

SAFETY AND HEALTH RESEARCH ON STEEP SLOPE LOGGING IN THE PACIFIC NORTHWEST

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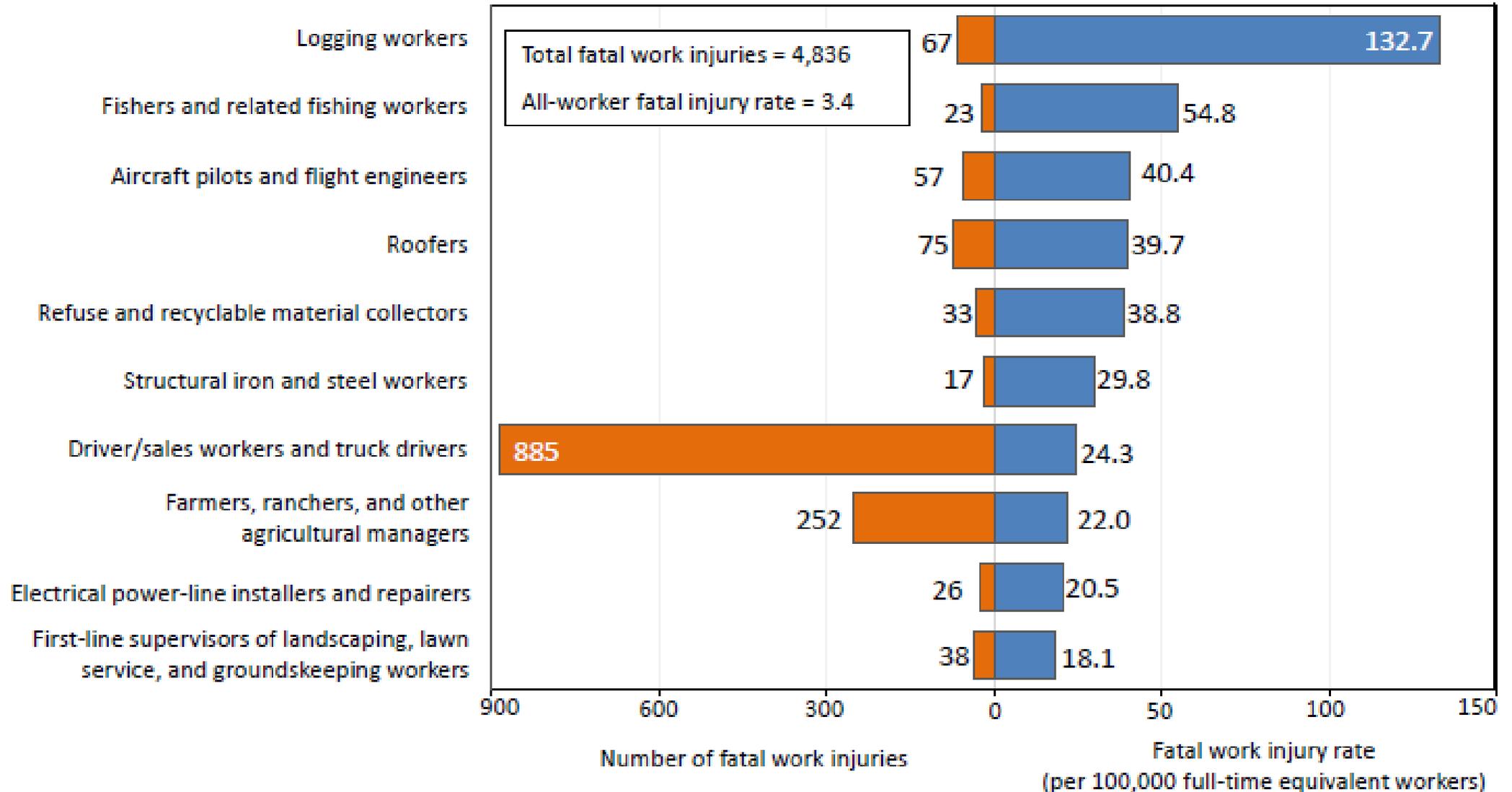
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Overview

- Introduction
- Project Goals
- Some Results to Date
- Program Next 12 months



Civilian occupations with high fatal work injury rates, 2015



In 2015, fatal work injury rates were high for logging workers and fishers and related fishing workers.

Driver/sales workers and truck drivers incurred the greatest number of fatal injuries.

National Occupational Safety and Health Program Grant

- 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

STEEP 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)

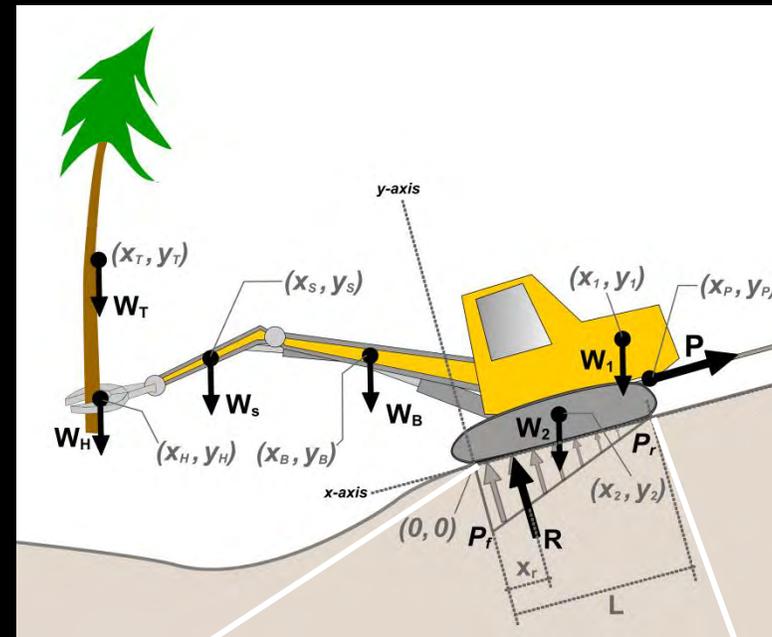
INDUSTRIAL COLLABORATORS

- Weyerhaeuser
- Hancock
- C&C Logging/EMS
- Summit Equipment
- Tigercat
- Caterpillar
- Additional contractor cooperators

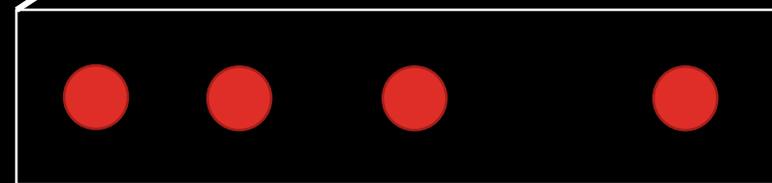


Background

- 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



Pressure Cell Layout



Bottom

Mid-Top

Mid-Bottom

Top

Stability Work to Date

- Pressure cell non-tethered tests with Tigercat 855 and CAT 522 at OSU on different slopes and boom positions
- Pressure cell tethered test with CAT 522 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



NEW Natural Gaze™
Design

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



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



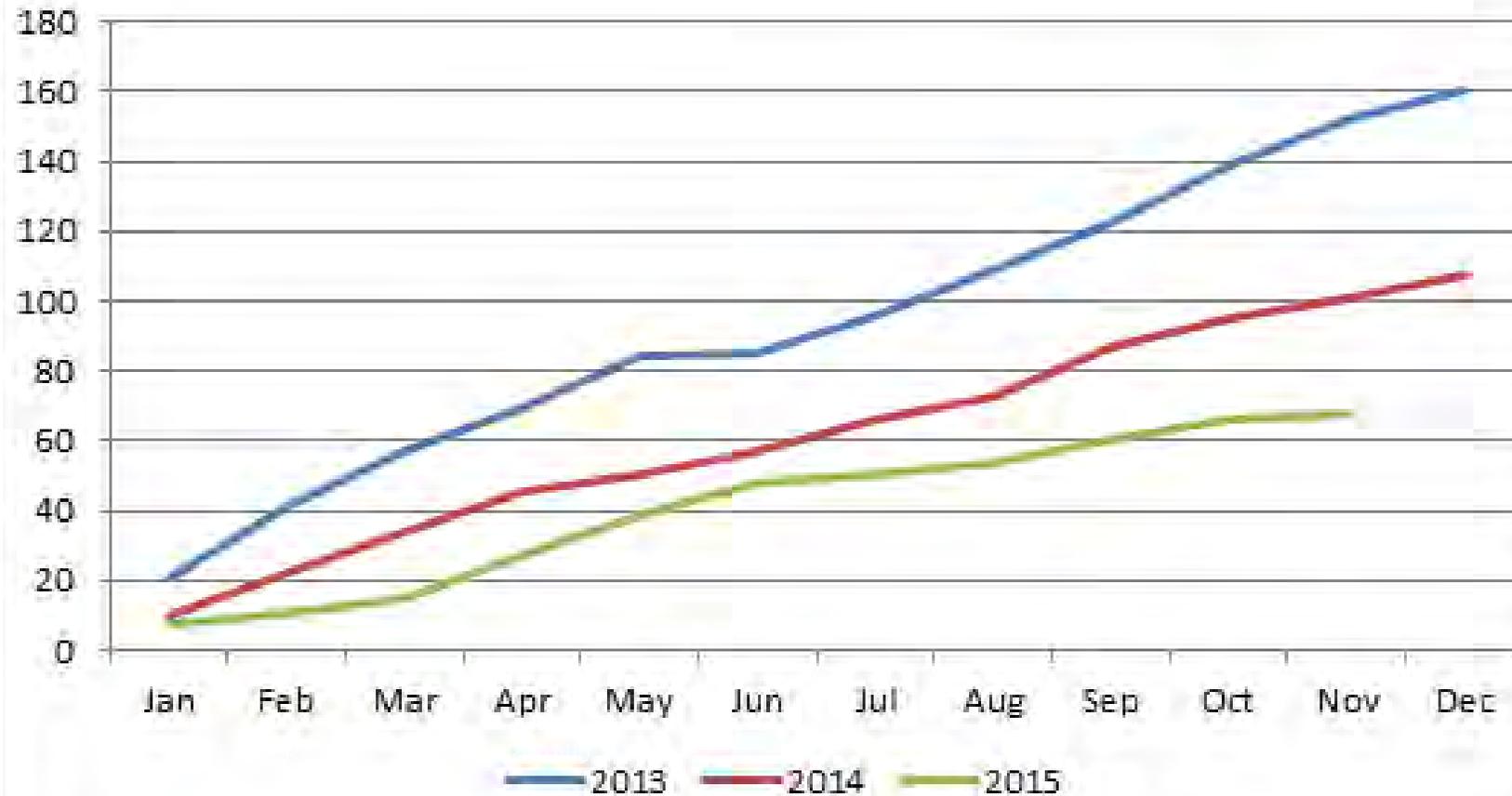
HOW TO MEASURE SAFETY DIFFERENCES?

- 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

Forestry Serious Harm Incidents Jan 2013 - Nov 2015

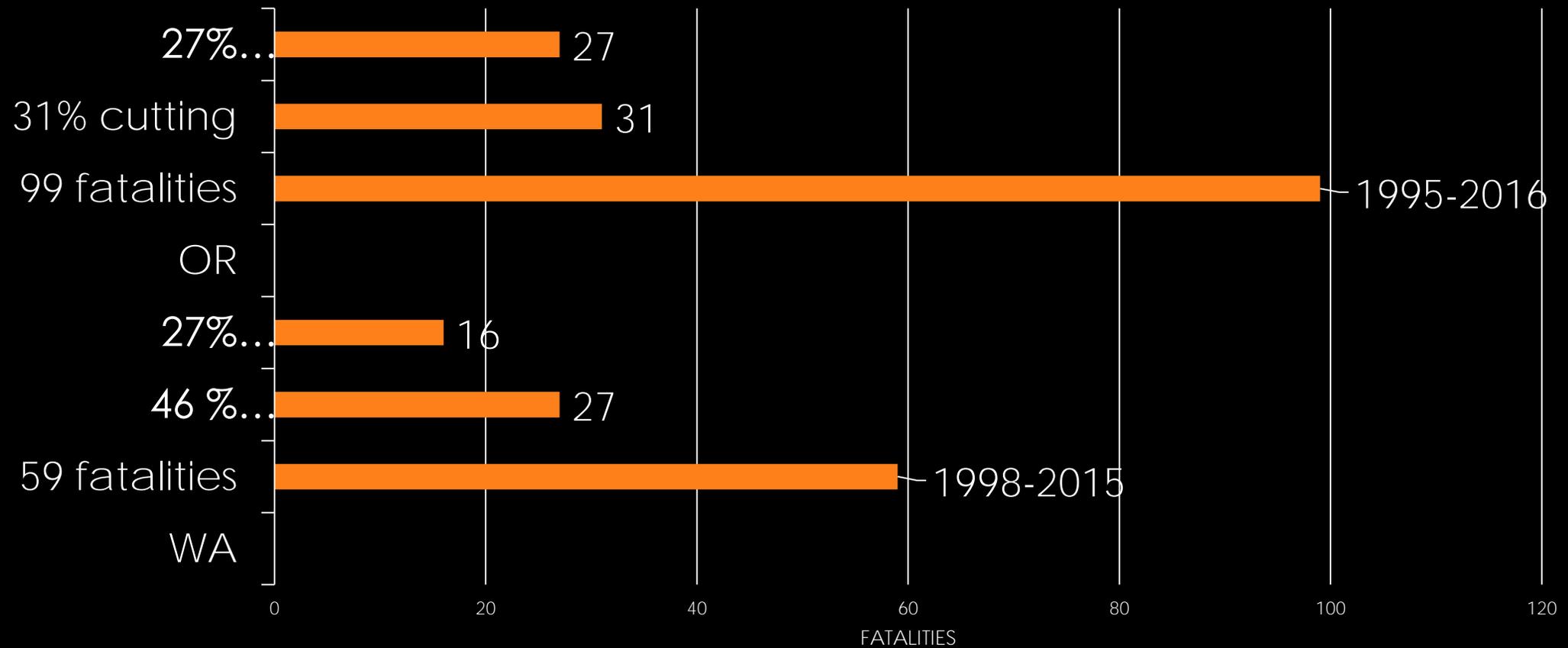


Accumulative Total: Forestry Serious Harm Incidents Jan 2013 - Nov 2015

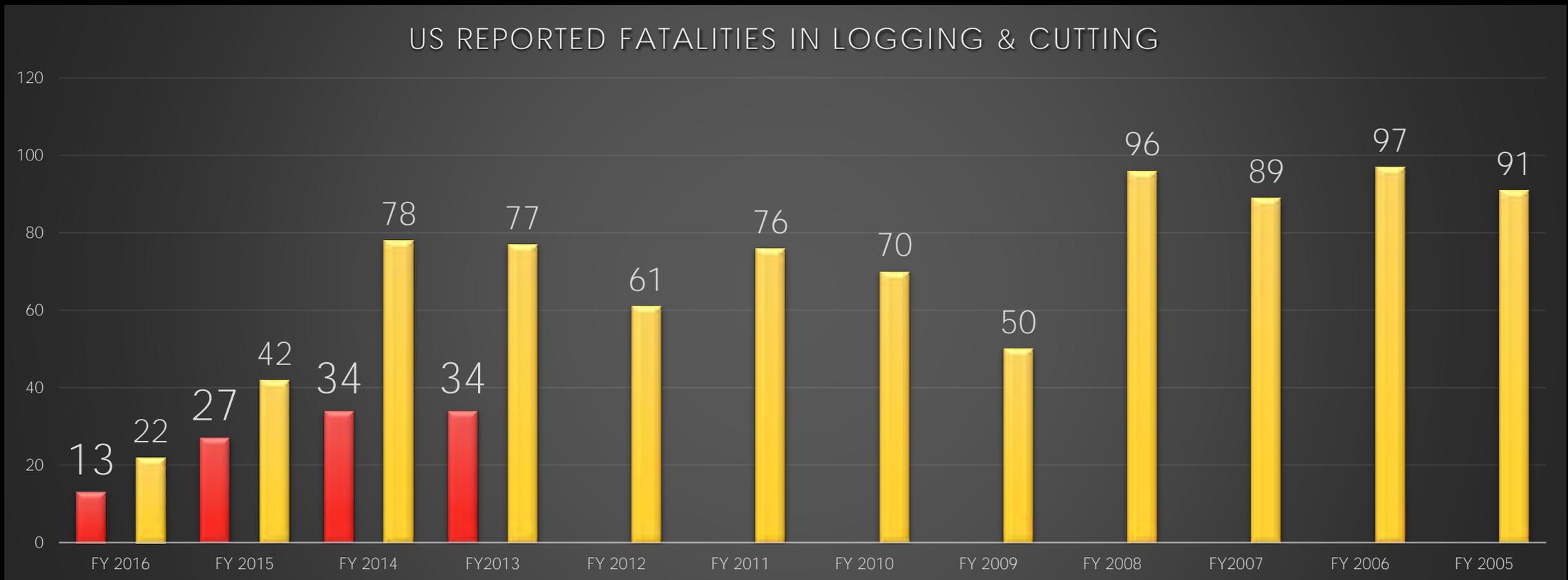


FATALITIES IN OR & WA

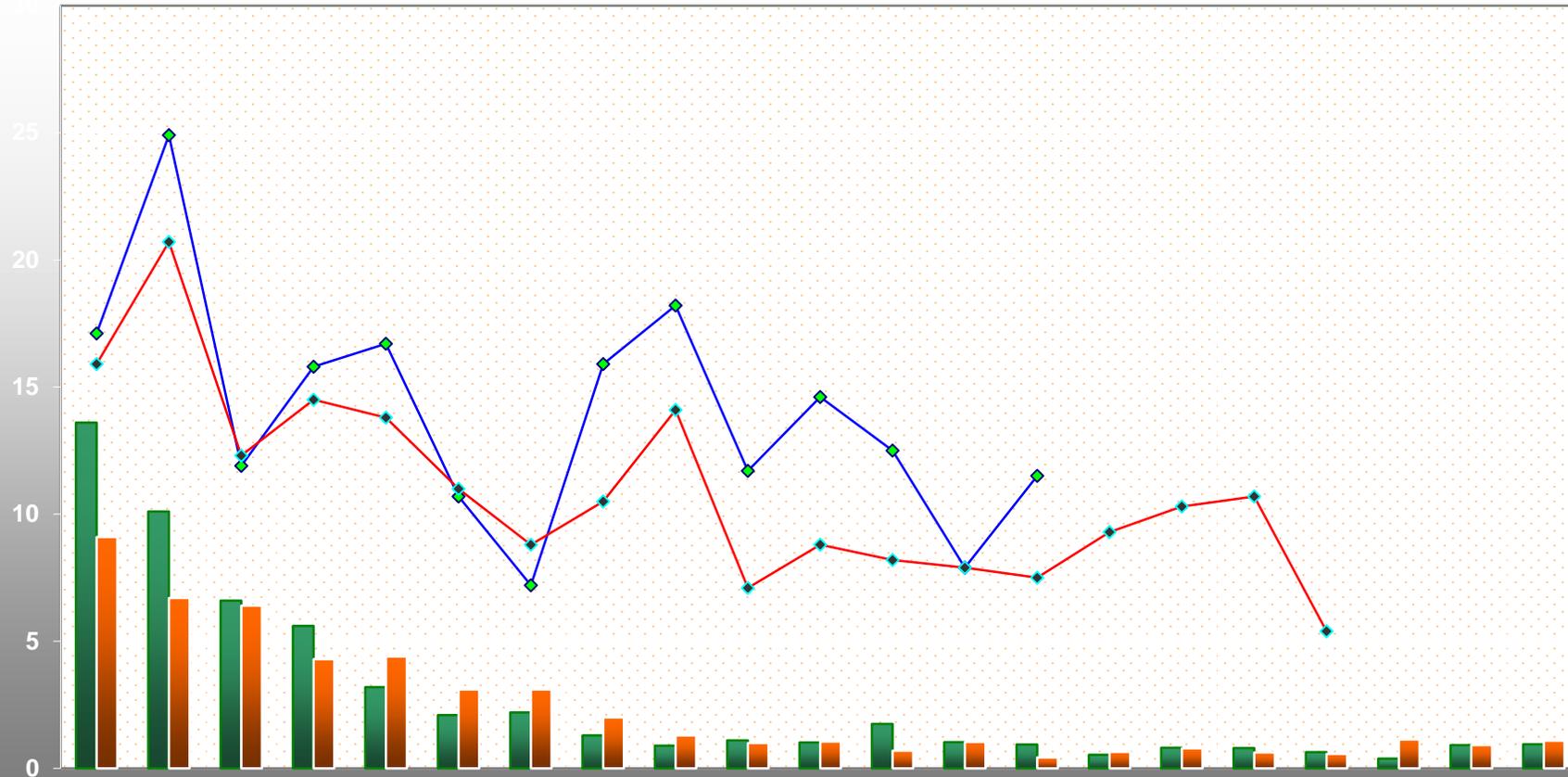
OR & WA LOGGING FATALITIES



US REPORTED FATALITIES LOGGING/CUTTING



MEASURES WITHIN THE FIRM ITSELF: RATES AND ACTUAL



EXPOSURE OF PEOPLE IN HAZARDOUS JOBS: LESS WORKERS

- IF TETHERED FELLING CAN COVER 2x 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 ASSESMENT AND CONTROL EVALUATION: FACE REPORTS
- ASSESSMENT FROM LITIGATION EXPERIENCE
- RIGGING CREW/CUTTER/OPERATOR INTERVIEWS

TASK ANALYSES OF JOBS

TASK	KNOWLEDGE	SKILLS	ABILITIES	RISKS
CUTTING TREES	TREES & DIFFERENCES	MATCHING CUTS TO CONTROL TREE & LOGS	WHOLE BODY STRENGTH & STAMINA	STRUCK BY TREES/LOGS/LIMBS, MATERIALS
INCLUDES KSAR's OF WALKING & CHAINSAW USE	PHYSICS OF TREE FALLING, HINGE WOOD, HOLDING WOOD, LEAN, CENTER OF GRAVITY	PREDICTING TREE/LOG MOVEMENT	SPATIAL ORIENTATION (SEE & PROJECT TREES FELLED)	OVERHEAD HAZARDS, TOPS, WIDOWMAKERS, SNAGS
	HOW TO ASSESS TREE & DETERMINE DIRECTION OF FALL	COMPLIANCE WITH REQUIREMENTS	VISION	LOG/TREE MOVEMENT UNDER TENSION
	HOW TO HANDLE LEANERS, SNAGS, SCHOOL MARMS, HANG-UPS, LIMB-LOCKED & PROBLEM TREES	COMMUNICATIONS	TOLERANT OF HEAT & COLD	WORKING BELOW UNSTABLE TREES & LOGS
	FALLING PATTERN OF UNIT & STRIP		AVERAGE OR BETTER IQ	
	FELLING HAZARDS		RISK TOLERANT	

BOS

BEHAVIORAL OBSERVATION MEASURES: STEEP SLOPE OPERATORS

ACTIVITY	TIME MEASURES						
	RARELY 0-30%	OCCASIONALLY 30-45%	FREQUENTLY 45-65%	USUALLY 65-85%	ALMOST ALWAYS 85-95%	ALWAYS 95%+	NOT APPLICABLE
TRAVELING HAZARDS	<input type="radio"/>						
OVERHEAD HAZARDS	<input type="radio"/>						
FRONTAL HAZARDS	<input type="radio"/>						
MAINTENANCE HAZARDS	<input type="radio"/>						
STABILITY INCIDENT, ROCKING, SHARP MOVEMENTS	<input type="radio"/>						
CHAINSHOT HAZARDS	<input type="radio"/>						
HEAT/COLD	<input type="radio"/>						

BRIEF WCB DESCRIPTION OF FATALITY

- 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.

OREGON FATALITY ASSESSMENT AND CONTROL EVALUATION

www.ohsu.edu/croet/face

Fatality Investigation Report

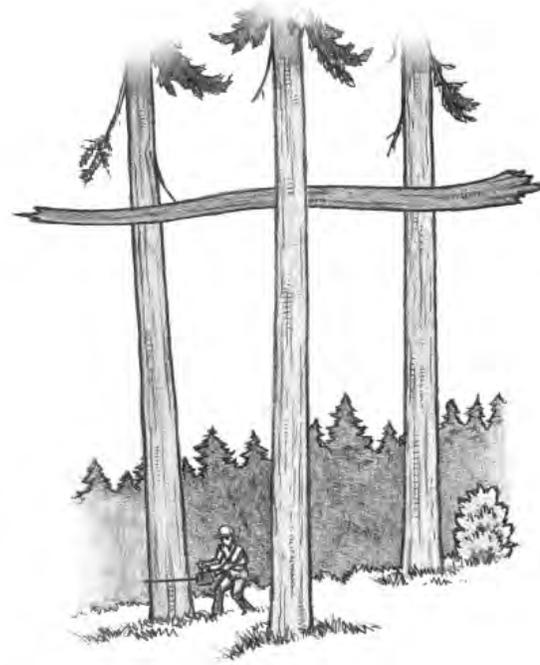
OR 2011-50-1

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 1pm 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: WIND AND WINDTHROW



ABILITY TO WORK IN LOW LIGHT



WHAT ARE THE COMPARISONS FOR 1MM UNIT?

Manual felling & yarding

- Cutters: 4 workers for 10 days
- Yarding: 5 workers for 6 days
- Workers Compensation Cost: WA=\$10,000 est.

Tethered felling & shovel yarding

- Cutting: 1 worker for 20 days
- Shovel Logging: 1 worker for 31 days
- Workers Compensation Cost: WA=\$1500 est.

WHAT ARE THE RISKS? TRADEOFFS

Manual felling & yarding

- HIGH FREQUENCY & HIGH IMPACTS
- STRUCK BY TREES & LOGS & LIMBS
- SLIPS, TRIPS, FALLS
- CHAINSAW INCIDENTS
- CUMULATIVE TRAUMA, BACKS, KNEES
- LOWER FREQUENCY, HEAT & COLD

Tethered felling & shovel yarding

- LOW FREQUENCY & HIGH IMPACT
- MACHINE TIPOVER/ROLLOVER
- STRUCK BY TREES & LOGS
- CHAINSHOT
- MAINTENANCE INJURIES
- UNKNOWN CUMULATIVE TRAUMA
- LOWER FREQUENCY, WALKING OUT

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: MILLENIALS? 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!

