By combining the inherent mobility of CRUSHER with advanced perception techniques including the use of learning and prior terrain data, the UPI program stresses systems design across vehicle, sensors and software so that the strengths of one component compensate for the weaknesses of another.
The UPI program, initiated July of 2004, extends the UGCV and PerceptOR efforts by integrating these parallel development programs into one. Created as a Future Combat Systems (FCS) technology feed program, test results found on the UPI program are influencing and leading efforts on many military vehicle programs targeting deployment in the near future.

Through the UPI program, NREC has designed CRUSHER, featuring a new hull, new suspensions, and many developments and improvements based upon the SPINNER version 1.0 vehicle.

With the addition of two new CRUSHER vehicles, the program is able to conduct parallel field testing agendas in varied terrain sites.

Building on successful results from PerceptOR, the perception and automation systems are being extended to provide improved automation capabilities at higher speeds. More focus is placed on learning technologies which allow the vehicle to experiment and react to previously untravelled terrains. Technologies that supervise or support off-road navigation in highly varying terrain are a priority.

Rigorous field testing continues to allow for improvement of endurance, obstacle capability, and payload fraction (the primary goals for the UGCV program). Vehicle performance is analyzed, modified, and tested continuously pushing to maximize inherent terrainability of the CRUSHER platform.

Payload development, integration and testing are proving out the intended mission scenarios. Leveraging upon unmanned vehicle capabilities and CRUSHER’s unique terrain capabilities, these field tests are helping to demonstrate and influence the use of autonomous vehicles in the future.

UPI brings together technologies and people to produce autonomous platforms capable of conducting missions with minimal intervention.

NREC and DARPA are working to create some of the most advanced and intelligent autonomous ground vehicle platforms available today.
Created in 2001, the UGCV Program developed vehicle prototypes that exhibit advanced performance in endurance, obstacle negotiation, and payload capability based on novel designs unrestrained by the need to accommodate human crews. The reduced logistical footprint resulting from high fuel economy, high payload fraction, and simplified transportability offers excellent deployability for the Future Combat Systems (FCS) program. DARPA and the Army evaluated UGCVs against three primary metrics:

1. Endurance (14-day missions; 450 km range without refueling),
2. Obstacle Capability (1m+ positive, 2m negative, 35º slopes), and
3. Payload Fraction (>25%).

In the UGCV program, NREC led a four-member team (Boeing, Timoney Technology, DRS-TEM) to build an innovative unmanned vehicle, "SPINNER," that couples extreme terrainability with fuel efficiency, survivability and payload flexibility to deliver the long-range capability required by FCS missions. SPINNER has completed two years of intense testing to fully assess its capability in a variety of terrains, weather conditions and operational scenarios. Results continue to show SPINNER as a viable option for UGCV technology in the future.

Key team members & vendors: Boeing (hull), Timoney Technology (suspensions and hubs), DRS-TEM (hybrid control), UQM (traction motors), Capstone (turbine), SAFT (battery pack), Novatel (positioning), SBS (computing).
S

tarted in 2001, the PerceptOR pro-
gram was created to develop per-
ception and autonomous navigation
abilities for ground vehicles operat-
ing in complex, off-road environments
and to test and evaluate these capabili-
ties on a variety of terrains in an unre-
hearsed manner.

The NREC led a four-member team
(with Sarnoff Corporation, Boeing, and
Robotics Engineering Excellence) in the
PerceptOR program. The team’s innova-
tive "Blitz" concept included a dedicat-
ed unmanned air vehicle - a "Flying
Eye" (FE) - that flies ahead of the UGV
to detect holes and other hazards
before the onboard UGV sensors would
otherwise be able to detect them. The
UGV itself carries its own extensive sen-
sor suite to address the broad range of
operating conditions at slower speeds
and to confirm the hazards seen from
the air. Both systems can operate fully
autonomously or with several levels of
operator involvement.

During Phase II (2002), the NREC team
successfully completed evaluation
experiments of unrehearsed courses
located in four terrains: Virginia
forests, Arizona desert, California
alpine and Louisiana forested low-
land. The team demonstrated fully-inte-
grated unmanned air/ground sensing
to detect and avoid negative obstacles
and other hazards. In addition, the
vehicles negotiated complex terrain
using only passive sensing, identified
and negotiated difficult terrain types
(ground cover, meter-high vegetation,
desert scrub) by fusing geometric and
color sensor data, and overcame brief
periods of GPS dropout with tight inte-
gration of GPS and odometry.

In Phase III (2003/2004) the team
matured UGV autonomous capabilities
through further development and field
trials. Improvements included dynami-
cally increasing UGV speed when
appropriate, classifying a broader
range of objects and surfaces, and
operating with degraded GPS and
communications.

During Phase II, the NREC team conducted rigorous tests at
the Yuma Proving Ground.
The National Robotics Engineering Center (NREC) develops and delivers leading edge automation technology to industry and government to enable new products and capability. Founded in 1995 as an operating unit within Carnegie Mellon’s Robotics Institute, NREC employs over 125 scientists, technical staff, graduate students and support personnel. The 100,000 sq. ft. facility is only a ten minute drive from the Carnegie Mellon campus.

We partner with clients so that our technology can be transitioned as quickly and effectively as possible. We mitigate client risk by continual team focus on measurable project objectives, accelerated product development, reuse of core NREC technologies and extensive field testing under real-world conditions.

(Above) Gladiator, an unmanned robotic vehicle that exhibits high mobility and advanced robotic scouting capabilities required for the Ground Combat Element of the United States Marine Corps.

(Left) Dragon Runner™, developed for the US Marine Corps Warfighting Laboratory, is a small, man-portable robot, capable of inverted operation and designed to increase situational awareness.

**Government Sponsors**

**PROGRAM MANAGER**

**BRIGADE COMBAT TEAM**

One Team-The Army/Defense/Industry

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