# Power & Mobility (P&M)

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#### Pushing The Limits With a 1000hp Transmission For Tracked Vehicles

Mike Brown & Greg Szkilnyk - Ker-Train Research Inc.

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# Agenda

- Power & Mobility (P&M)
- Brief Introduction to Ker-Train Research Inc. (KTR)
- Core Technologies
  - Binary Logic Transmission Architecture
  - Addendum Contact Gearing
  - PolyCone Clutches
  - Regenerative Steering Differential
- Innovative Combat Transmission (ICT)
  - History & Highlights
  - Overview & System Architecture
- Application Targets / Adaptability & Integration Flexibility
- Preliminary Testing Results

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#### Ker-Train Research Inc.

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- R&D Engineering firm based out of Kingston, Ontario, Canada
- Specializes in the development of unique *powertrain* technologies
  - Gearing
  - Clutching
  - Non-traditional driveline architectures
- Concept, design, simulation & analysis, build and test

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• Binary Logic Transmission Architecture

- Pioneered by KTR in the 1980's
- Interconnected series of two-state (i.e. binary) gear modules, each with a ratio state and a direct drive (1:1) state

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- Equal ratio steps between ranges
- Quasi-CVT like behavior



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- Addendum Contact Gearing
  - Unique tooth flank geometry (addendum contact only)
  - High contact ratios
  - High power density
  - Increased torque capacity
  - Low bending stress
  - Quiet

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Addendum Contact Gearing

- Manufacturing studies
  - Equivalent cost to traditional involute gearing
- Proprietary sizing tools





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- PolyCone Clutches
  - Blends features of a *disc clutch* and a *cone clutch*
  - Small axial envelope
  - Ability to stack *multiple* plates
  - High torque capacity
  - Low parasitic drag





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Regenerative Steering Differential

- Fully-geared steering system
- No meshing losses in straight drive
- In a turn scenario, the negative torque produced on the inner track is transmitted directly to the outer track through this differential

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# **ICT** Highlights







# **ICT** Overview & Architecture

1,000 / 785 hp Peak/Cont. Input Power 2,020 / 1,583 lbf-ft Peak/Cont. Input Torque 47.6 / 37.4 hp/ft<sup>3</sup> Peak/Cont. Power Density 32 Propulsion Ranges (Forward & Reverse)

**32** Steering Ranges (per side)

14.32:1 Highest Ratio

0.75:1 Lowest Ratio

16,000 lbf-ft Maximum Total Output Torque

3,785 rpm Maximum Output Speed



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# **Application Targets**

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#### **Original**

- Drop-in replacement for the **HMPT** in the *Bradley Fighting Vehicle (BFV)*
- Paired with Cummins 600 hp VT903 Engine



#### <u>Future</u>

- High power applications such as *Advanced Powertrain Demonstrator (APD)*
- Paired with Cummins 1000 hp Advanced Combat Engine (ACE)





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#### Adaptability & Integration Flexibility



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# **ICT** Testing

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Four phases of planned testing



# ICT Testing - Low Power @ KTR

- Average Mechanical Efficiency = 92.4%
- Average Overall Efficiency @ 400hp = 84.1% (brakes, pumps, etc.)
- Projected Overall Efficiency @ 785hp = 88.4% (brakes, pumps, etc.)

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# Conclusion

- Ker-Train's Innovative Combat Transmission offers a solution for 40-50ton tracked-vehicles platforms
- Design leverages 10+ years of development and testing
- High efficiency
  - Increased fuel economy, vehicle range and performance
  - More power to the sprockets and less to the cooling system
- Unique core technology allows for compact packaging and high power density
- Drive-by-wire capability
- Technology is reconfigurable and scalable

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