USING VALUE ANALYSIS TO IMPROVE THE SAFETY OF HIGHWAY MAINTENANCE

Canadian Value Symposium

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Overview

- *The issue with winter equipment visibility*
- *Brand Identity*
- *Literature Review*
- *The VA Workshop*
- *Workshop Results*
- *Proving Results (Follow-up Study)*
- *Implementation*

Winter Equipment Visibility – The Issue

- Snow removal equipment often operates under the most adverse conditions when conspicuity is most important

- Changes in delivery methods and equipment types have affected previous “brand identity” (yellow & black)
- Drivers are not always aware that they are approaching snow removal equipment
- Inappropriate driver reactions can lead to collisions

Loss of ‘Brand Identity’

What is it?... And what is happening?

Winter Equipment Visibility – The Response

- Agreed with industry to investigate and develop alternatives
- Held initial VA workshop in July to get the process started
- 4 of 5 AMC contractors participated and provided valuable input in generating ideas

Literature Review Conclusions

- Detection
  - LEDs recommended since brighter but concern re need for more frequent cleaning
  - Increasing intensity does not always improve detection due to threshold effect and can result in glare
  - Optimum detection requires different levels of intensity for day vs night
  - Blue most conspicuous colour day and night, and needs least intensity, thereby reducing glare

Literature Review Conclusions

- Detection
  - Short intense flash (i.e. strobes) evoked good detection but failed to convey closure rate
  - Second set of elevated stop-tail-turn and backup lights would assist under actual snow conditions
  - Strips of reflective tape should be added to the back of the snow plow box (concern re cleaning)

Literature Review Conclusions

- Recognition (hazard comprehension)
  - Stronger perception of hazard with combinations of yellow, blue and red, than with yellow alone
  - Suggested responses to red alone (78% indicated braking) were more dramatic than to yellow (42%) and blue (42%)
  - Connecting dots is important (lights + outline)
  - Brand (distinctive pattern) is helpful

Literature Review Conclusions

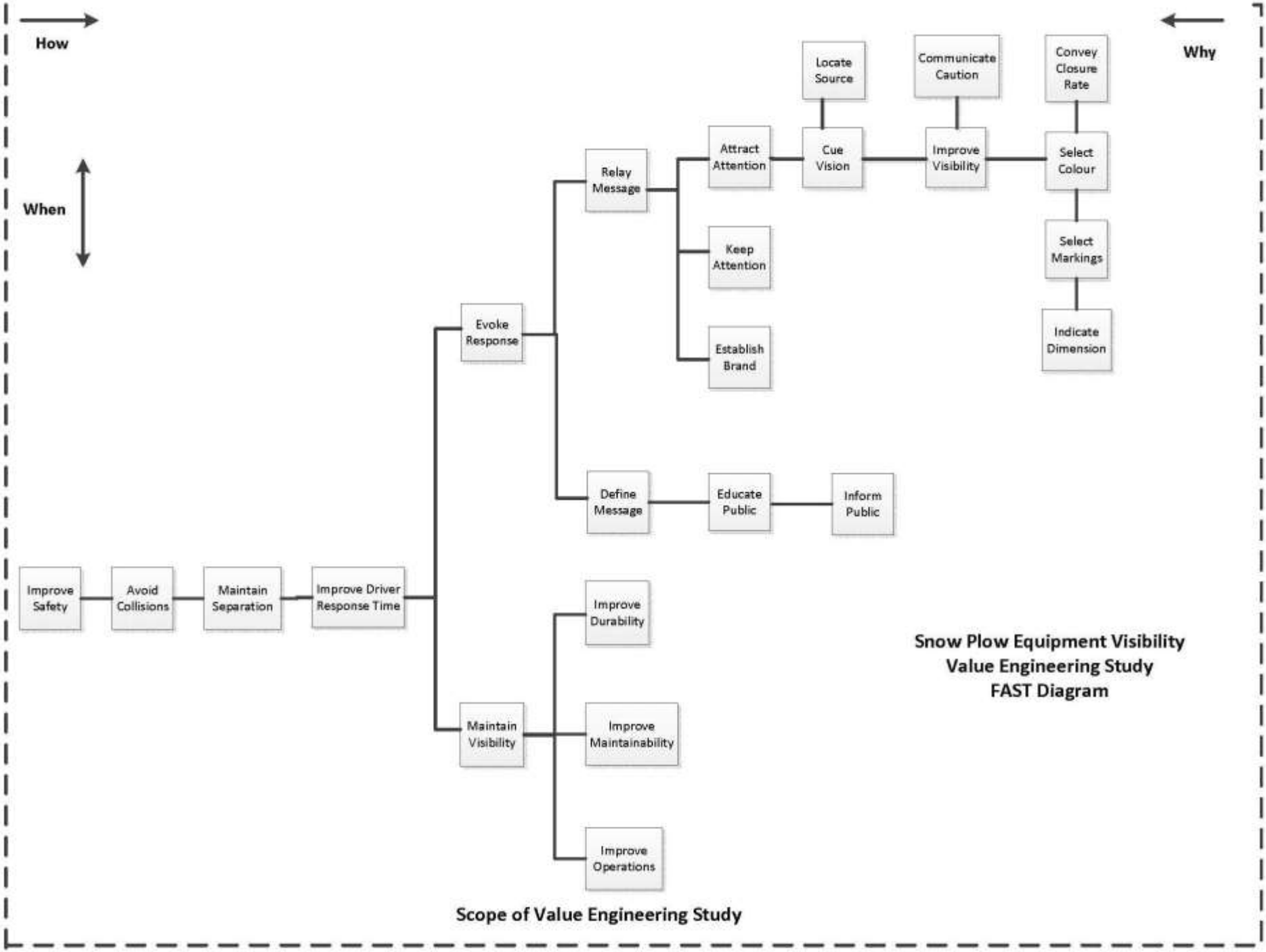
- Recognition (perception of closing speed)
  - Widely separated lights will give strongest cue
  - Retro-reflective contour markings assist at night
  - Longer duration lights (steady or incandescent) are better than short duration lights (strobe)

Literature Review Conclusions

- Decision
  - Slow/pass – dependent on driver awareness
- Response (speed, lane choice, lane changes)
  - Some evidence that
    - speed slower for yellow/blue combination than for yellow alone
    - yellow/blue/red is associated with greater brake activations than yellow alone
  - Light bar with 6 sequential flashers more effective than 4-way flashers re closing speed assessment
  - 4-way flashers and rotating single beacon also effective
  - Double flash strobes not effective

What We Need to Do?

- Grab the driver's attention (Detection)
- Allow the driver to locate the source (Recognition)
- Relay a message to the driver (Decision)
- Obtain the appropriate response (Response)


How
Why
When
Improve Safety
Avoid Collisions
Maintain Separation
Improve Driver Response Time
Evoke Response
Relay Message
Attract Attention
Keep Attention
Establish Brand
Cue Vision
Locate Source
Improve Visibility
Communicate Caution
Select Colour
Convey Closure Rate
Select Markings
Indicate Dimension
Define Message
Educate Public
Inform Public
Maintain Visibility
Improve Durability
Improve Maintainability
Improve Operations
Snow Plow Equipment Visibility
Value Engineering Study
FAST Diagram
Scope of Value Engineering Study

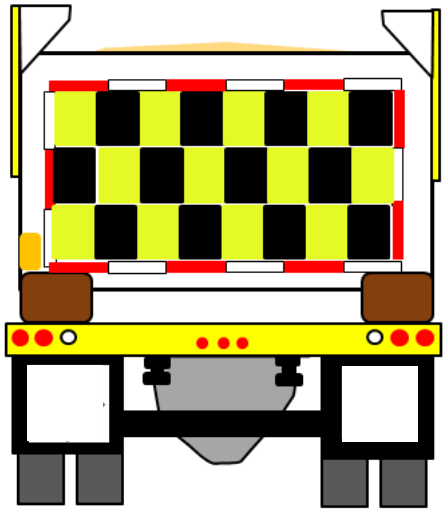
Summary of Creative Ideas

Value Target Areas	No. of Creative Ideas	No. of Ideas Developed	No. of Ideas Developed with Others
Improve Visibility (IV)	72	7	34
Maintain Safe Separation (MSS)	11	1	1
Educate Public (E)	31	8	15
Develop Standards (DS)	30	5	16
TOTAL	144	21	66

DEVELOPED PROPOSALS

Rear-End Markings

- Yellow-green on black checkerboard or similar to uniquely brand snow removal equipment
- Checkerboard can be attached by brackets to rear tailgate, and should fill the area of the tailgate or equivalent on the V-hopper or grader, with the exception of a border of red and white retro-reflective tape fully outlining the rear tailgate
- Need to verify colour combination



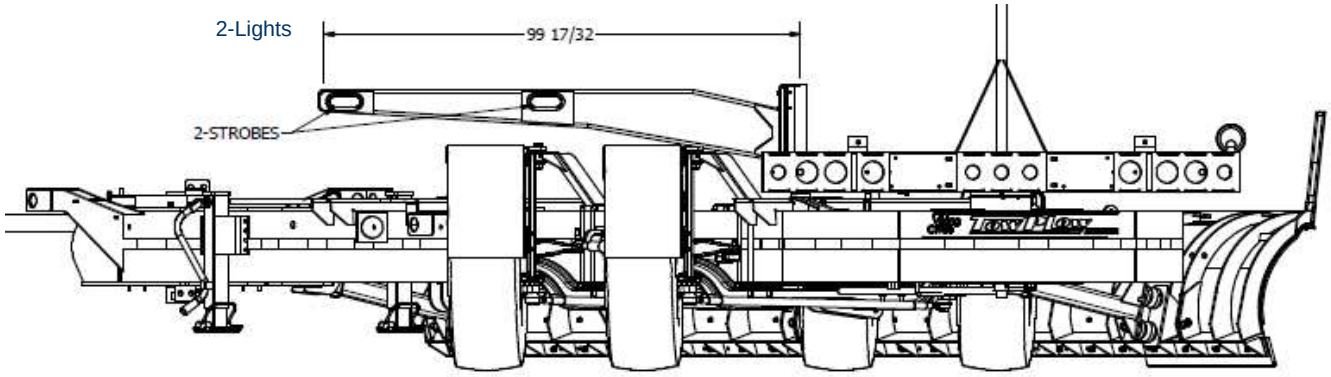
N.T.S.

Airfoils to Keep Snow off Back/Lights

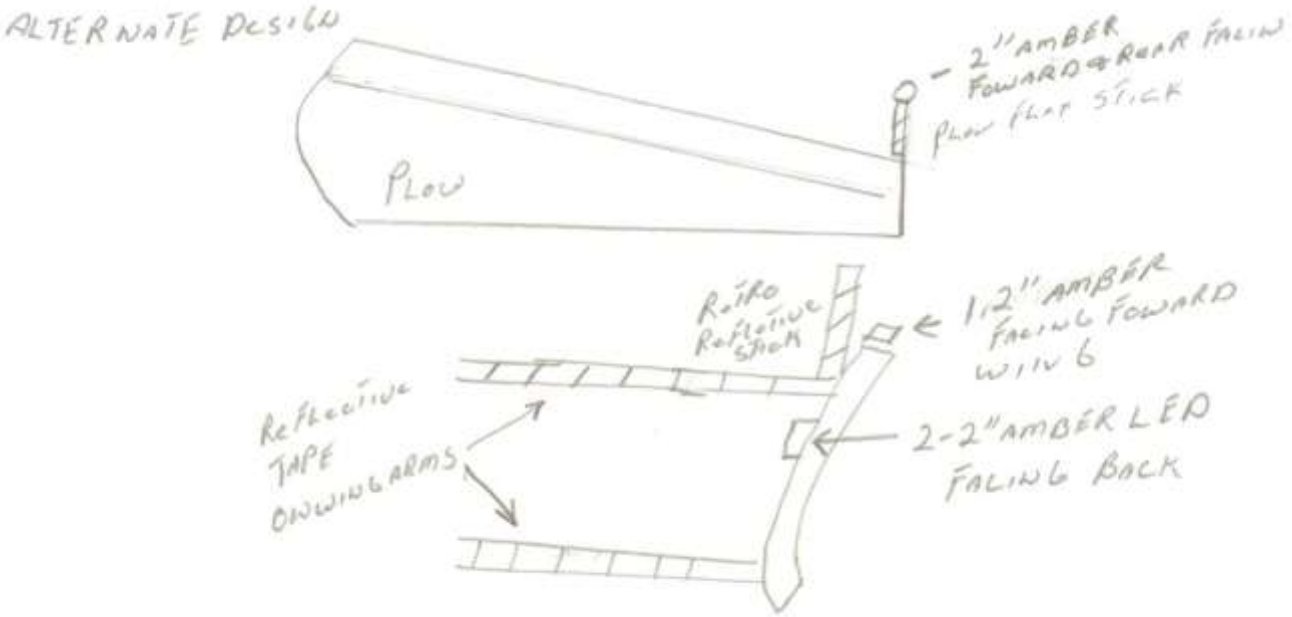
- This would give more visibility by helping keep lights and signs clear
- Alberta design is starting point

Tow Arm and Arm for Echelon Plowing

- The traffic arm would need to be lengthened to cover more of the lane that the Tow Plow was just occupying (the lane that the truck occupies)
- There would be a light at the tip of the traffic arm that would be visible from the rear regardless of position (working angle) of the Tow Plow
- Conspicuity tape would be placed along the length of the traffic arm that would show the physical length. The arm for Echelon plowing would be of similar design



Lighting on End of Tow Plow and Wing



Improved Lighting Conspicuity/Visibility on Rear of Snow Plow(s)/Spreader(s)

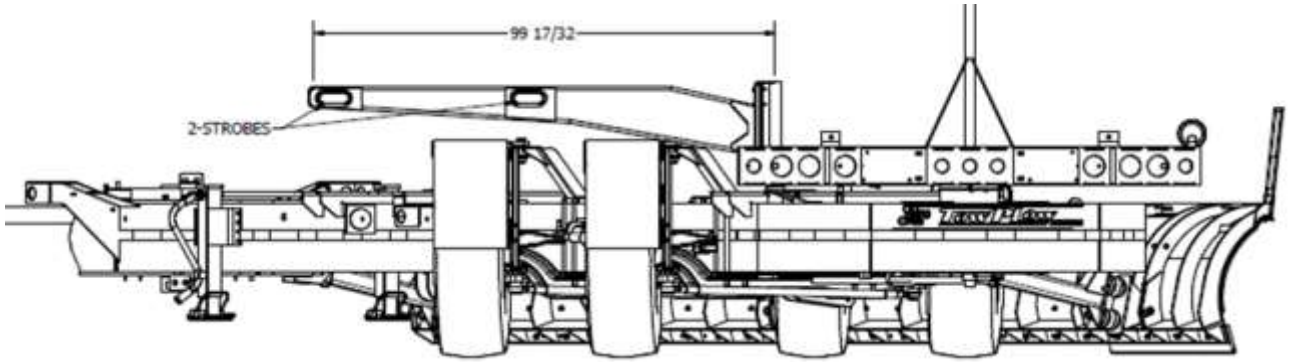
- Amber & blue L.E.D. lighting embodied in an “H” pattern on the rear of the unit
- Upper blue/amber beacons would flash alternately between the two colours at 1 Hz
- All other blue lights would cycle in conjunction with these “upper” beacons while the amber would remain constantly lit
- An increased strategic placement of retro reflective red & white tape around the outer perimeter of the unit and a checkerboard pattern to cover the bulk of the tailgate

Improved Lighting Conspicuity/Visibility on Rear of Snow Plow(s)/Spreader(s)

- The new proposed design incorporates several added advantages
  - L.E.D. lighting to increase life cycle/decrease maintenance, automatic adjustment of light intensity via photocell based on ambient lighting, lower amperage draw, more controlled light spectrum, increased vibration resistance
  - Effective communication of plow location and closure rate to following drivers
  - Increased ability to estimate size/dimension via use of additional retro-reflective tape and strategic light placement
  - Standardization of all lighting packages for all snow plows/sanders
  - Uniquely identifies snow plow/sander equipment

Improve Visibility and Driver Recognition

What is it… and what is happening?



Add lighting on front plow, wing and tow plows

Re-design larger arm on tow plows when deployed

VMS and PVMS Messaging

- Use VMS and PVMS messaging to warn drivers of slow snow removal equipment ahead, that they should slow down and not pass
  - **Advantages**
    - Provide education to the very drivers who need it and at the time they need it (i.e. to drivers approaching snow removal equipment, that they should slow down and not pass)
  - **Disadvantages**
    - Various VMS warning of snow removal equipment, including snowplows ahead, snow plows do not pass, but tested bilingual sign not yet available.
    - Producing a bilingual version of the message that fits on one sign will be challenging and should have a human factors evaluation to ensure drivers understand it.

Educate Public

- Media Campaign
  - Help establish public “brand recognition” of snow removal equipment
  - Greatly increase driver awareness of how to behave around snow removal equipment
- Drivers Handbook
- Social Media
  - Facebook and Twitter
- Stakeholder Involvement
  - Sessions at OnRoute Centres

PROOF OF CONCEPT

1. Rear Panel Colour and Pattern

- Tested nine (9) different colour and sheeting combinations
  - Daytime and nighttime conditions (November)
  - Closed road

2. Light Patterns / Configuration

- Confirm light patterns and compare to common emergency vehicles on highway to show unique conspicuity
  - Stop/turn lights as well as old and new configurations
  - Daytime and nighttime conditions (December)
  - Closed road – 12 test subjects
  - 12 test subjects

3. Monitored On-Road Testing

- Compared existing to new lighting
  - Daytime and nighttime (February)
  - Winter conditions (Huntsville)
  - 6 test subjects

Results

- Testing in November confirmed conspicuity panel should be ***fluorescent yellow-green and black***

- Testing in December confirmed ***optimal light pattern amber solid and blue 1Hz flash***
  - Also unique conspicuity compared to common emergency vehicles on highway

Results (continued)

- Testing in February confirmed ***conspicuity is improved in both urban and rural conditions***

- ***Perception of closing velocity is improved in order of 10%***

Additional Findings

- Need automatic light dimmers (day, night)
- Supplier differences: visibility and durability
- Air foils worked well – Alberta model
- Strobe lights worst

Implementation Underway…

QUESTIONS?