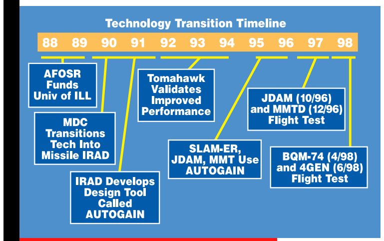
continued from page 1...

the currently fielded JDAM. However, the bomb's weight and volume decreased approximately 10-fold. These features will:

- significantly reduce logistics operations,
- enable new, low-observable aircraft such as the F-22 to carry many more bombs in their internal bays, and
- still maintain their stealth characteristics.


Dr. Kevin Wise




This is a stunning example of the impact of basic research. The size of the munitions was dramatically reduced because of the new controller design capability. Precise automatic control of the smart bomb's angle-of-attack gives it the same penetration capabilities against hardened targets as current munitions that are 10 times larger.


ABOVE: BQM-74 — Navy target Drone

In 1988 and 89, under AFOSR support, Dr. Juri Medanic and Dr. William Perkins, professors at UIUC, developed several new control design methodologies that simultaneously satisfied a diverse set of control requirements including transient performance, disturbance rejection, robustness and reliability. One method they developed, now known as *projective control theory*, is based on finding suitable projections from high-order complex optimal designs to much simpler, low-order controller designs, which achieve near optimal performance while meeting the design constraints.


ABOVE: 4th Generation Escape System

Dr. Kevin Wise, at the Boeing Phantom Works in St. Louis, leveraged the AFOSR-sponsored research. He developed a revolutionary flight control design tool called AUTOGAIN that completely automates autopilot design over the entire flight envelope. The enabling technology in AUTOGAIN was the projective control theory, used to project optimal state feedback designs into output feedback designs, thus eliminating hardware sensors in the implementation. AUTOGAIN's success has made it a "best practice" in the

continued on back page...



# New Design Tools to Expand Use of Composite Materials

New composite materials design and life-prediction tools — derived from AFOSR-sponsored interdisciplinary research — will give structural material designers unprecedented creativity in tailoring composites for demanding, high-performance applications in next-generation aircraft.

Composite material payoffs include:

- Higher temperature performance and stability
- Accurate damage evolution and tolerance prediction
- Optimized fiber-matrix design patterns

Air Force goals of 40 to 50% weight/fuel/cost reductions for 21$^{st}$ century systems like the Air Superiority Fighter (F-22) and the Reusable Space Launch Vehicle (X-33) can be achieved by the expanded use of composites. Lightweight, high-strength composites offer several performance advantages over alloys currently in wide use. Composites inherent thermal resistance (more than double that of alloys) simultaneously affords higher operating temperatures, greater engine thrust, and lighter system weight resulting in thrust/weight ratio improvements of at least 15%. For example, composite propellant tanks on space vehicles can reduce overall primary structural weight by 30%.

However, composite use to date has been limited to non-critical subsystem applications due to the lack of comprehensive, interdisciplinary study of their damage modes under realistic

# New Molecular Dynamics Theory Bene

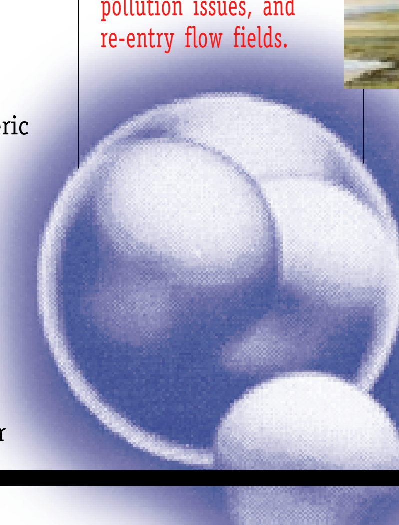
A Georgia Institute of Technology professor's work has potential for important advances in the ability to detect missiles during their boost phase.

Raymond Flannery's AFOSR-supported research is important for the understanding of many phenomena, including radar wave propagation, atmospheric recombination effects of missiles during boost phase, environmental and pollution issues, and re-entry flow fields.

Dr. Raymond Flannery's microscopic theory of three-body recombination processes of electrons and ions in gases has improved researchers' understanding of collisions between atoms and molecules in specific highly excited states.

Understanding these recombination processes will further development of many Air Force capabilities:

- improved radar signatures
- enhanced missile signatures and atmospheric re-entry detection, identification
- advanced techniques to counter enemy detection of friendly missiles
- reduced missile/aircraft atmospheric pollution, and
- integrated circuit manufacture



By improving the understanding of rocket exhaust radar signatures, for example, the Air