

# Low Cost, High G, High Accuracy, MEMS IMU Coordinated Development and Manufacturing Effort for Common Guidance

## PROBLEM / OBJECTIVE

The U.S. Army RDECOM Armament Research, Development, and Engineering Center (ARDEC), and the Aviation & Missile Research, Development, and Engineering Center (AMRDEC) collaborated on a six year coordinated development and manufacturing effort to mature and demonstrate key Micro Electro-Mechanical Systems (MEMS), Inertial Measurement Unit (IMU) technology. Phase I and II of the program objectives were to design, develop, and produce an IMU that can survive launch accelerations of >20,000 Gs, have an accuracy of  $\leq 20$  degrees per hour over the launch environment, at a volume of 4 cubic inches. Phase III objectives are to produce a Deeply Integrated (GPS/IMU) Guidance and Navigation Unit (DIGNU) in conjunction with Global Positioning System (GPS) technologies. This program leveraged the developments of DARPA and the tri-services' MEMS IMU/gyro and accelerometer efforts. It was coordinated with the Air Force and Navy ManTech program offices to ensure that efforts were complementary.

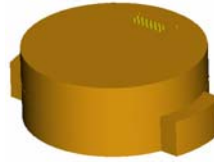
## ACCOMPLISHMENTS / PAYOFF

**Process Improvement:** ManTech investments integrated design, production processes, test automation and inspection. The accelerometer fabrication transitioned from a 4" wafer to a 6" wafer due to ManTech efforts, which resulted in a yield increase of more than 200%. Phase II objectives have been demonstrated and are making an impact on Department of Defense (DOD) weapon systems. The U.S. Army's XM982 Excalibur munition selected the Phase II IMU for their guidance/navigation solution to proceed to early fielding. The Phase II DIGNU is also integral in the development of the U.S. Navy's Advanced Gun System (AGS) / Long-Range Land Attack Projectile (LRLAP). The Phase II effort has laid the foundation for a Phase III final product which will incorporate DIGNU.

### Implementation and Technology Transfer:

Both PM for Armament Munitions Systems and PM for Air to Ground Missile Systems have budgeted for the integration and qualification of these units. Phase III IMU is planned for production with a production goal of the IMU in 200K lots over 5 years of \$1200 per unit. The production unit cost goal of the DIGNU in 200K lots over 5 years is \$1500 per unit.

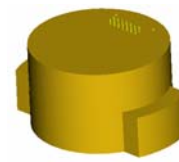
### Phase I



#### Features:

Bias < 75 deg/hr  
Vol < 8 in<sup>3</sup>  
Accel >10,000G

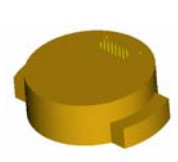
### Phase II



#### Features:

Bias <20 deg/hr  
Vol <4 in<sup>3</sup>  
Accel >20,000G

### Phase III



#### Features:

Bias <1 deg/hr  
Vol <2 - 4 in<sup>3</sup>  
Accel >20,000 G

### Expected Benefits:

The MEMS IMU program has enabled a new class of weapons across the services. It will allow current and future commanders the benefits of:

- Increased Lethality
- Improved Deployability
- Complete System Commonality
- Reduced collateral damage
- Minimized non-combatant casualties

Program strategy and technical success combined for a resultant product that became the guidance and navigation solution for key DoD weapon systems including Excalibur, Small Diameter Bomb (SDB), Hellfire, and Mid-Range Munition. These programs represent a total buy of approximately 110,000 units giving the Army a Return on Investment (ROI) of approximately 6:1.

## TIME LINE / MILESTONE

Start Date: May 2001  
End Date: October 2007

## FUNDING

Army ManTech: \$33.1M  
Army S&T: \$100.2M

## PARTICIPANTS

Honeywell, Minneapolis, MN