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Industrial Fabrication Inc.
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MINING DIESEL mdec EMISSIONS COUNCIL

UT150-*e*MV

From Concept to Reality

Oct 8, 2014

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UT150-*e*MV From Concept to Reality

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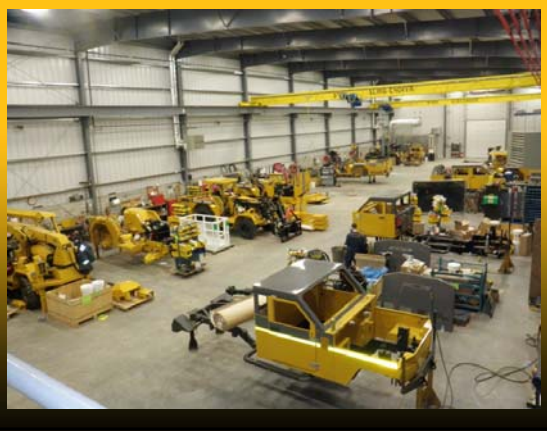
Who we are

- Canadian owned, new 37000 ft² facility
- 450 Minecats working around the world
- Capacity of 12 units per month



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Our Team, Our Vision

To continue to grow by helping miners to find innovative solutions to specific problems using cost effective utility vehicles.

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Why Electrify?

- Health and Safety - diesel exhaust
- Reduction of ventilation requirements and costs
- Reduction in energy requirements and fuel savings
- Reduction in maintenance costs

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Electrification for Health and Safety

- Diesel engine exhaust listed as a Group 1 carcinogen in 2012.
- Reduced vibration and noise = operator comfort and reduced stress

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Electrification = Ventilation Cost Reduction

- Ventilation cost is large
- CFM per HP
- Less diesel = reduction in costly ventilation
- Battery electric drivetrain by itself causes no requirement for ventilation
- Reduction in heat generation

Cost Down

Ventilation Cost Savings for UT150-eMV

	Horsepower	CFM per HP	CFM	Cost per CFM	1 year cost	5 year Cost
UT99 Diesel	100	100	10000	$ 4.50	$ 45,000.00	$ 225,000.00
Land Cruiser	134	100	13400	$ 4.50	$ 60,300.00	$ 301,500.00
UT150-eMV electric	200	0		n/a	$ -	$ -

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Electrification = Fuel Cost Reduction

- $10000-$13000 annual savings per vehicle
- Efficiency of a diesel engine is 40-50%, vs 90%+ with our PMAC

Cost Down

Fuel Cost for UT99

Average Liters/Day	Days	$/Litre	1 year cost	5 year Cost
19.96	360	$ 1.40	$ 10,059.84	$ 50,299.20
19.96	360	$ 1.75	$ 12,574.80	$ 62,874.00
19.96	360	$ 2.00	$ 14,371.20	$ 71,856.00

Electric Charging Cost for UT150-eMV

Pack Size (kWh)	Days	cost per kWh	1 year cost	5 year Cost
26	360	$ 0.05	$ 468.00	$ 2,340.00
26	360	$ 0.10	$ 936.00	$ 4,680.00
26	360	$ 0.15	$ 1,404.00	$ 7,020.00

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Electrification = Maintenance Savings

- 77% reduction in part numbers
- 1000 fewer parts
- Eliminating filters, fan belts, alternators, starters, radiators = 30% reduction in maintenance costs.

Cost Down

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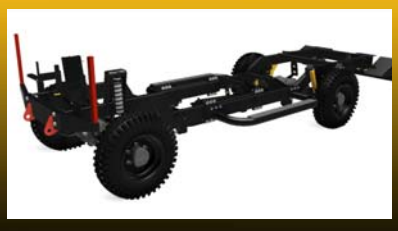
Platform Description

- Industrial Fabrication began looking at electric drive trains in 2005
- Technology not ready at the time
- In 2011, we decided to embark on an electric mining vehicle project – eMV was born



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Platform Description

- Same chassis and body as our popular UT99 utility truck.
- Purpose built for mining, Rugged modular frame for durability and cageability,
- Industrial axles with SAHR brakes, a dedicated hydraulic system
- Heavy gauge ROPS/FOPS level 2 certified cab.

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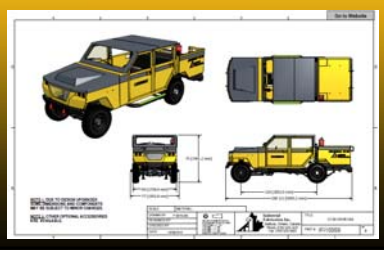
UT150-eMV – Design Process

- Data collection and drive cycle analysis
- Power and energy requirements
- Battery pack sizing and mechanical design
- Motor design
- EDS Supporting equipment
- Hydraulic system design
- Assembly and tuning

Date	Runtime [hr]	Runtime [min]	Fuel Consumed [L]	Energy Consumed [kWh]	Distance [km]
13/03/2012	2.47	148.23	15.85	153.79	30.91
14/03/2012	4.00	239.84	22.17	215.05	40.82
15/03/2012	3.48	208.57	18.76	181.99	35.40
16/03/2012	3.12	186.99	19.18	186.06	37.61
17/03/2012	3.19	191.65	21.96	213.06	43.69
18/03/2012	1.71	102.84	10.60	102.84	20.65
19/03/2012	3.46	207.67	18.83	182.66	34.94
20/03/2012	3.49	209.54	18.38	178.32	35.18
21/03/2012	4.64	278.63	21.28	206.42	38.67
22/03/2012	2.95	177.17	17.12	166.10	32.68
23/03/2012	4.70	282.28	21.29	206.53	37.99
24/03/2012	3.31	198.34	18.40	178.50	35.25
25/03/2012	2.97	178.09	17.33	168.13	33.63
26/03/2012	2.27	136.38	11.14	108.05	20.24
27/03/2012	3.26	195.56	17.34	168.24	33.22
28/03/2012	3.17	189.92	14.91	144.60	28.80
29/03/2012	3.75	224.95	19.48	188.98	36.67
30/03/2012	5.31	318.39	25.01	242.63	48.61
31/03/2012	3.02	181.36	14.27	138.43	24.56
01/04/2012	2.49	149.47	13.64	132.27	26.14
02/04/2012	2.13	127.96	12.55	121.75	24.12
03/04/2012	4.72	282.92	22.33	216.57	42.44
04/04/2012	0.62	37.02	3.01	29.18	5.00



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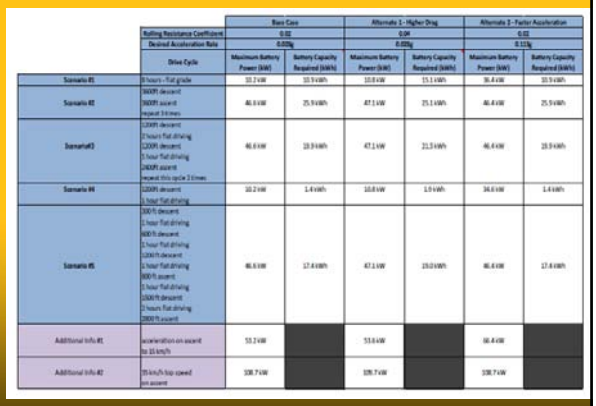
UT150-eMV – Design Process

- Data collection and drive cycle analysis
  - Two sites
  - Large data set
  - Energy simulation partners
- Power and energy requirements
  - Defines battery



	Rolling Resistance Coefficient	Base Case		Alternate 1 - Higher Drag		Alternate 2 - Faster Acceleration	
	Desired Acceleration Rate	0.02		0.04		0.02	
		0.05g		0.05g		0.11g	
	Drive Cycle	Maximum Battery Power (kW)	Battery Capacity Required (kWh)	Maximum Battery Power (kW)	Battery Capacity Required (kWh)	Maximum Battery Power (kW)	Battery Capacity Required (kWh)
Scenario #1	8 hours - flat grade	10.2 kW	10.9 kWh	10.8 kW	15.1 kWh	36.4 kW	10.9 kWh
Scenario #2	3600ft descent 3600ft ascent repeat 3 times	46.6 kW	25.9 kWh	47.1 kW	25.1 kWh	46.4 kW	25.9 kWh
Scenario#3	1200ft descent 2 hours flat driving 1200ft descent 1 hour flat driving 2400ft ascent repeat this cycle 2 times	46.6 kW	18.9 kWh	47.1 kW	21.3 kWh	46.4 kW	18.9 kWh
Scenario #4	1200ft descent 1 hour flat driving	10.2 kW	1.4 kWh	10.8 kW	1.9 kWh	34.6 kW	1.4 kWh
Scenario #5	300 ft descent 1 hour flat driving 600 ft descent 1 hour flat driving 1200 ft descent 1 hour flat driving 600 ft ascent 1 hour flat driving 1800 ft descent 2 hours flat driving 2400 ft ascent	46.6 kW	17.4 kWh	47.1 kW	19.0 kWh	46.4 kW	17.4 kWh
Additional Info #1	acceleration on ascent to 15 km/h	53.2 kW		53.6 kW		66.4 kW	
Additional Info #2	35 km/h top speed on ascent	108.7 kW		109.7 kW		108.7 kW	

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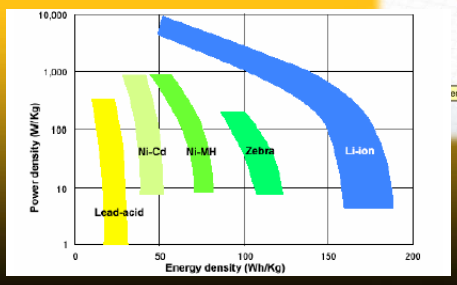
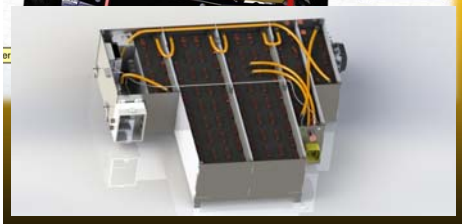
UT150-eMV – Design Process

- Battery pack sizing and design
  - Shape / volume available
  - Target weight
- Battery chemistry
  - Li-Ion dominates BEV market
  - 50% reduction by 2020





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UT150-eMV – Design Process

Motor design

- Unique drivetrain = Demanding parameters
- Liquid cooled PMAC
- Light and powerful, 52kg 150 kW

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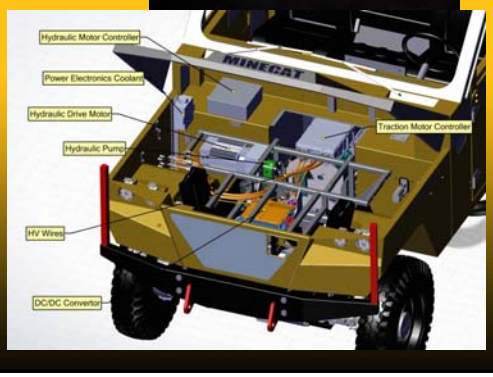
UT150-eMV – Design Process

- Inverter, BMS, Control system, charger
- Inverter
  - DC to AC
  - Full control through custom programming
- BMS
  - Continually monitors battery
  - Safety device



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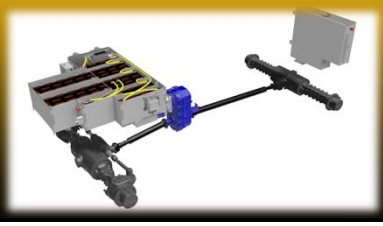
UT150-eMV – Design Process

- Charger
  - 220V, 208V, 600V
  - Onboard – multiple charge points
- Elec. Hydraulic system (EHS)
  - Steering, braking, and standard attachments
  - HV drive with helical gear pump
  - Ramp Test approved 2013



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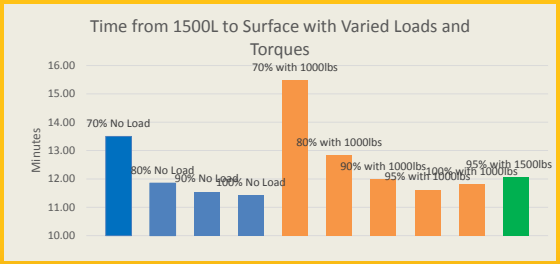
UT150-eMV – Design Process

Prototype tuning and testing

- 8 week "battery" of tests
- Torque, amperage, speed and payload tested

Verification of Range

- 42 km range ramp travel, 50% ascent, 50% descent.
- 5 trips from 1500L to surface and back



Torque and Load	70%-No Load	80%-No Load	90%-No Load	100%-No Load	70%-1000lbs	80%-1000lbs	90%-1000lbs	95%-1000lbs	100%-1000lbs
Battery Used	28%	30%	30%	29%	32%	32%	33%	32%	34%
Battery Regen	11%	11%	11%	10%	13%	12%	12%	13%	12%
Time (m:s)	13:30	11:51	11:33	11:25	15:29	12:50	12:00	11:37	11:50
Avg Peak Current	120A	145A	155A	165A	120A	145A	165A	165A	170A

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UT150-eMV – Production version Details

- Drive characteristics
  - Lack of noise
  - Torque
  - Regenerative braking
- Design details and specifications
  - 150kW motor
  - Li-Ion battery, 10 yrs, 3000 full DOD cycles
  - 11% more energy storage with new cells

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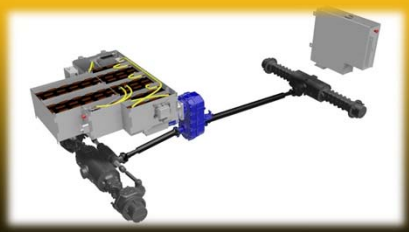
UT150-eMV – Production version Details

- Range
  - 50+km ramp travel
  - 80km flat terrain
- Charge Time
  - 3.5 hrs for 0-100% with standard production pack
  - "Opportunity" charging 35% in 1 hr
- Cost Impact
  - 30-40% premium



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Thank you!