OPERATORS IN STEEP SLOPE LOGGING AND SAFETY MEASUREMENT

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Overview

• Introduction
• Project Goals
• Some Results to Date
• Program Next 12 months
Civilian occupations with high fatal work injury rates, 2014

- Total fatal work injuries = 4,821
- All-worker fatal injury rate = 3.4

- Logging workers: 78 injuries, 110.9 rate
- Fishers and related fishing workers: 22 injuries, 80.8 rate
- Aircraft pilots and flight engineers: 82 injuries, 64.0 rate
- Roofers: 83 injuries, 47.4 rate
- Refuse and recyclable material collectors: 27 injuries, 35.8 rate
- Farmers, ranchers, and other agricultural managers: 270 injuries, 26.7 rate
- Structural iron and steel workers: 15 injuries, 25.2 rate
- Driver/sales workers and truck drivers: 880 injuries, 24.7 rate
- Electrical power-line installers and repairers: 25 injuries, 19.2 rate
- Taxi drivers and chauffeurs: 68 injuries, 18.0 rate

Number of fatal work injuries vs. Fatal work injury rate (per 100,000 full-time equivalent workers)
Combines engineering analysis with human-factors approach to take a full-system perspective on improving the safety of the logging operation.

Four specific aims:

1) demonstrate new mechanized logging systems with industry cooperators;
2) assess practical and physiological response of workers during operation;
3) develop design guidelines and criteria for new logging systems; and
4) deliver outreach and educational components to people in the logging occupation.
MENTION OR DEPICTION OF MACHINES OR TRADE NAMES DOES NOT CONSTITUTE ENDORSEMENT BY OREGON STATE UNIVERSITY OR ANY AGENCY OF THE FEDERAL GOVERNMENT
STEPP SLOPE LOGGING SYSTEMS

- Conventional Manual Timber Falling, Choker Setting and Yarding
- Feller-Buncher with Choker Setting and Yarding
- Feller-Buncher with Shovel Logging
- Feller-Buncher with Mechanized Grapple Yarding
- Feller-Buncher with Grapple Skidder
- Harvester with Forwarder
NEW SYSTEMS BRING QUESTIONS

- Are New Systems Safer?
- Do New Systems Bring New Hazards?
- Are New Systems Technically Feasible?
- Are New Systems Economically Viable?
- What Are Training Requirements?
- Are New Systems Environmentally Acceptable? (Beyond Scope of NIOSH Project)
INDUSTRIAL COLLABORATORS

• Weyerhaeuser
• Hancock
• C&C Logging/EMS
• Summit Equipment
• Tigercat
• Caterpillar
• Additional contractor cooperators
Increased ground pressures from heavy equipment can cause soil disturbance and equipment instability.

Use of a cable assist or “tether” can stabilize equipment and reduce needed tractive effort.

Tether tension can also enable safer operation on slopes.

Performed series of field tests, monitored ground pressures.
Stability Work to Date

- Pressure cell non-tethered tests with Tigercat 855 and CAT522 at OSU on different slopes and boom positions

- Pressure cell tethered test with CAT522 with C&C Logging in western Washington on different slopes, boom positions, and cable tension

- Data Analysis and Model Building
RAPID EXPANSION OF TETHERING
SYSTEM SAFETY COMPARISONS

- Workload comparisons across systems using heart rate measures
- Hazard exposure time and type by system
- Unsafe behaviors by time and system: behavioral observation
- Interviews with workers and operators on larger sample
- Review of state safety codes relative to systems
- Review ISO standards relative to systems
INTERACTIONS WITH OPERATORS REQUIRE INSTITUTIONAL REVIEW BOARD APPROVAL
OPERATORS: AUTO CONTROL COMPARISON

- STEEP SLOPES VS. CURRENT LIMITS ON SLOPE
- HAZARD EXPOSURE FOR OPERATORS
- MEASUREMENT OF VIBRATION/MOVEMENT
- MEASURES OF STRESS
- MEASURES OF FATIGUE
- OPERATOR ATTENTION TO TASK/ENVIRONMENT
- OPERATOR PERCEPTIONS
OPERATORS WILL BE WIRED!
SOME MEASUREMENT IS NEW TO LOGGING

SMI Eye Tracking Glasses 2 Wireless
Mobile eye tracking made easy, robust, efficient and versatile
MEASURES RELATED TO OPERATIONAL STATUS: ESP. AFTER HAZARDOUS SITUATION ON SLOPE

- operator’s heart rate,
- camera recording of eye movements
- camera of operator in cab
- body movements,
- whole-body vibration at low frequencies
- measurement of respiration
- galvanic skin response
- fatigue measures w/interviews
- periodic interviews, response to situation
- task time in operational status (time study)
REVIEW OF OPERATOR RESTRAINTS

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WHAT MEASUREMENT IS AVAILABLE FROM MACHINE
EXPECTED OUTCOMES

- For manual felling and yarding, compare hazards and exposures to proposed systems of mechanical felling, grapple yarding and forwarding with and without cable assistance.
- Identify new hazards of proposed systems and conditions affecting safe operation (e.g., maintenance hazards on steep slopes)
- Monitor operator conditions during typical and steep slopes to identify physical responses to guide improvements, e.g., more robust operator restraint systems.
- Assess current safety codes & ISO standards for steep slopes & suitability for proposed logging methods.
DIFFERENT APPROACHES
ACCIDENTS DO HAPPEN

TETHERED FELLING MACHINE ROLL OVER

Where cab was after roll over, before being assisted back onto its tracks.
HOW TO MEASURE SAFETY DIFFERENCES?

• INDUSTRY WIDE STATISTICS: NUMBER & TYPE OF INJURIES
• MEASURES WITHIN THE LOGGING FIRM: NUMBER & TYPE
• EXPOSURE OF PEOPLE IN HAZARDOUS JOBS: LESS WORKERS
• LESS EXPOSURE TO HAZARDS FOR WORKERS: NUMBER & TYPE
• REDUCTION IN FATIGUE RELATED INJURIES
• IDENTIFICATION OF HAZARDS WITH NEW SYSTEMS
• GREATER SKILL DEMANDED OF CUTTERS FOR STANDS/TREES NOT SUITABLE FOR MECHANIZED CUTTING
Accumulative Total: Forestry Serious Harm Incidents Jan 2013 - Nov 2015

- 2013
- 2014
- 2015
FATALITIES IN OR & WA

OR & WA LOGGING FATALITIES

- 99 fatalities
- 31% cutting
- 27%...
- 46%...
- 59 fatalities

1998-2015:
- 27 fatalities
- 16 fatalities
- 27 fatalities

1995-2016:
- 31 fatalities

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US REPORTED FATALITIES
LOGGING / CUTTING

US REPORTED FATALITIES IN LOGGING & CUTTING

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<td>89</td>
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JANUARY 19, 2017
GARLAND
MEASURES WITHIN THE FIRM ITSELF: RATES AND ACTUAL
EXPOSURE OF PEOPLE IN HAZARDOUS JOBS: LESS WORKERS

• If tethered felling can cover 4x the area of a single cutter in a day, then fewer cutters would be exposed to hazards.

• If tethered shovel logging or forwarding has only a single operator versus a 5 person rigging crew, then fewer workers are exposed to hazards.
HOW TO IDENTIFY JOB HAZARDS?

• TASK ANALYSES OF JOBS
• REVIEW OF ACCIDENTS REPORTED: OROSHA, WORKERS COMP DATA
• FATALITY ASSESSMENT AND CONTROL EVALUATION: FACE REPORTS
• ASSESSMENT FROM LITIGATION EXPERIENCE
• RIGGING CREW/CUTTER/OPERATOR INTERVIEWS
<table>
<thead>
<tr>
<th>TASK</th>
<th>KNOWLEDGE</th>
<th>SKILLS</th>
<th>ABILITIES</th>
<th>RISKS</th>
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<tbody>
<tr>
<td>CUTTING TREES</td>
<td>TREES &amp; DIFFERENCES</td>
<td>MATCHING CUTS TO CONTROL TREE &amp; LOGS</td>
<td>WHOLE BODY STRENGTH &amp; STAMINA</td>
<td>STRUCK BY TREES/LOGS/LIMBS, MATERIALS</td>
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<tr>
<td>INCLUDES KSAR’S OF WALKING &amp; CHAINSAW USE</td>
<td>PHYSICS OF TREE FALLING, HINGE WOOD, HOLDING WOOD, LEAN, CENTER OF GRAVITY</td>
<td>PREDICTING TREE/LOG MOVEMENT</td>
<td>SPATIAL ORIENTATION (SEE &amp; PROJECT TREES FELLED)</td>
<td>TO OVERHEAD HAZARDS, TOPS, WIDOWMAKERS, SNAGS</td>
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<tr>
<td>HOW TO ASSESS TREE &amp; DETERMINE DIRECTION OF FALL</td>
<td></td>
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<td>VISION</td>
<td>LOG/TREE MOVEMENT UNDER TENSION</td>
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<td>HOW TO HANDLE LEANERS, SNAGS, SCHOOL MARMS, HANG-UPS, LIMB-LOCKED &amp; PROBLEM TREES</td>
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<td>WORKING BELOW UNSTABLE TREES &amp; LOGS</td>
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<td>FALLING PATTERN OF UNIT &amp; STRIP</td>
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<td>FELLING HAZARDS</td>
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WRC OFE J U N Y E 1 9 , 2 0 1 7  G A R L A N D
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<tr>
<th>Activity</th>
<th>Rarely 0-30%</th>
<th>Occasionally 30-45%</th>
<th>Frequently 45-65%</th>
<th>Usually 65-85%</th>
<th>Almost Always 85-95%</th>
<th>Always 95%+</th>
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<td>Traveling Hazards</td>
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<td>Frontal Hazards</td>
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<td>Maintenance Hazards</td>
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<td>Stability Incident, Rocking, Sharp Movements</td>
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<td>Chains Shot Hazards</td>
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<td>Heat/Cold</td>
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Timber faller, using a chainsaw, was falling a 93'5" white fir tree when it hit other trees as it was falling and kicked back 12 feet into the worker's chest. A Humboldt face cut was used, producing a notch of just 15 degrees instead of the usual 45-90 degrees. The back cut was made at and below the horizontal component of the Humboldt's face cut, failing to provide a platform that would block the tree from kicking back once the hinge broke. Delayed EMS.
Fatality Investigation Report

SPECIAL ALERT – hung limbs and snags in trees are a recurring contributing factor to occupational fatalities among tree fallers in Oregon.

Timber faller killed while working under a hung tree limb

SUMMARY

On December 29, 2011, a 41-year-old Hispanic male was killed while working as a timber faller. The incident occurred at about 1 pm on a workday. The victim, working as a lone faller, was attempting to fell a tree that had an alder limb hung up in it. The alder limb was approximately 34 feet in length and 11 inches in diameter. The victim’s cutting partner was working on a separate strip of timber approximately 400 to 500 feet away. Witness accounts state that they had observed the hung alder limb in the victim’s cutting strip about two hours prior to the incident (see Figure at right). The victim was found underneath the alder limb and was pronounced dead at the scene.
MACHINE TRAVEL VS WALKING
SAMPLE HAZARD COMPARISON FOR CUTTING: FREQUENCY & SEVERITY

MANUAL CUTTING

• HAZARDS OF WALKING IN THE WOODS, SLIPS, TRIPS, FALLS, HEAT/COLD, KNEES/BACK, ETC

• CHAINSAW HAZARDS, KICKBACK, CUTS, NOISE, EYE/FACE, WHITE FINGERS, ETC.

• WIDOWMAKERS, SNAGS, FALLING & ROLLING LOGS/TREES, TENSION WOOD

• FATIGUE INDUCED INJURIES

MECHANIZED CUTTING

• TIPOVERS/ROLLOVERS

• MAINTENANCE HAZARDS

• WHOLE BODY VIBRATION, NECK/SHOULDER CUMULATIVE

• OVERHEAD/FRONTAL HAZARDS

• CHAINSHOT HAZARDS
ABILITY TO DEAL WITH HAZARDS
ABILITY TO WORK IN LOW LIGHT
HOW TO MEASURE FULL BENEFITS & COSTS AND IDENTIFY ISSUES?

- COST IMPROVEMENTS AND DISTRIBUTION OF GAINS
- IMPROVED WORKER COMPENSATION RATES
- POTENTIAL FOR WAGE INCREASES
- CAPITAL AVAILABILITY QUESTIONS
- WORKFORCE AVAILABILITY: MILLENNIALS? WOMEN?
- FORM OF BUSINESS: SOLE PROPRIETOR v. CORPORATION
- ENVIRONMENTAL TRADEOFFS
- TRAINING DEMANDS & METHODS OF OPERATION
- PLANNING REQUIREMENTS & METHODS
- NEEDED DEVELOPMENTS? CAMERAS, REMOTE CONTROLS, ???
WELCOME THEM TO THE WOODS
HOW TO EXPAND TO INDUSTRY LEVEL?

• EMPLOYMENT: WORKERS BY OCCUPATION
• VOLUME HARVESTED BY SLOPE CLASS
• AREA HARVESTED BY SLOPE CLASS
• NUMBER OF FIRMS USING SYSTEMS
MORE TO DO!
THERE IS NOTHING SO POWERFUL AS AN IDEA WHOSE TIME HAS COME!