

## Focus on Forest Engineering 2011

*The application of Full-tree and Tree-length Systems on Difficult Terrain:  
Increasing our knowledge base to better  
select and operate FT and TL equipment*

Gary Olsen

International Sales Manager

November 2011



# International Paper, Brasil





# ExpoForest 2011, International Paper, Brasil







**Sipitang, Malaysia**





**Sipitang, Malaysia**





**New Zealand**



**New Zealand**



# Cenibra, Brasil





**Scotland**





# PG Bison, Ugie, Eastern Cape



## Descriptive Terrain Classification

**Slope – 0 to 45 ° or 0 to 100 %**

**Ground Roughness – Obstacles i.e. Rocks,  
Stumps or depressions – Size and Frequency**

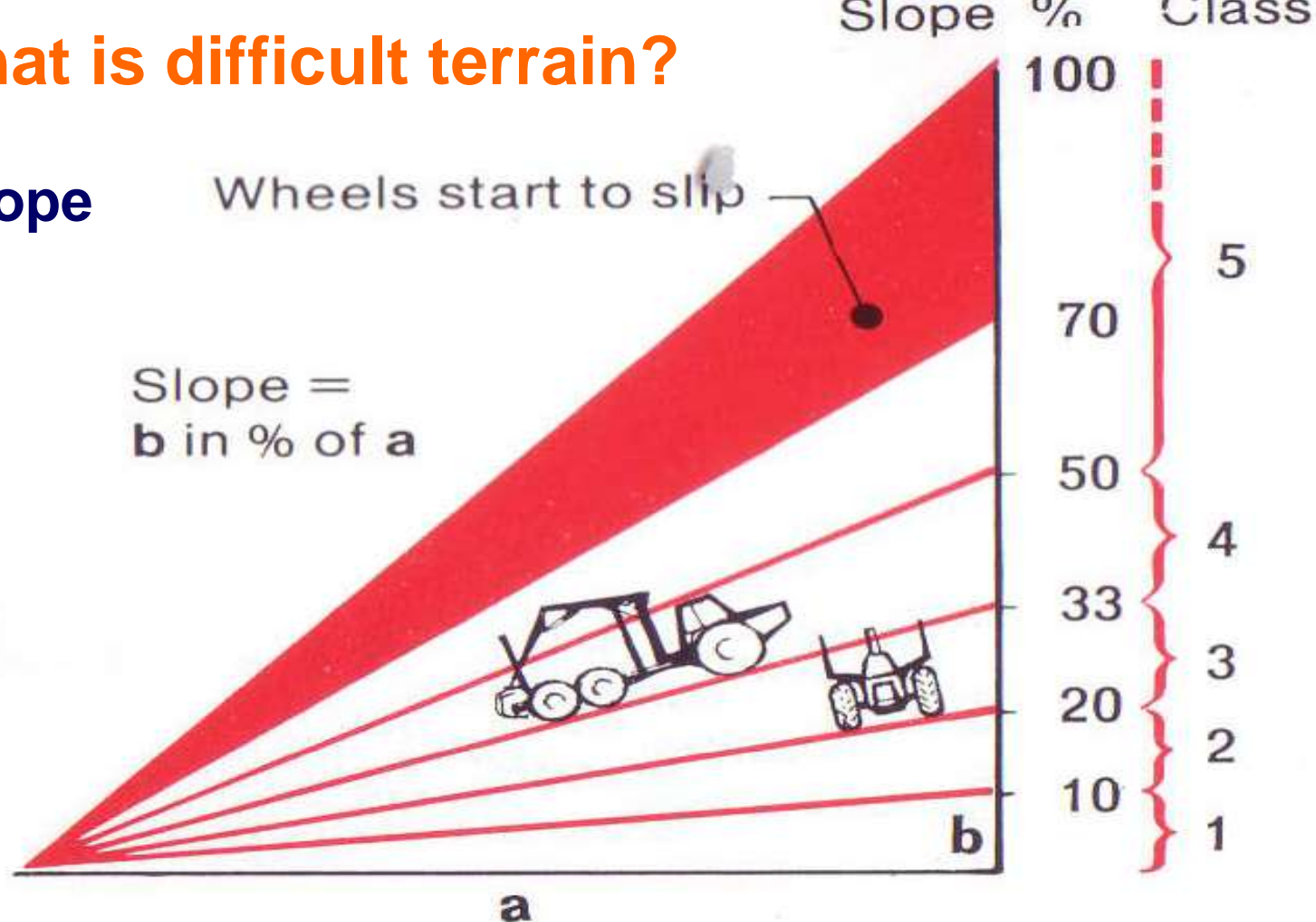
**Ground Conditions – Soil types and textures –  
soil strength – changes with changing moisture  
content**

**ICFR Bulletin - National Terrain Classification System 4/93**



# What is difficult terrain?

## Slope



## Slope

**The traditional division into classes is made as follows:**

- 1. 0 – 10% Flat or gentle slope**
- 2. 10 -20% Intermediate slope**
- 3. 20 – 32% Moderate slope**
- 4. 33 – 50% Middle class slope**
- 5. > 50% Steep slope**

**If needed the slope direction can divided into uphill, downhill and side hill slopes**



## Functional Terrain Classification

- **Matching the machine to the site**
- **Ground based harvesting systems**
  - **Wheeled**
  - **Tracked**
- **Aerial harvesting systems**
  - **Cable Yarding systems**
  - **Helicopter systems**

# Tigercat

## MACHINE TO TERRAIN MATCHING GUIDELINES

TERRAIN CLASSIFICATION	MOTOR- MANUAL& MANUAL	WHEELED			TRACKED			
		SWING BOOM		FIXED BOOM	SWING BOOM		FIXED BOOM	
		LEVELING	NON-LEVEL		LEVELING	NON-LEVEL		
SLOPE (%) : UP DOWN GROUND ROUGHNESS: GROUND CONDITION:	0 - 60 @	0 - 45	0 - 35	0 - 15	0 - 55	0 - 35	0 -35	
	0 - 60 @	0 - 25	0 - 15	0 - 10	0 - 30	0 - 20	0 - 15	
	1 - 5	1 - 3	1 - 3	1 - 3	1 - 2	1 - 2	1 - 2	
	1 - 5	1 - 3	1 - 2	1 - 2	1 - 3 *	1 - 3 *	1 - 3	
TERRAIN CLASSIFICATION	MANUAL	WHEELED LOADERS			KNUCKLE BOOM LOADERS			
		THREE WHEELED	FOUR WHEELED	FRONT END LOADER	4 WHEELED LOADER	TRACKED LOADER		
SLOPE (%) : UP DOWN GROUND ROUGHNESS: GROUND CONDITION:	0 - 50	0 - 15	0 - 15	0 - 15	0 - 15	0 - 40		
	0 - 50	0 - 15	0 - 15	0 - 15	0 - 15	0 - 20		
	1 - 5	1 - 3	1 - 2	1 - 2	1 - 2	1 - 2		
	1 - 5	1 - 3	1 - 2	1 - 2	1 - 3	1 - 3 *		
TERRAIN CLASSIFICATION & RECOMMENDATIONS	AGRIC. TRACTOR	WHEELED CABLE OR GRAPPLE SKIDDERS			HYDROSTATIC 4 WHEEL DRIVE SKIDDERS	HYDROSTATIC 6 WHEEL DRIVE SKIDDERS	CLAMBUNK SKIDDER	TRACKED/ CRAWLER SKIDDER
		STANDARD TYRES	FLOTATION TYRES	WITH CHAINS OR TRACKS				
SLOPE (%) : UP DOWN GROUND ROUGHNESS: GROUND CONDITION: SKIDDING DISTANCE (m)	0 - 20	0 - 25	0 - 25	0 - 30	0 - 35	0 - 40	0 - 25	0 - 40
	0 - 20	0 - 35	0 - 35	0 - 40	0 - 45	0 - 50	0 - 40	0 - 55
	1 - 2	1 - 3	1 - 2	1 - 2	1 - 2	1 - 2	1 - 2	1 - 2
	1 - 2	1 - 3	1 - 4	1 - 3	1 - 3	1 - 3	1 - 3	1 - 3
	50 - 300	50 - 500	50 - 500	50 - 500	50 - 1000	50 - 1000	50 - 1000	0 - 100
TERRAIN CLASSIFICATION & RECOMMENDATIONS	AGRIC. TRACTOR TRAILER	ARTICULATED DUMP TRUCK	WHEELED FORWARDERS					
			FOUR WHEELED	SIX WHEELED	EIGHT WHEELED	6*6 WITH TRACKS	8*8 WITH TRACKS	
SLOPE (%) : UP DOWN GROUND ROUGHNESS: GROUND CONDITION: FORWARDING DIST (m) SHORT HAUL DIST	0 - 20	0 - 20	0 - 25	0 - 30	0 - 35	0 - 35	0 - 40	
	0 - 20	0 - 25	0 - 35	0 - 35	0 - 45	0 - 40	0 - 50	
	1 - 2	1 - 3	1 - 2	1 - 2	1 - 2	1 - 2	1 - 2	
	1 - 2	1 - 3	1 - 4	1 - 3	1 - 3	1 - 3	1 - 3	
	50 - 1000	50 - 1000	50 - 300	50 - 500	50 - 500	50 - 500	50 - 500	
	1 - 15 km	1 - 20 km	NONE	NONE	NONE	NONE	NONE	



## Clarification statement:

**No amount of modern day harvesting equipment and technology, nor any future ordinary or miraculous inventions and developments, will ever replace or reduce the need for sound tactical and operational harvesting planning!!**

**“Gary Olsen – Focus on Forest Engineering November 2011”**

- **Traditional marginalisation of forest industries to areas where agriculture is no longer a sustainable or cost effective land use activity.**
- **Continued and ever increasing pressure on the better land for either food security or biomass for bio-energy production.**
- **Because some idiot silviculture forester thought that some day in the future there will be harvesting technology to do so!!**



**There seems to be just about only two scenarios when it comes to trees growing on difficult terrain !!**

Small and tough to work with







**Big and  
tough to work  
with**



## 1. Safety

**Regardless of the type of equipment some fundamentals:**

- **Always work up and down the slope**
- **Don't push machines beyond their design**
- **Make sure the design meets the safety requirements**
- **The “Self leveling” misnomer**
- **Specialised training is imperative**



## 2. Productivity

**Regardless of the type of equipment some fundamentals:**

- **Slope and excessive slope will negatively affect machine productivity and fuel consumption – more apparent on flat bottomed machines than leveling machines**
- **Feller Buncher “Cut and carrying” to facilitate all forms of extraction**
- **“Load accumulation” by a grapple skidder is and expensive activity – especially in small**

## 3. Productivity

**Regardless of the type of equipment some fundamentals:**

- **Both slope and soft underfoot conditions will negatively affect fuel consumption – more apparent on flat bottomed machines than leveling machines**



## Tracked machine design for steep slopes:

- **Fighting gravity to save fuel – slewing a leveled upper versus a flat bottomed machine**
- **Steep slopes – Heavy weight versus light weight conundrum**
- **How steep a slope can I work on? Yes**
- **How far can I track my machine to avoid paying for a low bed truck? Yes**

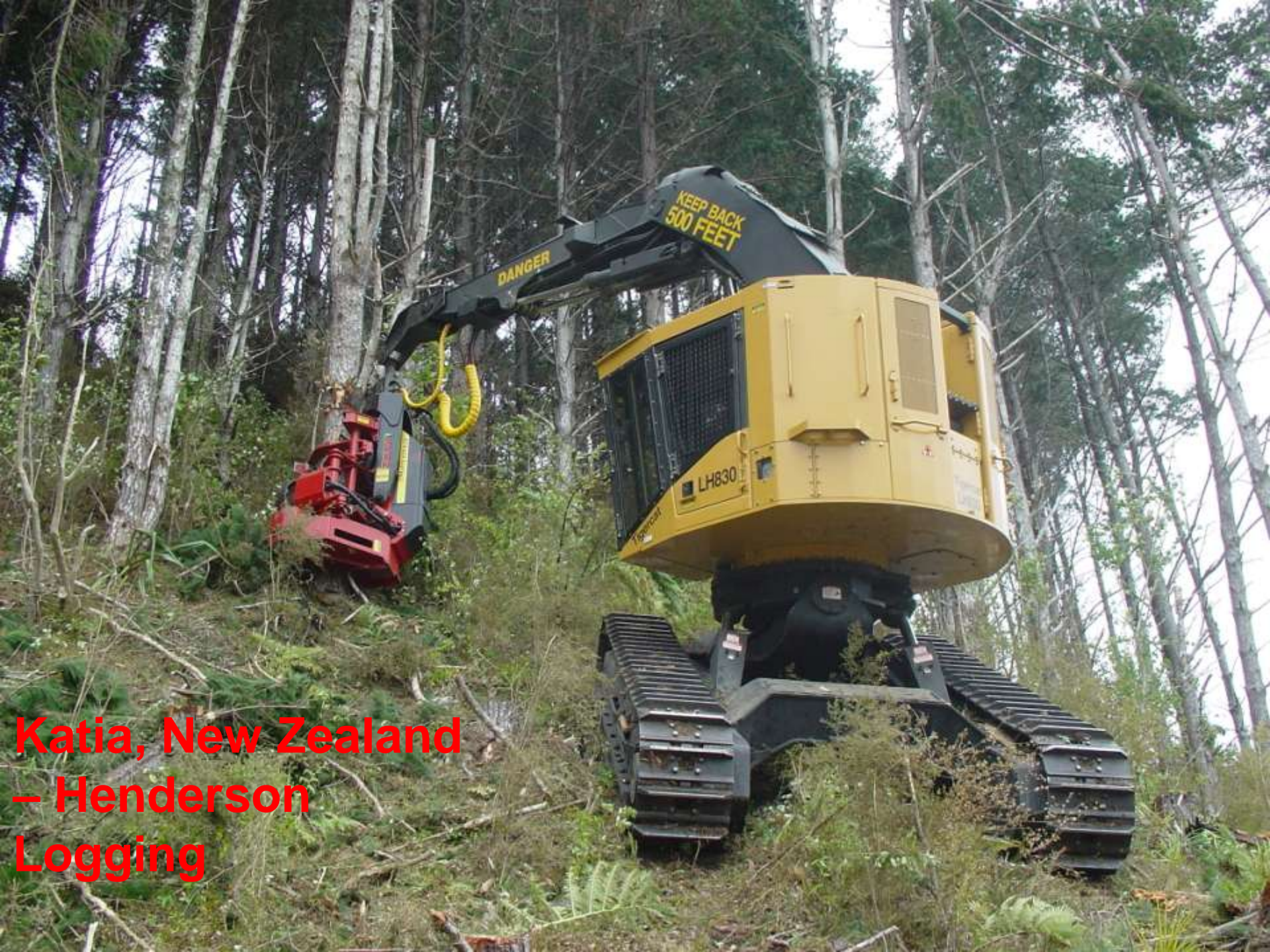
## Tracked machine design for steep slopes:

**Most tracked machines designed to receive:**

- **Harvesting heads – tree length**
- **Directional felling heads – full tree**
- **Disc and shear felling heads – full tree**

**Tracked feller buncher carriers are now also being deployed as shovel loggers**





**Katia, New Zealand  
– Henderson  
Logging**











# L830C and DT2000 Shear Felling head





***Twin-post design promotes excellent visibility***

**Tigercat**

ated from thick  
enter of gravity  
achine center

Large diameter pins and bushings

In-line dual-arm accumulating  
system, holds stems in tight  
parallel alignment

Durable, well  
guarded shear  
cylinder

Duty spindle  
springs

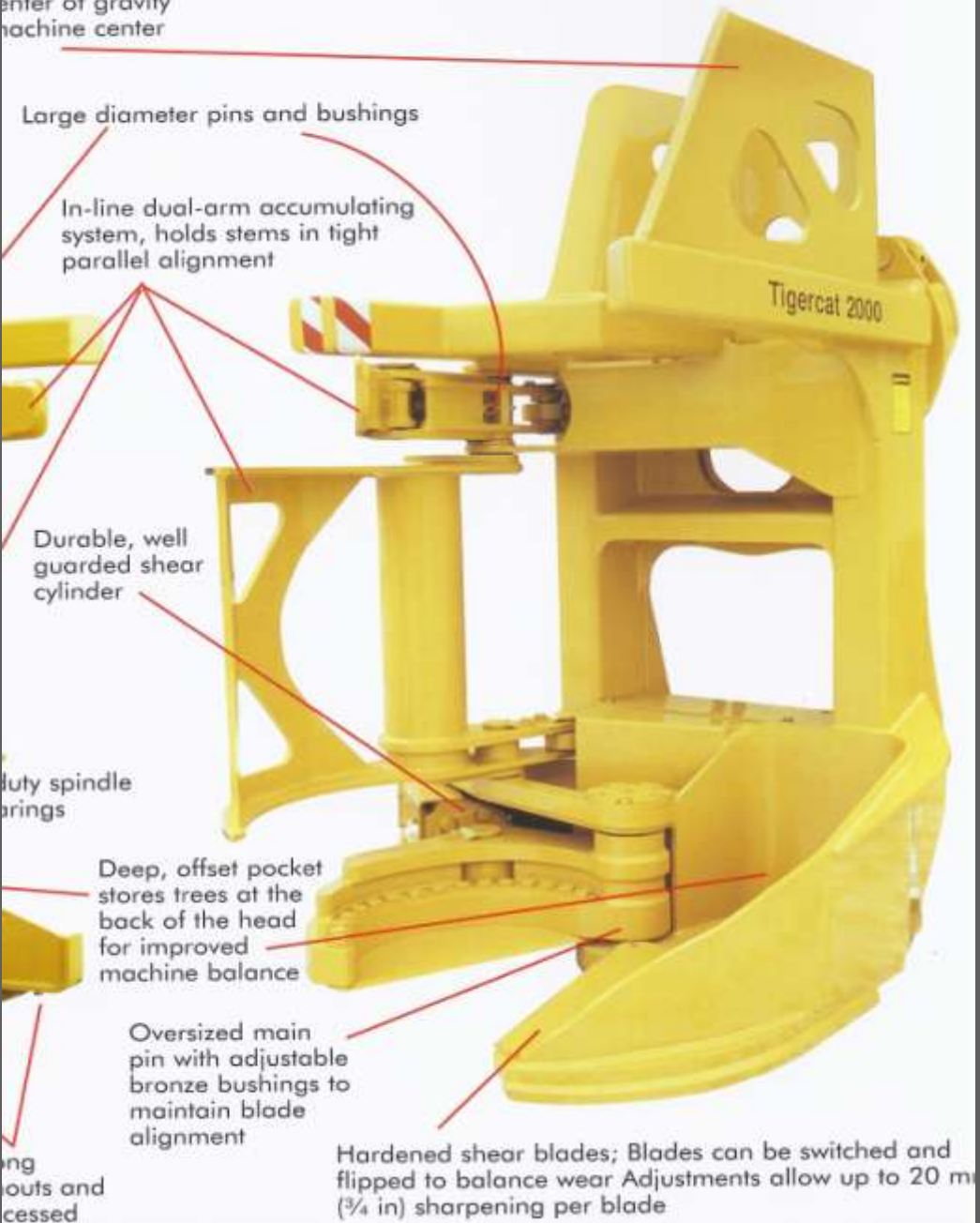
Deep, offset pocket  
stores trees at the  
back of the head  
for improved  
machine balance

Oversized main  
pin with adjustable  
bronze bushings to  
maintain blade  
alignment

ng  
outs and  
cessed

Hardened shear blades; Blades can be switched and  
flipped to balance wear Adjustments allow up to 20 mm  
( $\frac{3}{4}$  in) sharpening per blade

## **Tigercat DT2002 Shear Felling Head**



## Felling head wrist options



Standard 30° wrist



110° wrist



340° high rotation wrist



























The old





The New





















**Shovel logging – Just a fad or here to stay?**

## Advantages of shovel loggers:

**In the right conditions (mainly extraction distances) it is a low cost extraction tool in difficult terrain**

**Environmentally it is a low impact extraction tool (full suspension extraction)**

**Very useful tool for optimal load accumulation facilitating low cost grapple skidder extraction – especially in small trees**

**Versatile tool for an operation in terms of product sorting, loading and cleaning of landings**













**Some shovel loader figures and facts learned so far:**

**Rule of thumb is around 3 “touches” (60 m) seems to be the cut off for cost effective shovel logging**

**Productivity when purely shovel logging is around 45 m<sup>3</sup> per hour over the 60 metre distance**

**Excellent and more cost effective than a skidder for single grab “roadside” extraction**

**Track wear is slightly higher than a tracked feller buncher due to more tracking**

**Fuel consumption is around 25 l/hr vs a feller buncher at 35l/hr**



**Leveling feller buncher and shovel  
logger combination machines**





**Tigercat LH855C  
Feller Buncher and  
Shovel Logger  
combination**

























**Skidder extraction on  
difficult terrain**

**Six wheels versus four?**

**Some advantages of six wheeled skidders on difficult terrain:**

**An extra set of wheels for stability**

**An extra set of wheels for more surface contact area with the soil**

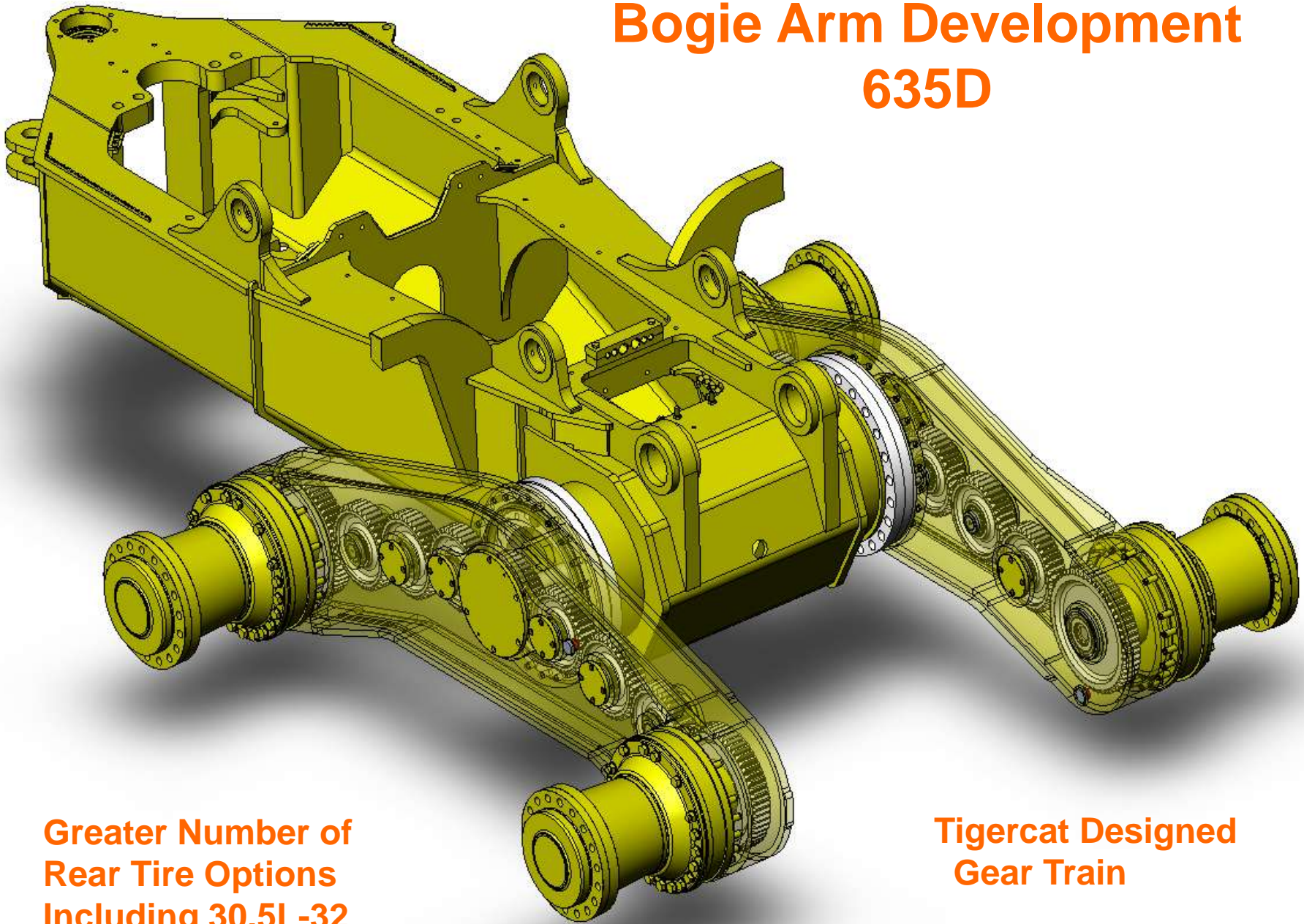
**Less ground pressure than four wheels with a larger payload**

**Larger payload skidder is less sensitive to longer extraction distances, commonplace in difficult terrain**

**Combined with tractive devices it can climb slopes previously deemed cable yarding area**



# Bogie Arm Development 635D



Greater Number of  
Rear Tire Options  
Including 30.5L-32

Tigercat Designed  
Gear Train



## Rear View























13.01.2010 15:41





13.01.2010 15:41



























# Malaysian slope benching technique





# Malaysian slope benching technique





**Increased use of excavator based swing yarders where possible**

**Increased use of leveling shovel logger/skidder combinations following leveling feller bunchers for a fully mechanised solution**

**Where appropriate, the increased use of full tree harvesting methods where residues are required for biofuel feedstock**

**Difficult terrain will always present challenges for machine manufacturers but technology also will have its limitations**









**Questions or Comments**