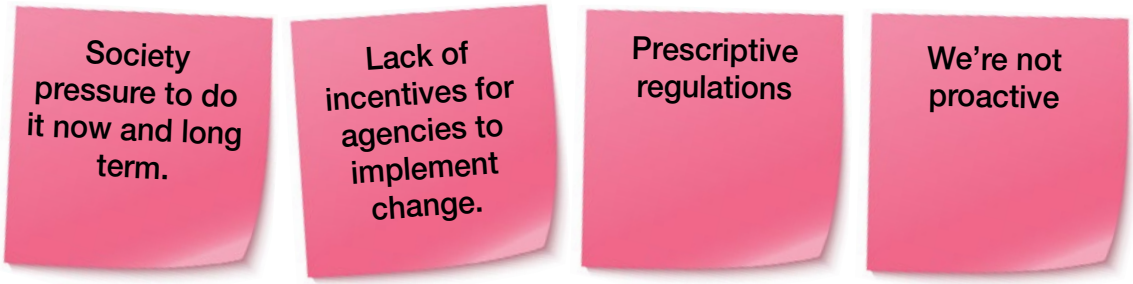
- How do new recycled materials age?
- Some of the recycled materials compromise recyclability of asphalt.
- When recycled materials are used they are overheated.
- What are the new approaches/ tests we have to develop to evaluate new materials for performance?
- Will new recycled materials (RAP) contribute the same to asphalt as they currently do?
- We don't have boundaries for recycling other materials in roads/
- How many times can we re-re-recycle these materials?
- What is the real impact on sustainability?

INVESTMENT

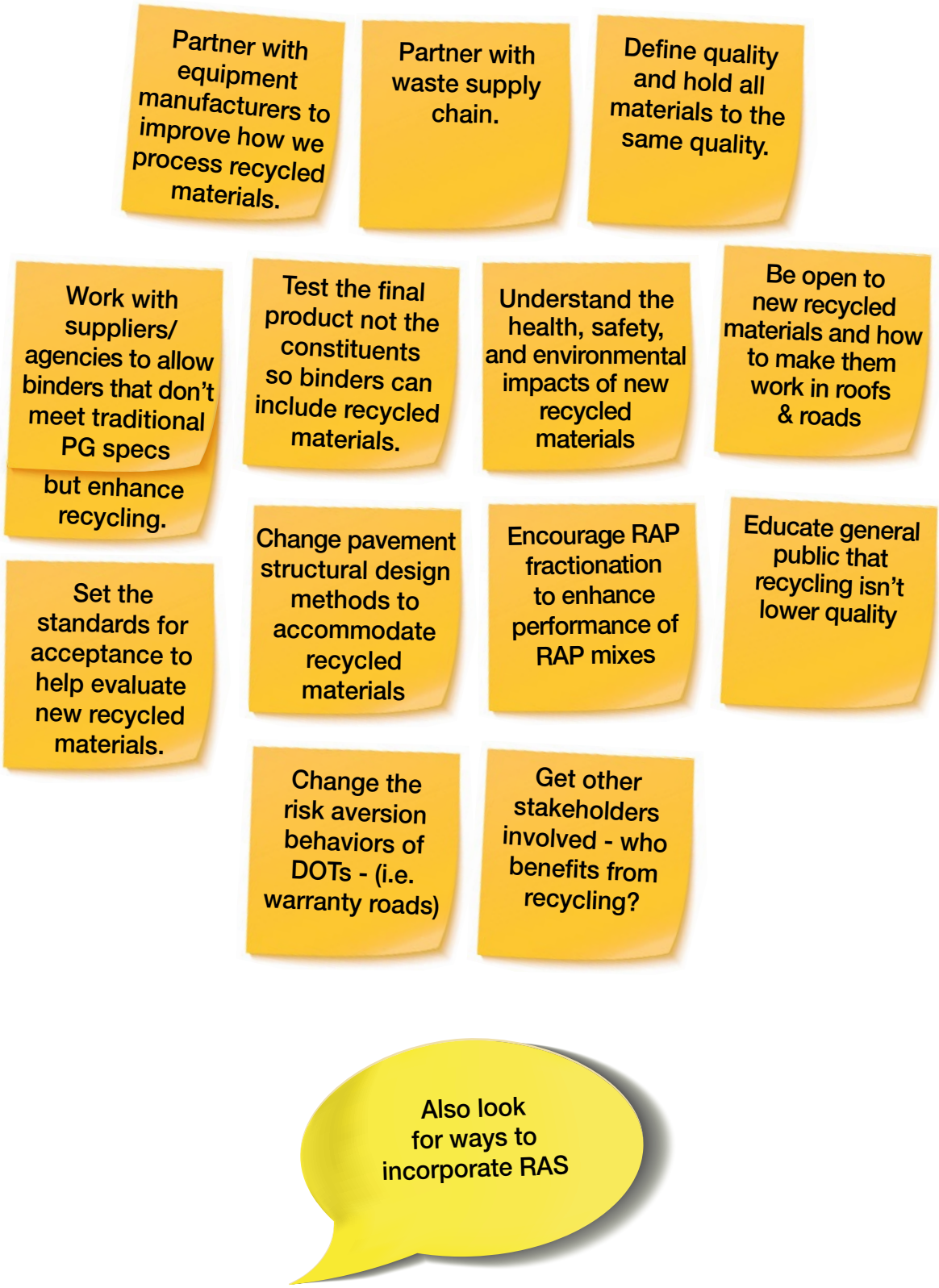
- What is the return of investment by using recycled materials?
- Are roads the best place for some of these recycled materials?

QUALITY & PERFORMANCE

PRESSURES

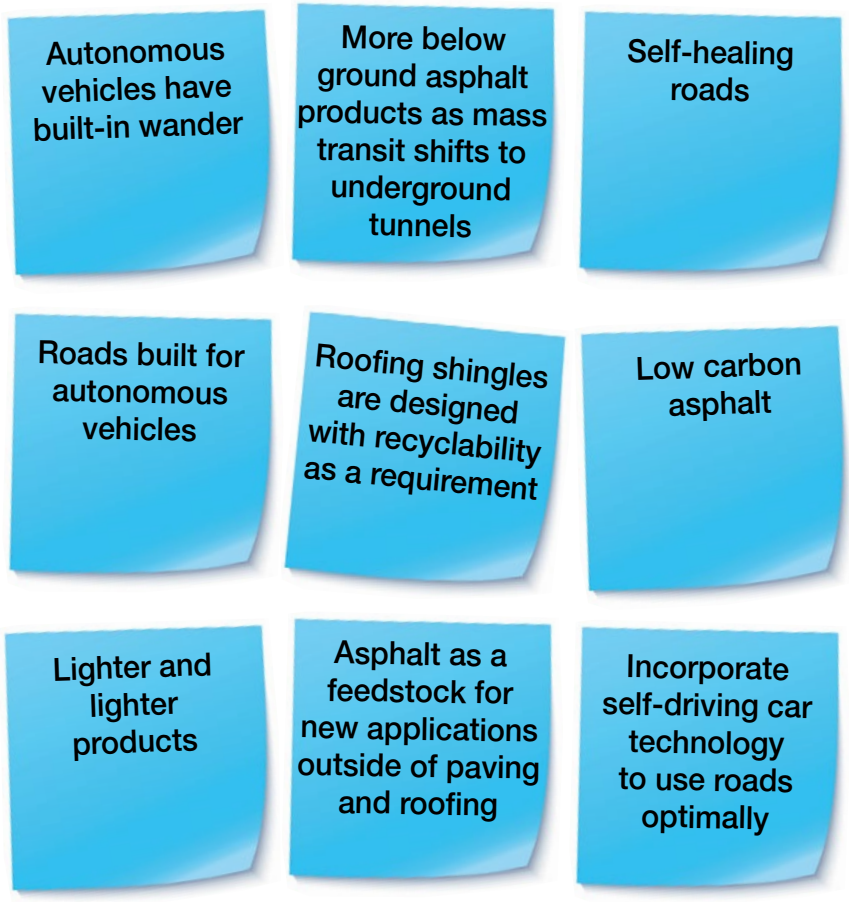


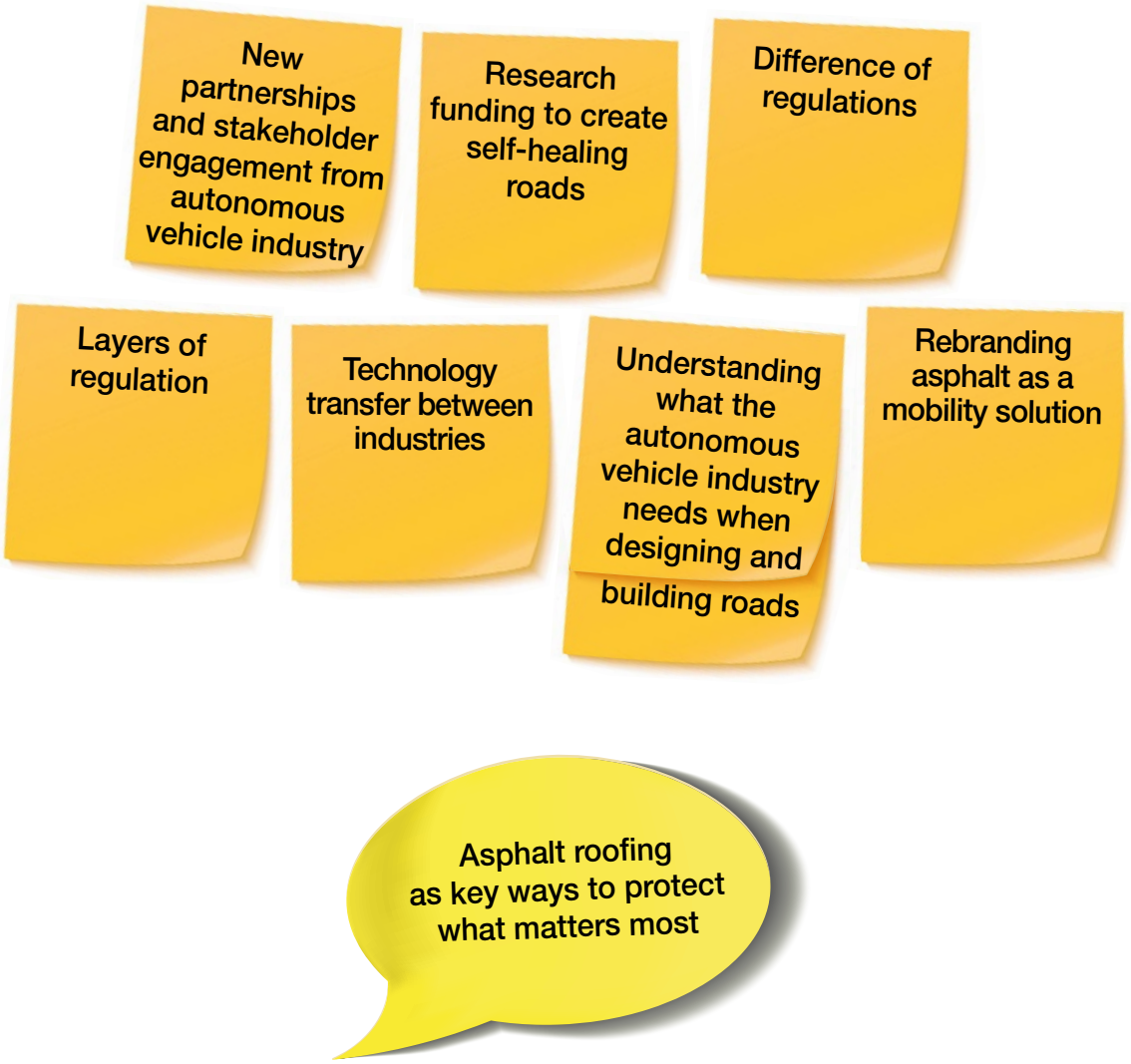

Have intuitively simple methods for recycling.
Selection of technology based on a life cycle cost analysis.
Zero downcycling.
Enhance quality of recycled materials before adding them to roads.
Build roads and roofs to have a longer life, lower cost, lower environmental footprint.
Our industry will solve other industry's recycling problems without creating more problems for us.


Partner with equipment manufacturers to improve how we process recycled materials.
Partner with waste supply chain.
Define quality and hold all materials to the same quality.
Work with suppliers/ agencies to allow binders that don't meet traditional PG specs but enhance recycling.
Test the final product not the constituents so binders can include recycled materials.
Understand the health, safety, and environmental impacts of new recycled materials
Be open to new recycled materials and how to make them work in roofs & roads
Set the standards for acceptance to help evaluate new recycled materials.
Change pavement structural design methods to accommodate recycled materials
Encourage RAP fractionation to enhance performance of RAP mixes
Educate general public that recycling isn't lower quality
Change the risk aversion behaviors of DOTs - (i.e. warranty roads)
Get other stakeholders involved - who benefits from recycling?
Also look for ways to incorporate RAS

PERFORMANCE (DURABILITY) FUTURE USE


Delivery system is geared for vehicles not multifunctional pavements i.e. stormwater etc.
Constrained by already built roads
Making a new technology of asphalt cost effective for future use
Lack of research funding for newer asphalt
American public does not want to deviate away from roads
Gen Z does not want to drive - could impact future travel
How do we access roofs
Different use of roads
Functionality of ownership is siloed between different organizations
Roofs get smaller - subs get more affordable
Using asphalt roofs for roof gardens
Private v. Commercial funding
Roads are a barrier for other uses
Less Wander = More rutting


Autonomous vehicles have built-in wander
More below ground asphalt products as mass transit shifts to underground tunnels
Self-healing roads
Roads built for autonomous vehicles
Roofing shingles are designed with recyclability as a requirement
Low carbon asphalt
Lighter and lighter products
Asphalt as a feedstock for new applications outside of paving and roofing
Incorporate self-driving car technology to use roads optimally


New partnerships and stakeholder engagement from autonomous vehicle industry
Research funding to create self-healing roads
Difference of regulations
Layers of regulation
Technology transfer between industries
Understanding what the autonomous vehicle industry needs when designing and building roads
Rebranding asphalt as a mobility solution
Asphalt roofing as key ways to protect what matters most

PERFORMANCE (DURABILITY) PREDICTIVE TESTING

INADEQUATE ACCEPTANCE

- Loosely related to performance
- Predictive testing not universally accepted
- Failure to define performance with acceptable accuracy

ORGANIZATIONAL CHALLENGES

- Not sure on what we want to predict
- Predictive tests dependent on material and properties
- Lack of information collection (low sample size, long-term performance not included)
- Perception Problem

LAB VS FIELD

- Field environment cannot be replicated in lab
- Rely on lab specimens, jump to simplest surrogate
- Aging not characterized properly
- Material properties not translated to pavement properties and the effects of construction

METHODOLOGICAL CHALLENGES

- Simplest test for complex prediction
- Lack of data on underlying materials
- Lack of consistency in determining meaningful predictor
- Variability

MODELING

- Doubts around adequacy of existing predictive models
- Large datasets required are time-consuming and expensive to create

LAB VS FIELD/PLANT

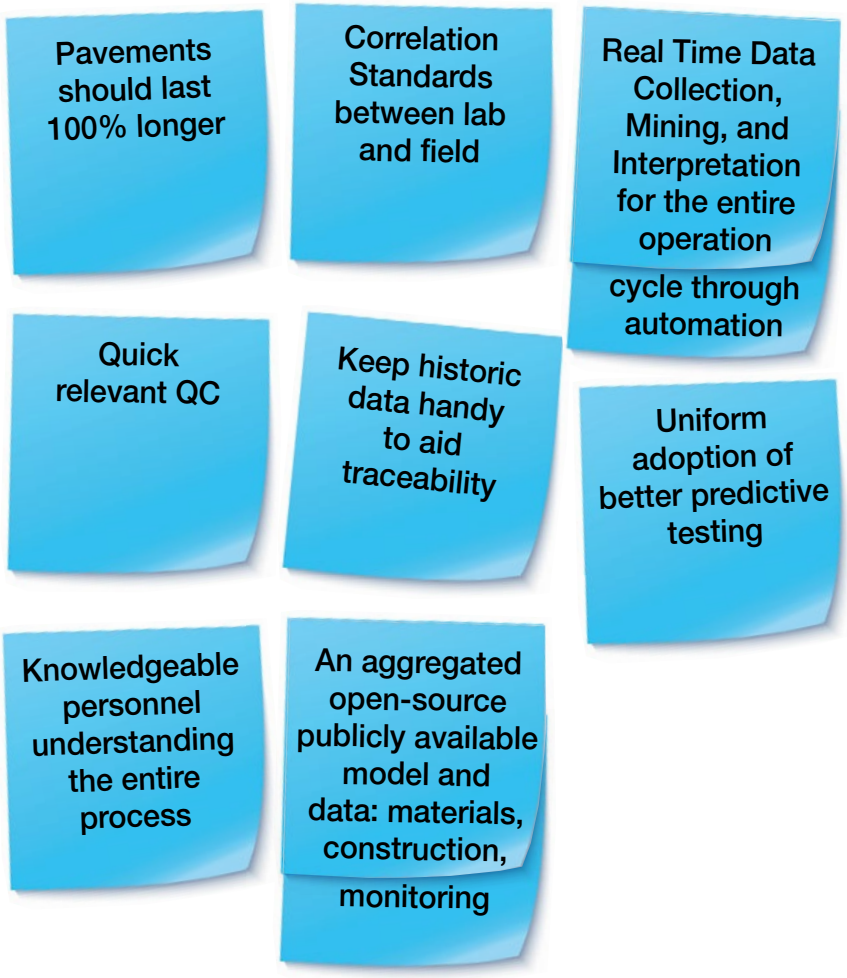
- Lack of communication between lab and field personnel
- Field/Plant environment cannot be replicated in lab
- Indeterminate correlation between testing conditions

ORGANIZATIONAL CHALLENGES

- Lack of Industry wide co-operation/ agreement on standard testing
- Working in silos and non-availability of consistent data
- Underestimate potential of lab personnel predicting properties
- Not sure what the acceptable accuracy is

METHODOLOGICAL CHALLENGES

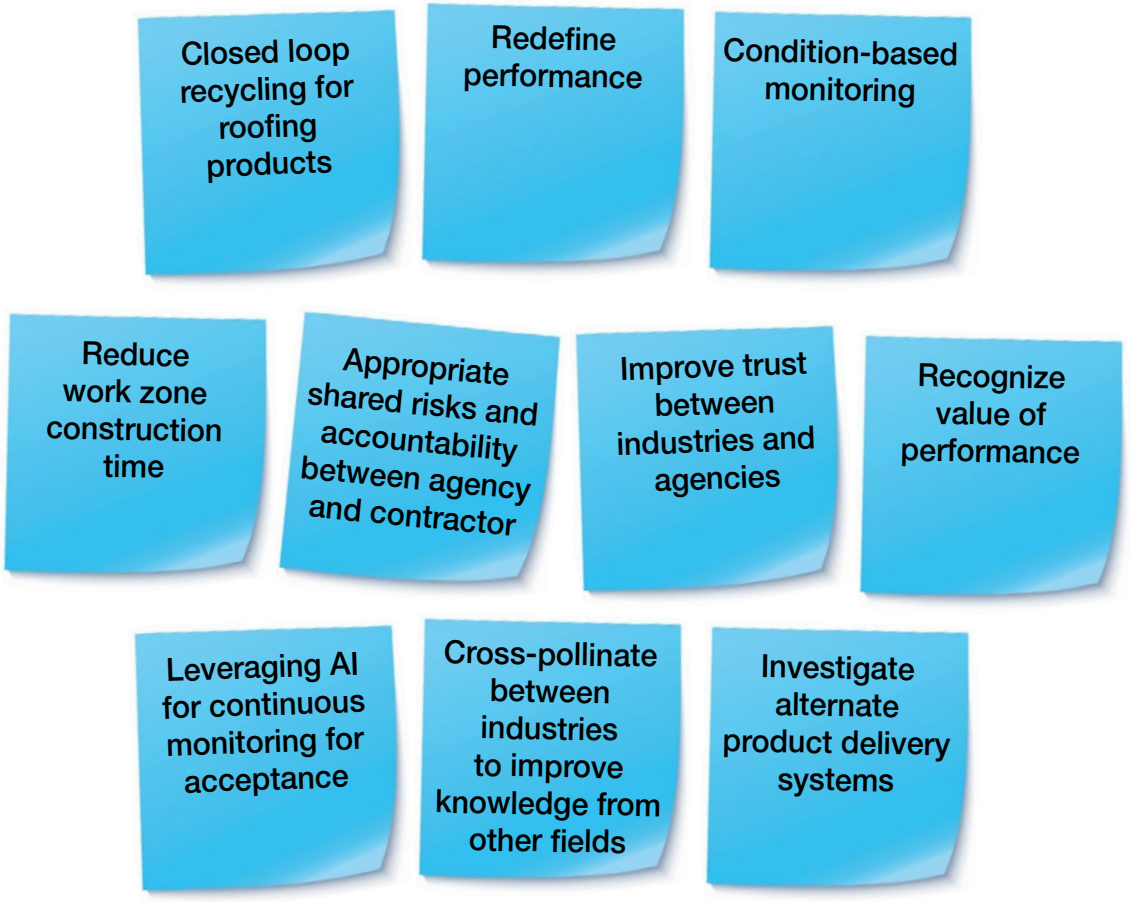
- Bad construction practices undermining good materials
- Lack of representative samples
- Lack of consideration of sunlight spectrum in performance prediction

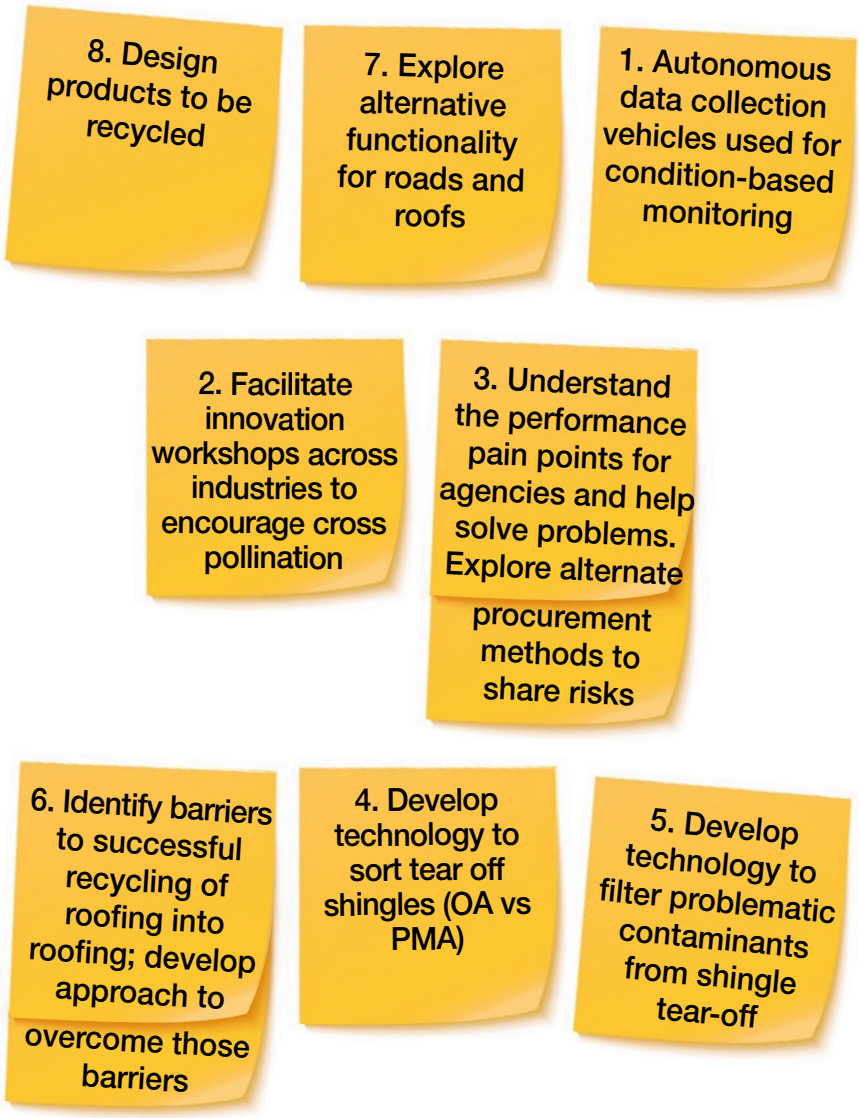

Pavements should last 100% longer
Correlation Standards between lab and field
Real Time Data Collection, Mining, and Interpretation for the entire operation cycle through automation
Quick relevant QC
Keep historic data handy to aid traceability
Uniform adoption of better predictive testing
Knowledgeable personnel understanding the entire process
An aggregated open-source publicly available model and data: materials, construction, monitoring


1. Create tools to predict pavement service life
2. Collaborating with Asset Management Team
3. Artificial Intelligence for pavement management system
4. Collaboration with global set of Road Owners, industry, Academia for next generation testing
5. Efficient management of data systems collecting, storing pavement management data
6. Cross training and involvement for lab personnel
7. Establish data governance standards: promote altruistic, trustworthy, and transparent data science models to predict performance
8. BIM for Pavements (Include whole life cycle)
9. Tie predictive testing to warranty of pavements (include warranty within bid process)
10. Develop new predictive tests that evaluates performance after the placement
A. Collaborating with Asset Management Team. Collaboration with global set of Road Owners, industry, Academia for next generation testing. Establish data governance standards: Promote altruistic, trustworthy and transparent data science models to predict performance
B. Artificial Intelligence for Pavement Management System. Efficient management of data systems collecting, storing pavement management data. BIM for Pavements (Include whole life cycle)
C. Training and collaboration to ensure consistent results from all parties
D. Develop new predictive tests that evaluates performance after the placement. Create tools to predict pavement service life
E. Develop Systems/ Promote/ Review for Site Investigation
BIM Strategic Roadmap
Building Information Modeling (BIM) for Infrastructure Overview
Analysis tools
Pavements and Materials data, data governance, and data standards are a large gap in the overall BIM for Infrastructure National Strategic Roadmap efforts. Pavement data needs to be accessible and leveraged for data driven decisions across the whole asset lifecycle and included in BIM efforts.

PERFORMANCE (DURABILITY) OTHER

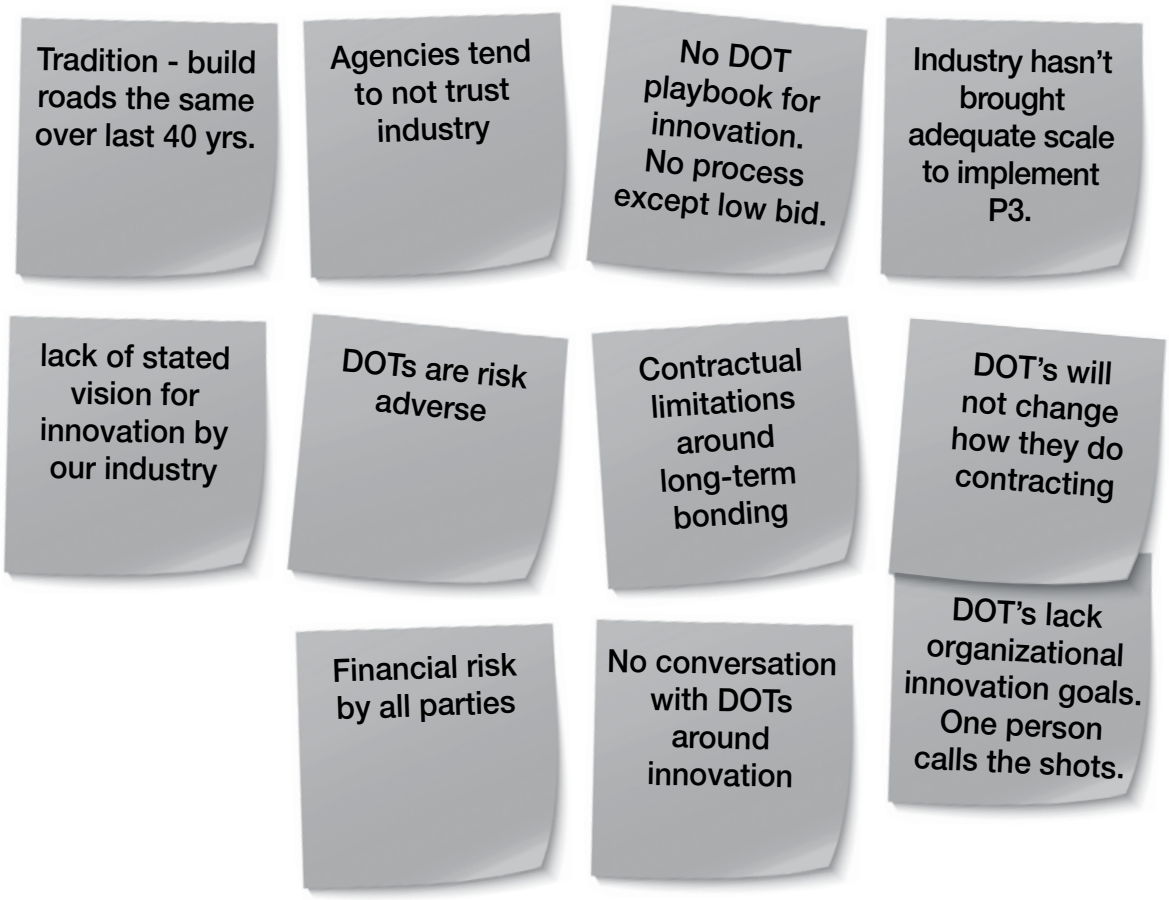

Don't measure performance
Cost/time for agency monitoring and follow up
No financial responsibility or accountability
Development and innovation constraints
What will binders look like in 20 years?
Low cost/low bid
Reactive rather than proactive mindset to design
What will asphalt mixtures look like in 20 years?
Lack of maintenance
Unwillingness to take risks to improve performance
Outdated research
Neglect implementation of research
Don't make use of knowledge from other fields


Closed loop recycling for roofing products
Redefine performance
Condition-based monitoring
Reduce work zone construction time
Appropriate shared risks and accountability between agency and contractor
Improve trust between industries and agencies
Recognize value of performance
Leveraging AI for continuous monitoring for acceptance
Cross-pollinate between industries to improve knowledge from other fields
Investigate alternate product delivery systems

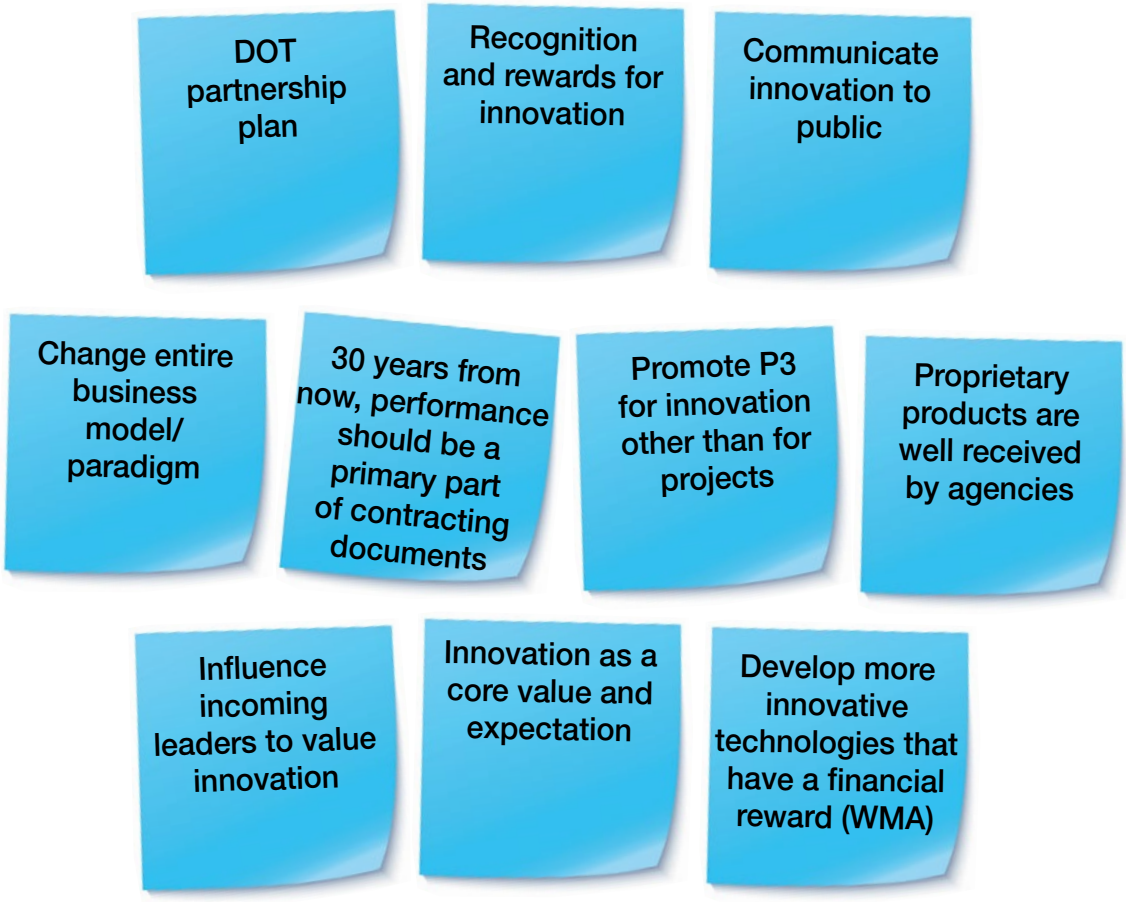

8. Design products to be recycled
7. Explore alternative functionality for roads and roofs
1. Autonomous data collection vehicles used for condition-based monitoring
2. Facilitate innovation workshops across industries to encourage cross pollination
3. Understand the performance pain points for agencies and help solve problems. Explore alternate procurement methods to share risks
6. Identify barriers to successful recycling of roofing into roofing; develop approach to overcome those barriers
4. Develop technology to sort tear off shingles (OA vs PMA)
5. Develop technology to filter problematic contaminants from shingle tear-off

MURAL SUPPLEMENT

ECONOMICS (INFRASTRUCTURE POLICY AND FUNDING)
INCENTIVIZE INNOVATION

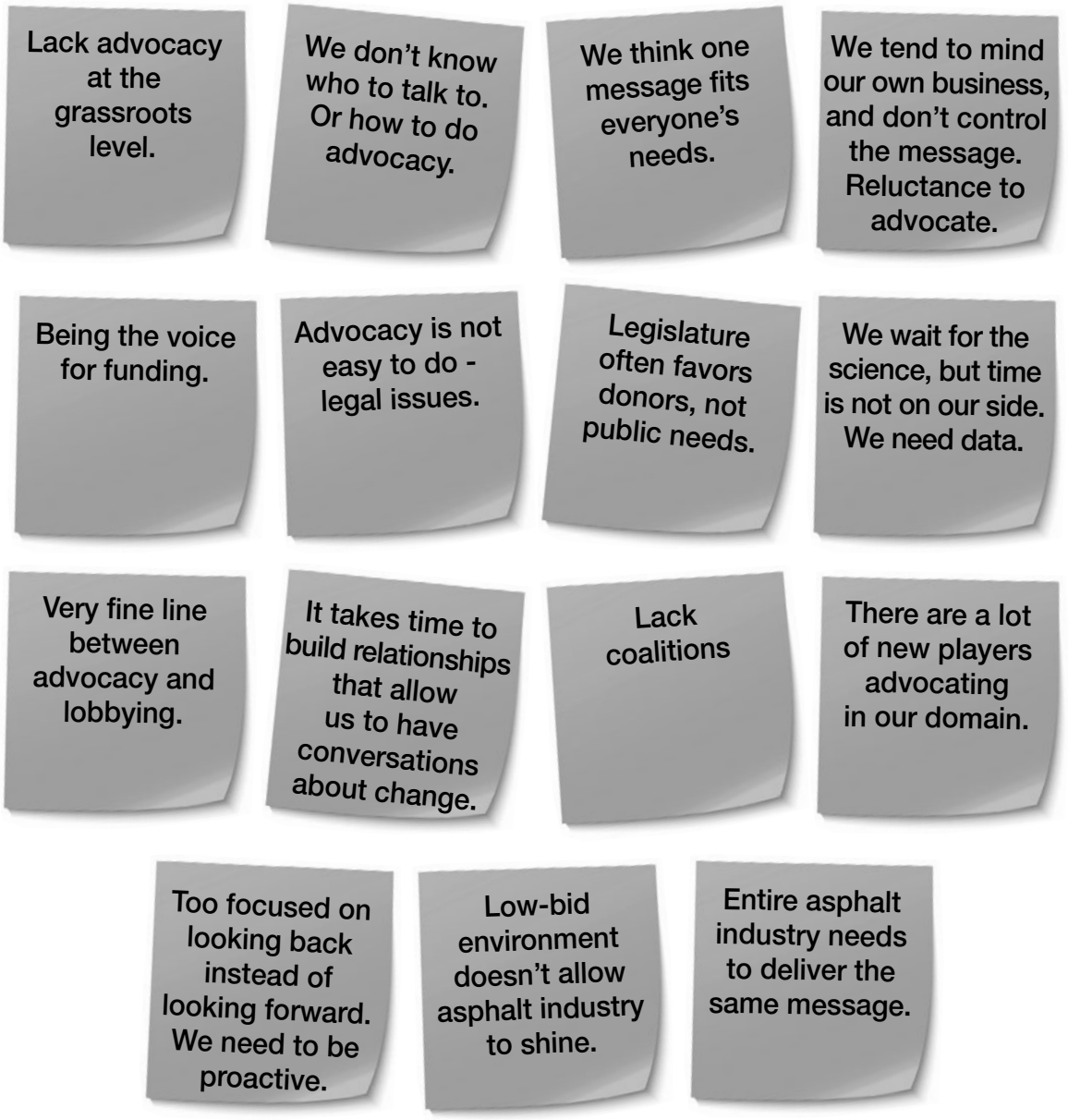



Not enough of our industry is knowledgeable enough for real innovation
Specs are written around recipe and meeting minimum criteria
Gap between what buyer specifies and what industry can produce
DOTs are driven by low cost and meeting specs. Performance not part of decision
Lack of leadership and willingness to change
Lack of trust between interested parties
No payback for innovation


DOT partnership plan
Recognition and rewards for innovation
Communicate innovation to public
Change entire business model/ paradigm
30 years from now, performance should be a primary part of contracting documents
Promote P3 for innovation other than for projects
Proprietary products are well received by agencies
Influence incoming leaders to value innovation
Innovation as a core value and expectation
Develop more innovative technologies that have a financial reward (WMA)


Build lease model where Govt leases land and contractor owns road
Create culture of recognizing failure as part of innovation
Work with AASHTO leaders and FHWA to include performance in contracting methods
How do we get more value engineering
Figure out how to change DOT culture of being risk adverse
Move toward more true performance parameters in specs
Work with DOTs to have innovation included in job descriptions
Partner with Big Innovative Companies (Amazon) to advocate for good roads and funding
Fund implementation of innovative research

ECONOMICS (INFRASTRUCTURE POLICY AND FUNDING)
ADVOCACY




Our broader industry doesn't want change because of cost and risk.
We don't communicate to the public in language they understand.
We lack the right skills to communicate to the public.
Public takes roads for granted. Unless there's a problem.
We've put ourselves in a "non-lobbying" box.
We're not advocating to the local people - they can be the voice.
We leave the advocacy to associations only.
We're not proactive.
Public lacks basic knowledge about roads/ infrastructure.
Alignment of message between different associations.


Unified message among industry associations.
Action based advocacy from Government.
Look ahead and define key topics for 5-10 years
The public is our greatest advocate
Government trusts the asphalt industry
Eliminate negative pressure advocacy
Create messages that the oil companies can use for their businesses
We become a solution to the sustainability goals.


Partner with agency to deliver message to the public
Foster collaborative advocacy with governments

ECONOMICS (INFRASTRUCTURE POLICY AND FUNDING)
ADVOCACY

POLITICAL/LEADERSHIP

- Government/ Political standpoint preventing sustainability funding
- Sustainability made political
- Sustainability/ EPDs not a priority in a low-bid system/ specifications
- Sustainability not driven by top-down/ bottom-up approach
- No initiative from Industry

COMPLEXITY

- Sustainability is complex
- Lack of consensus on measuring carbon/ sustainability metrics
- Federal/state DOTs don't have in-house expertise to implement sustainability

ECONOMICS

- No standard definition on non-monetary incentives?
- Sustainability will cost more perception

EXPOSURE/BENCHMARK

- No Baseline set for binder emissions
- No standardized data model/ format to quantify sustainability
- Goals within sustainability not specifically defined, Value not defined properly
- No sufficient exposure to sustainable technologies/ materials


Industry stuck in its own paradigms - looking backwards not proactive/lack of personal ownership
Lack of education on sustainability being a priority
Lack of a clear definition of sustainability
Lack of public education on holistic nature of sustainability (need to have long-lasting pavements)
No standardized value assigned to sustainability
No unified front from both top-down and bottom-up within the industry leading to zero implementation
Lack of bottom-up drive from public towards sustainability
Sustainability has no end point: it is a process
Misconception on being green inversely related to cost
Human Nature: Change is hard, not scared enough around climate change
Politics around sustainability/ sensitive to political climate
Lack of accountability around sustainability
Organizational approach may not align with sustainability
Lack of trade-off examples around sustainability: trust issues

EDUCATION/CONSENSUS

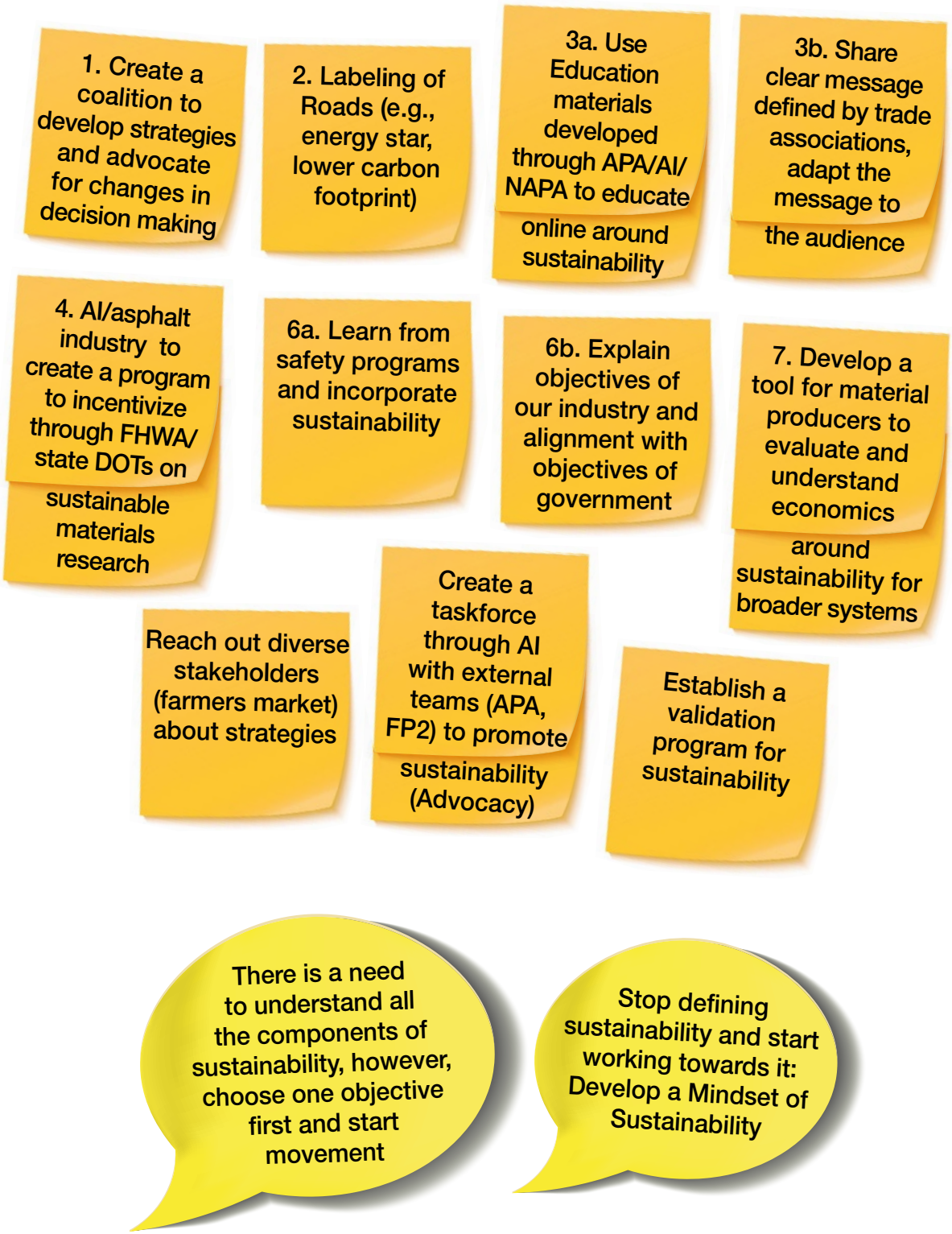
- Standard definition for sustainability with monetary incentives
- Industry sustainability vision clearly defined
- Consensus on the value of the environmental and societal impact

WELL-INFORMED STAKEHOLDERS

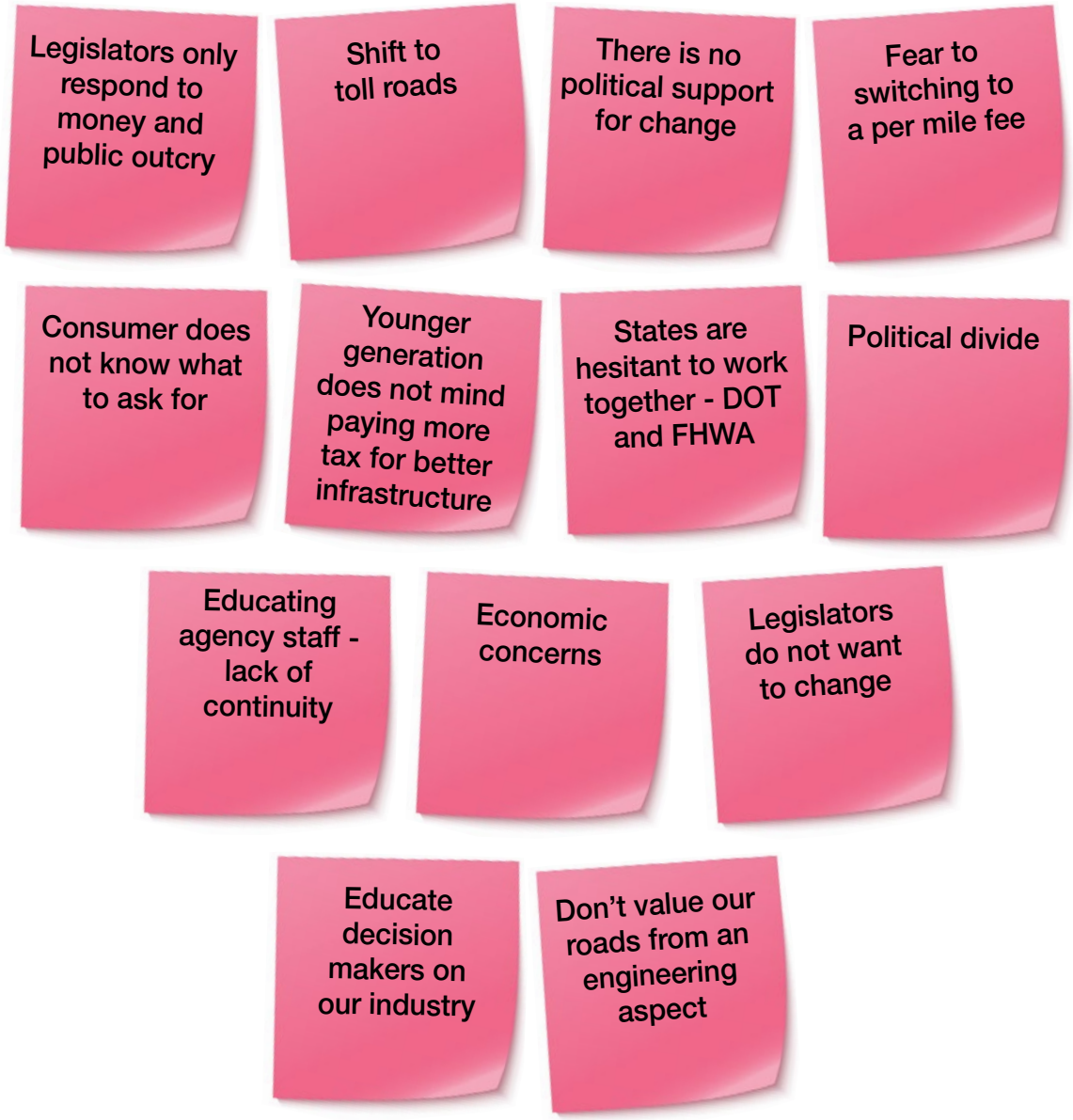
- Find the Who first then the How
- Agency decision makers are educated on operationalizing sustainability
- Educate general public

SUSTAINABILITY IN DECISION-MAKING

- Planning horizon much longer
- *Incorporating sustainable values within industry*
- All tenders include sustainability value component that can determine awarding of a contract
- Sustainability Culture is strong as Safety Culture


1. Create a coalition to develop strategies and advocate for changes in decision making
2. Labeling of Roads (e.g., energy star, lower carbon footprint)
3a. Use Education materials developed through APA/AI/ NAPA to educate online around sustainability
3b. Share clear message defined by trade associations, adapt the message to the audience
4. AI/asphalt industry to create a program to incentivize through FHWA/ state DOTs on sustainable materials research
6a. Learn from safety programs and incorporate sustainability
6b. Explain objectives of our industry and alignment with objectives of government
7. Develop a tool for material producers to evaluate and understand economics around sustainability for broader systems
Reach out diverse stakeholders (farmers market) about strategies
Create a taskforce through AI with external teams (APA, FP2) to promote sustainability (Advocacy)
Establish a validation program for sustainability
There is a need to understand all the components of sustainability, however, choose one objective first and start movement
Stop defining sustainability and start working towards it: Develop a Mindset of Sustainability

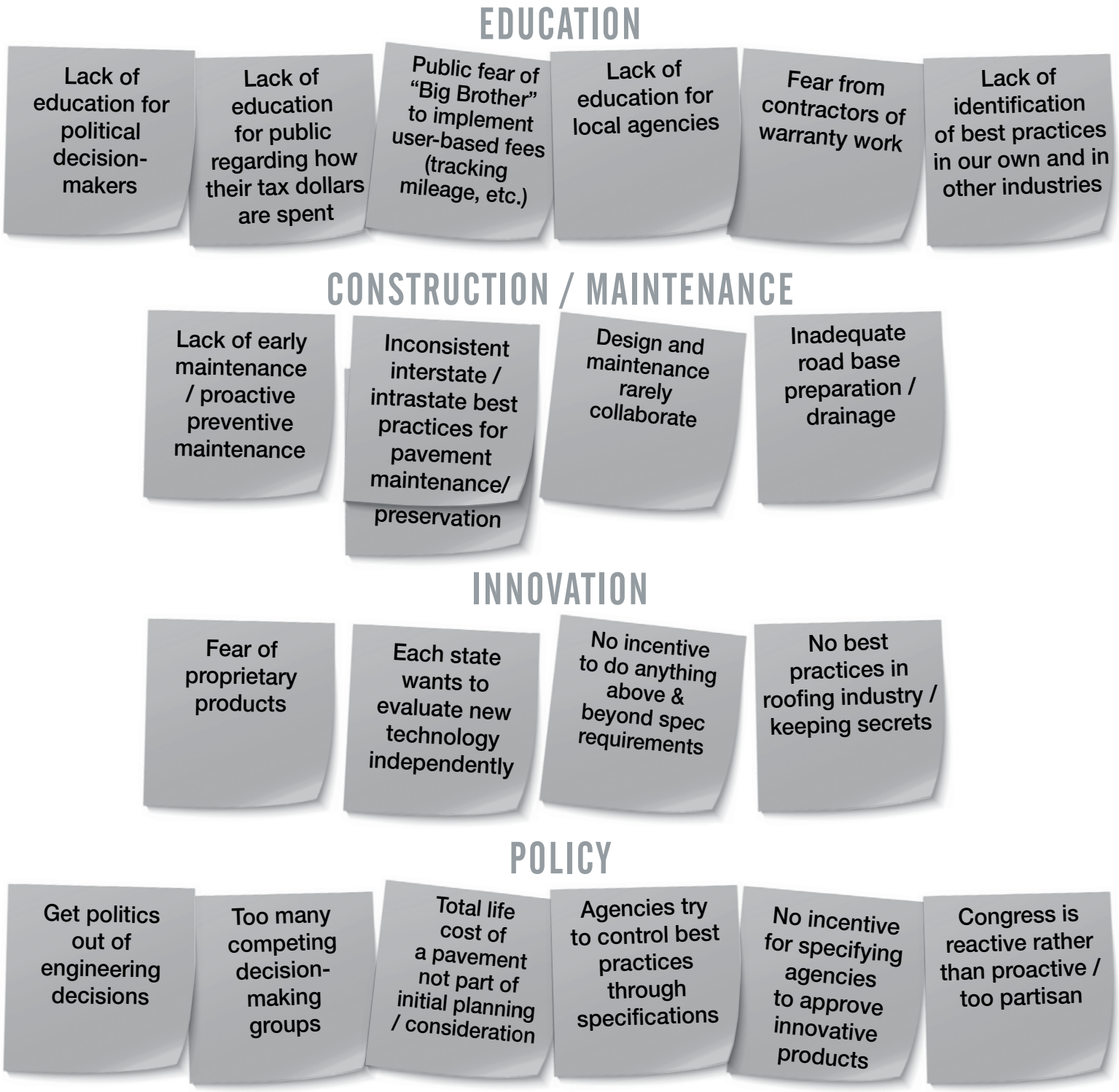
ECONOMICS (INFRASTRUCTURE POLICY AND FUNDING)
EDUCATE DECISION-MAKERS


Legislators only respond to money and public outcry
Shift to toll roads
There is no political support for change
Fear to switching to a per mile fee
Consumer does not know what to ask for
Younger generation does not mind paying more tax for better infrastructure
States are hesitant to work together - DOT and FHWA
Political divide
Educating agency staff - lack of continuity
Economic concerns
Legislators do not want to change
Educate decision makers on our industry
Don't value our roads from an engineering aspect


Have to get in front of decision makers
Visionary leader to improve infrastructure
Global influencer to advocate on our behalf i.e. Bill Gates, Elon Musk etc.
Provide examples of our successes/ innovations
Broad goal would be to keep congress focused on infrastructure
Trusted resource for decision makers
Talk to decision makers, we need to move up the list
Motivate legislators
Educate general public on the value of roads


Different funding mechanism for policy changes
We need to know the needs for the autonomous vehicle industry
Education seminar/ workshop for DOT/FHWA aimed at legislators
Connect with transporters to advocate for better infrastructure
Promote our industry - Roads are important
For roofing: working with insurance companies and contractors
Roofs are used every day

ECONOMICS (INFRASTRUCTURE POLICY AND FUNDING)
BEST PRACTICES



INABILITY TO COMMUNICATE / TRUST

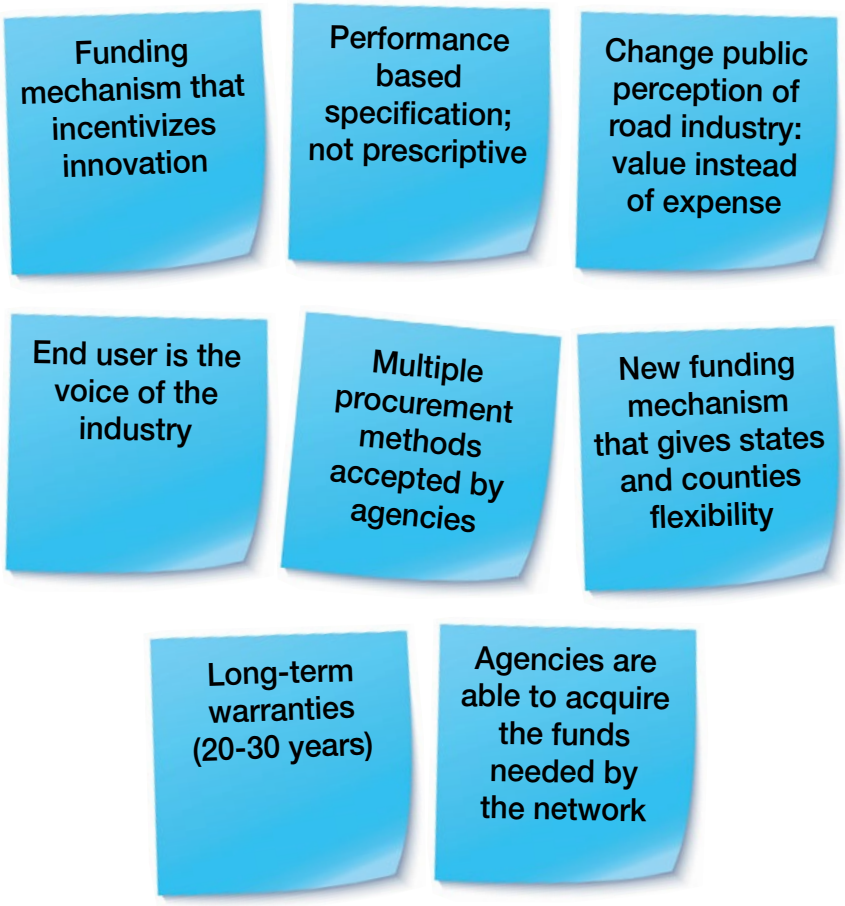
INABILITY TO CHANGE


Incentivize industry sharing of best practices
Recognize there is no end point
Become proactive in all aspects of our industry
Get out of comfort zone
Create loud, clear, consistent voice to communicate our message
Fully integrate pavement & materials data into Building Information Management
(BIM) for infrastructure as a construction best practice
Compile and use data for best practices
Funding policy should be economically, environmentally, socially responsible
Provide more leadership from our industry
Take responsibility for our own actions /stop finger pointing/perform to highest ethical level at all times
Create some mechanism or forum for discussion / partnership
Total commitment
Be more strategic / future-thinking in discussions
Build and grow relationships within industry and owners and all stakeholders


1. Implement similar strategic planning symposiums to identify points of alignment
2. Develop leadership certification for innovation
3. Encourage user/producer groups to prioritize sharing of best practices
4.Create an innovation department within each DOT / organization
6. Identify / provide more targeted training of impact of best practices on economics
7. Invite agencies to strategic planning events
8. Encourage / require LTAPs to collaborate on how to optimize funding
9. Training agencies about ROI and net present value
10. Encourage agencies to develop long-term strategies (double-digit years in the future)
11. Encourage best practices in risk assessment
12. Create social media campaigns to educate general public about what is possible with proper design / maintenance (radio, internet, virtual reality, etc.)
13. Use Oculus / virtual reality for training /to bring users to jobsite / investigations
15. Take ideas to figure out the "how"

ECONOMICS (INFRASTRUCTURE POLICY AND FUNDING)
OTHER


Maintenance costs are high, little political incentive to fund until critical state (FAC)
Top-down approach to funding rather than collaborative
Short election cycle leads to focus on short term issues
Decoupling between engineer at decision level and broader policies
States and counties own the roads
Risk aversion by agency personnel and broader industry
Aversion to alternative procurement process
Too much inertia - takes effort to make changes
Limited taxpayer dollars available
No funding dedicated to innovation


Funding mechanism that incentivizes innovation
Performance based specification; not prescriptive
Change public perception of road industry: value instead of expense
End user is the voice of the industry
Multiple procurement methods accepted by agencies
New funding mechanism that gives states and counties flexibility
Long-term warranties (20-30 years)
Agencies are able to acquire the funds needed by the network

INNOVATION-DRIVEN FUNDING

1. Redefine structure of funding to agencies (more holistic view)

4. Conduct RCM & B-RCM pilot projects to prove and incentivize value of performance -based maintenance (FAC)

7. Explore alternative funding mechanisms based on movement of goods

RCM = reliability centered maintenance; B-RCM = backfilled reliability centered maintenance

TARGETED STAKEHOLDER PARTNERSHIPS

5. Partner with other industries to communicate value; other stakeholders (e.g. Amazon)

8. Build dedicated truck lanes

OUTREACH

2. Establish consistent messaging and strategy to build and maintain relationships

3. Develop course on infrastructure and how we pay for infrastructure in schools

6. Develop summary of different mechanisms to implement strategies

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