The U.S. Army's Vehicle Intelligence Program (AVIP): The Future of Manned, Wheeled Tactical Vehicles

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NATIONAL TRANSPORTATION RESEARCH CENTER

ITS

ornl

Intelligent Transportation Systems Research Program

Oak Ridge National Laboratory

National Transportation Research Center

http://www.ornl.gov/ORNLReview/v33_3_00/features.htm

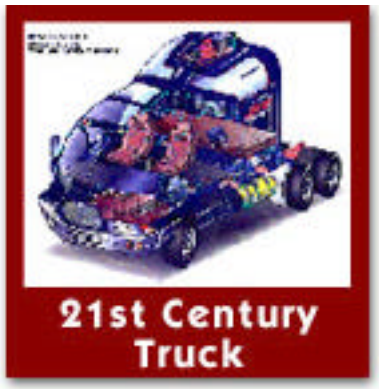
1. **Propulsion, Vehicle and Power Systems**
2. **Information and Decision Support Systems**
3. **Materials, Structures, and Mechanical Systems**
4. **Safety, Security and Human Factors**
5. **Systems Operations and Control**
6. **Energy Efficiency and Environment**

National Automotive Center

U.S. Army Tank-automotive & Armament Command

http://www.tacom.army.mil/tardec/nac/index.htm

- Founded in 1992
- DoD/Army focal point for collaborative ground vehicle research and development (R&D)
- Its primary focus is to benefit current and future military ground vehicle systems through:
  - performance improvements,
  - service life extensions, and
  - reduction in ground vehicle design, manufacturing, production and operating and support costs.



- increase fuel efficiency
- enhance safety
- cut total owning and operating costs
- reduce emissions
- maintain or enhance performance

- University of Alaska Fairbanks
- Clemson University
- University of Iowa
- University of Michigan
- Oakland University
- University of Tennessee
- Wayne State University
- University of Wisconsin - Madison

Vehicle Intelligence

Vehicle Intelligence (VI) is the application and integration of vehicle electronics (telematics) within vehicles in order to provide a more efficient and safer driving task/mission.

VI provides new driving functionalities, and enhances existing functionalities, that will optimize performance in real-world driving environments. Specifically, VI can:

- **enhance mission logistics**
- **optimize fuel consumption,**
- **enhance driver efficiency**
- **increase mission safety margins**
- **minimize vehicle emissions**

VI Issues in the U.S

- Product Liability
- Limited Direct Control Functions
- Untrained Population
- Independent, Non-Integrated Systems

Evolutionary Process:

* Driver Warning
* Driver Advise
* Driver Assistance
* Partial Control
* Autonomous Control Functions

The Army Vehicle Intelligence Program (AVIP)

A New U.S. Army Concept to Enhance Productivity, Efficiency, Sustainability, Safety, and Driving Quality of It's Wheeled Tactical Fleet…

AVIP will:

1. Build on the Lessons Learned of the US-DOT ITS Program.

2. Conduct Research in Advanced Vehicle Control

3. Integrate Robotics Technologies

4. Demonstrate Advanced Vehicle, Soldier-in-the-Loop Concepts

AVIP Objectives:

- **Assess the utility of commercial ITS/VI technologies for application to Army Transformation, Future Combat System (FCS), and 21st Century Truck (21CT).**

- **Develop advanced vehicle control technologies that center on the soldier/driver in the loop.**

AVIP Objectives:

- **Develop on-board information management technologies that are sensitive to soldier/driver cognitive loading, the potential for distraction, and appropriately directed soldier/driver attention.**

- **Develop advanced control functions that will allow various types of soldier/driver-vehicle interactions. For Example:**
  - **Low Workload - Warnings**
  - **Higher Workload - Advice**
  - **Even Higher Workload - Driving Assistance**
  - **Semi-Autonomous Functions**
  - **Autonomous Driving**

AVIP Objectives:

- Build on the Army's extensive robotics technologies (Unmanned Ground Vehicle, Demo III, etc.)

-Autonomous Collaborative Systems

-Control and Coordination of Distributed Systems

-Depth Extraction

-Image Clutter Characterization

-Machine Learning

-Machine Vision

-Multi-Spectral Imaging and Analysis

-Object Recognition/Tracking

-Performance of Degraded Systems

-Sensor Fusion

-Stereo Vision

-Supervisory and other Advanced Control

-Vision-Based Navigation

AVIP Objectives:

- **Demonstrate through modeling, laboratory experiments, and Field Operational Tests, how AVIP technologies can:**
  - **improve fuel efficiencies**
  - **enhance driver/soldier efficiency/productivity**
  - **enhance mission efficiencies/logistics, and**
  - **improve safety.**

The AVIP Paradigm (a System of Systems Approach)

Vehicle

Driver

Intelligent Vehicle Advanced Control Capabilities -

Human Factors and Advanced Human-System Interfaces

On-Board Information Integration and Management

On-Board Systems

Communications

External Environment

The Importance of AVIP

- **It will stimulate the assimilation of VI Technologies into the Army's Tactical Fleet.**
- **It will allow the Army to lead research areas that are too slow in coming from the private industry.**
- **It will allow the Army to be early beneficiaries of research results that can contribute to Army Transformation, FCS, and 21CT; and enhance ground vehicle logistics, mission/fuel efficiencies, safety, etc.**
- **It will function to draw the interests of other Federal Agencies (e.g., DOT) and private industry.**

Major AVIP Research Methods

1. Modeling (Assessment of the Impact of VI Technologies on Military Applications).

2. Laboratory Studies (Functional and Physical Integration, Data/Message Handling, Human-System Interface Research, Algorithm Development).

3. Vehicle Demonstrations (Bringing Laboratory Results to Life).

4. Field Operational Tests (Collection of Data to Assess Impacts and Benefits).

AVIP Research Areas

1. Physical Integration of VI Technologies
2. Functional Integration of VI Technologies
3. VI Information Fusion
4. Driver Associate Concepts
5. Advanced Soldier-Vehicle Interfaces
6. Advanced Control: Autonomous Functionalities and Semi-Autonomous Control
7. Integration of Robotics Technologies

Candidate ITS/VI Technologies for AVIP

- Adaptive Cruise Control
- Collision Avoidance and Prevention
- Drive-by-Wire
- Driver Condition Monitoring
- Driver's Associate
- Fleet Management.Logistics
- Fuel Burn Optimization
- In-Vehicle Information Fusion
- Lane Tracking
- Navigation Systems
- Night Vision/Vision Enhancement
- Platooning/Electronic Tow Bar/Vehicle Following
- Route Guidance
- Truck Rollover Warning
- Truck Stability Technologies

The Army's Tactical Wheeled Vehicle Fleet Several Different Families of Trucks

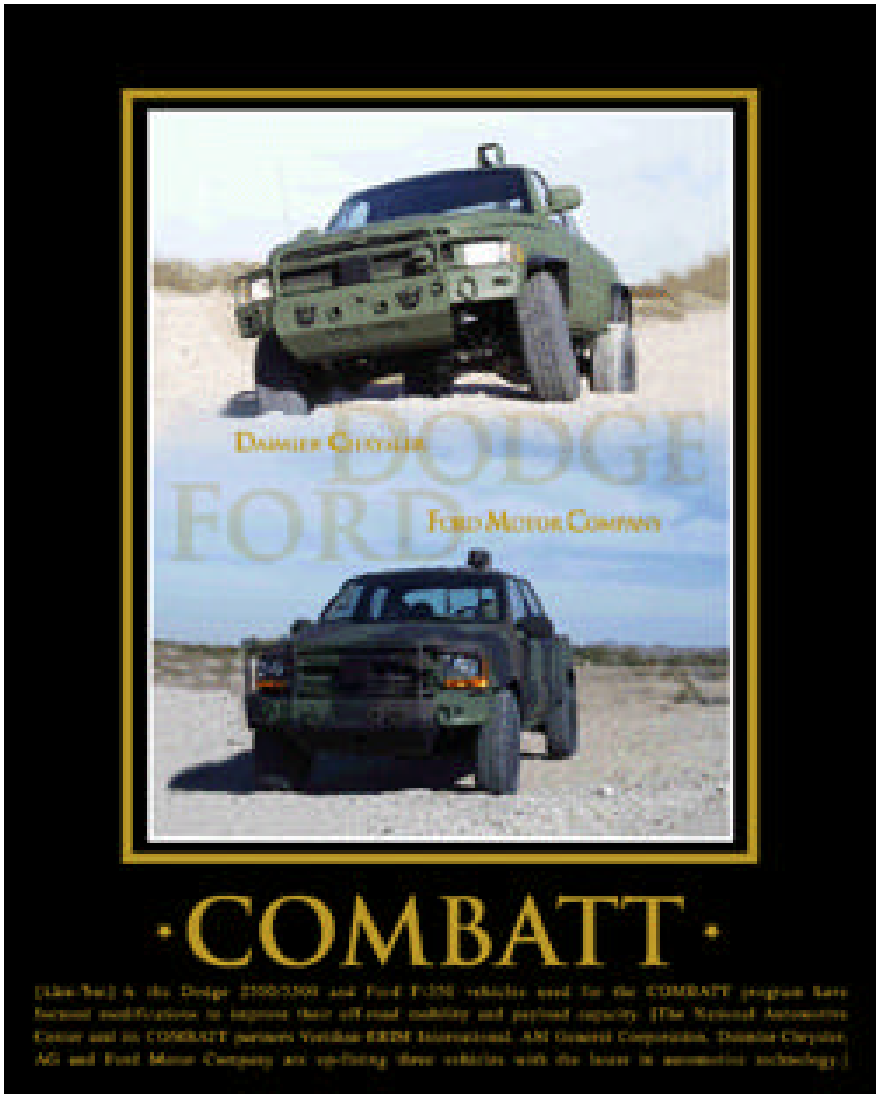
- Commercial Utility Cargo Vehicles (CUCVs)
- High Mobility Multi-Purpose Wheeled Vehicles (HMMWVs)
- Family of Medium Tactical Vehicles (FMTVs)
- M900 series line haul tractors and special bodies
- Heavy Expanded Mobility Tactical Truck (HEMTTs)
- Palletized Loading Systems
- Heavy Equipment Transporter Systems (HETSs)
- M809/M939 and older series 5-Ton Trucks

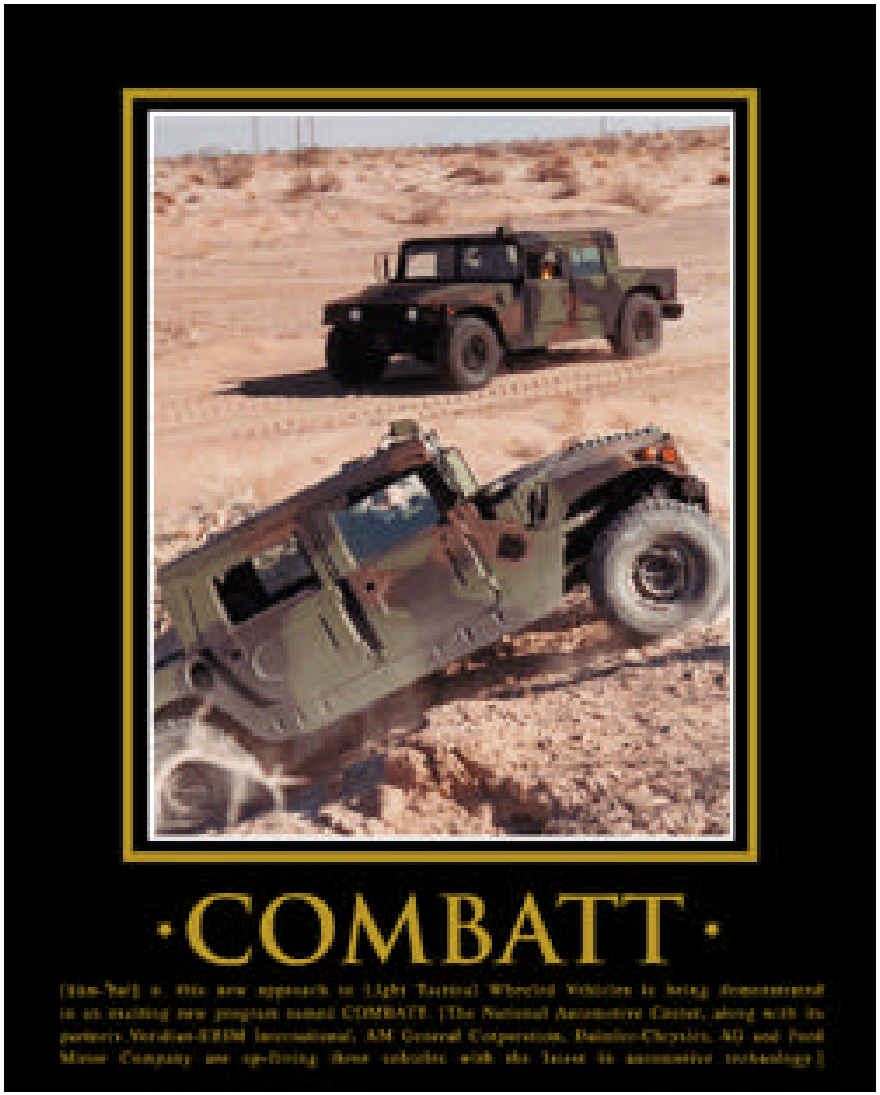
Representative Pictures of Three of These family types

Class IIB – HMMWV M998 Utility Vehicle

Class VIII – M915 Line Haul Rig

Class VI – FMTV Tactical Truck





COMmercially BAsed Tactical Truck (COMBATT)

SMART TRUCK

Audiovox Mobile Video
Countermeasures
Delphi QUADRASTEER™
ECLIPSE Commander
Cutler-Hammer PanelMates
Biocentric/AuthenTec Fingerprint Identification
ICRC Remote Control Weapon Station
Raytheon Night Vision
Valde Vehicle PC
DriverTech Truck PC

Integrate and demonstrate a hybrid electric drivetrain for improved fuel economy and range

Integrate next generation voice controlled navigation computer with map display

Develop and evaluate a satellite linked data acquisition system and flight recorder box for improved soldier safety

Lower maintenance, operating and support costs with on-board computers used for improved and faster diagnostics and service.

Demonstrate first multiple databus concept on military trucks

Reduce cost and increase frequency of computer communications upgrades by embracing “plug-and-play” commercial and off-the-shelf technology

Share cost of research and development with private industry.

Future Direction

- **DOD funding is being put into place.**
- **Leveraging opportunities are being sought with other U.S Federal Agencies.**
- **Team building with private industry/academia is taking place.**
- **Initial efforts (~ $2M) are being planned for FY-02.**
- **Longer-term efforts (~$15M/yr.) are being defined.**

Conclusions

- **AVIP is an important element in the Army's Transformation.**
- **The soldier/driver will remain a key element of the Army's Interim and Objective Force Projections.**
- **AVIP will improve fuel efficiencies, mission efficiencies, logistics, safety, and sustainability.**
- **AVIP will be the catalyst for implementing ITS/VI technologies into the Army's wheeled tactical fleet, and will lead the development of advanced control technologies.**