TITLE	CONTRACTOR	COST
Insectithopter	Advanced Technology Center	$105,376

ORN NO.: [redacted] (b)(3)

MONTH TO LET: September 1972

SUB-CATEGORY/ELEMENT: Collection Systems/Emplacement Systems

PROJECT: Long Range/Concept Analysis

DESCRIPTION: This is a follow-on program to demonstrate control and communication feasibility of the insectithopter. Under this program, free-flight tests and payload/endurance capabilities will be conducted, and communication, navigation, and propulsion technologies developed.

BACKGROUND: The insectithopter has been tested in free-flight and wind tunnel tests. Concepts for using the "ROME" laser system for command, control, and data link look promising but no specific experiments have been conducted. It is proposed that this system be interfaced with the vehicle and flight tested to at least 300 feet to establish total system feasibility. The "ROME" laser system uses a very small retro-modulator as one mirror of a long laser cavity.

SECRET

COORDINATION: [redacted] (b)(3)

Contract # [redacted]

TYPE OF WORK: Advanced Development

Comp. Date: 11/13/73

FIELD OF WORK: Electronics

COMPLETED AND HISTORY

IDEA	PROP. SOLICITED	PROP. IN H[redacted]

[redacted] (b)(3)

ISSUE DATE	FAN NO.	DIV[redacted]	
9/7/72	[redacted]	Donald Reiser	Charles N. Adkins [redacted]

TITLE	ORN NO.	CONTRACTOR	COST
Insectithopter K-73	[redacted]	Advanced Tech.Cen.	$105,376

(b)(3)

SECRET

ORD-1531-74

4 April 1974

PROJECT HISTORY

Title: Insectithopter ORN: [redacted] (b)(3)
Contractor: Advanced Technology Center
Amount: $105,376

1. Intelligence Objective: To provide a clandestine insect-like (dragonfly) vehicle capable of being directed to a specific target at least 100 meters distant for the purpose of emplacing an audio surveillance device (optical microphone). At the outset of this program, both the aerodynamic and propulsive feasibility had been demonstrated by flight tests during a phase zero effort of $40,000. In addition, the proposed method of providing tracking and guidance (the "ROME Laser" system) was a proven operational concept. On the other hand, the optical microphone had been demonstrated only in breadboard form and further development would be required to meet size and weight requirements.

2. Original Project Goal: Demonstrate system feasibility by:

a. Building a ROME laser system to track the vehicle and provide at least one channel of control signals to the vehicle.

[redacted] (b)(3)

EXEMPT FROM GENERAL DECLASSIFICATION OF E. O. 11652, EXEMPTION CATEGORY:
§ 5B(1), (2), (3) or (4) (circle one or more)
AUTOMATICALLY DECLASSIFIED ON
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(unless impossible, insert date or event)

SECRET

b. Designing and implementing at least a one-axis control system (yaw) which will steer the vehicle upon command.

c. Building a vehicle with sufficient performance to carry the on-board control system and a 0.1-gram payload.

d. Demonstrating system performance by conducting flight tests.

3. Modifications of Project Goal: None.

4. Accomplishments of This Effort Relative to Project Goal and Contribution Toward Intelligence Objective: Even though the project goals were accomplished, additional work must be done to meet the intelligence objective. These include:

a. Provide an additional channel (pitch) of control in both the laser and on-board guidance system.

b. Demonstrate two-channel controlled powered flight outdoors in varying wind conditions to determine emplacement accuracy.

c. Develop further the optical microphone payload to meet weight and size requirements.

The feasibility of a controlled insectithopter vehicle with limited operational capability has been investigated and all program goals to this point have been achieved, either by operational demonstration or through analysis of experimental results. Basic vehicle technology has been developed to provide a vehicle capable of flying at 0.8 g gross weight with flapping wing propulsion alone and at 1.0 g with jet propulsion and cosmetic wing flapping. The actual empty weight is nominally 0.4 g compared to a target weight of 0.6 g. Performance measurements indicate range and endurance capabilities of 200 meters and 60 seconds with jet propulsion and cosmetic flapping for 1.0 g launch weight.

Satisfactory stability and control characteristics were analytically determined and experimentally demonstrated in wind tunnel and free flight tests. Heading error with controls fixed for both straight and turning unpowered flight was repeatably less than ± 50 mils.

A tracking, guidance, and control system was developed and demonstrated for single-channel directional control of the vehicle. The system includes a ROME laser and telescope assembly which has been demonstrated at ranges in excess of 140 meters with a 1 mm target. Transmitted power has been measured in excess of 1.2 watts with a field of view of 80 mils. Tracking was demonstrated up to 140 meter range with a moving target on both indoor and outdoor ranges in various sunlight and wind conditions. Designs for more sophisticated multi-channel systems have been developed and analyzed.

A thermo-pneumatic, ROME-powered rudder actuator was developed and demonstrated at vehicle scale and weight in wind tunnel and flight tests, meeting the control power and response time requirements for directional control of the vehicle.

Wind tunnel and flight test experiments have demonstrated the feasibility of the complete integrated system. Controlled flight was repeatedly demonstrated with a gliding vehicle and the ROME laser on an indoor flight range. Limited powered flight tests were conducted outdoors with fixed controls in winds up to 10 mph with a heading error less than ± 100 mils.

The ultimate demonstration of controlled powered flight has not yet been achieved. Considering the extensive burden placed on the laser operator in the tracking procedure and the additional directional perturbation effects experienced with powered flights, it was concluded that insufficient time remained in the contract period to satisfactorily develop techniques for meaningful powered controlled flights.

5. Evaluation of Project and Contractor: Technically, the project must be evaluated as excellent. However, there appears to be a decreasing lack of support from potential users, and the additional research funds required to meet the final intelligence objective is larger than expected.

The contractor's performance in solving the most difficult and unique problems associated with this unusual program can only receive the highest acclaim.

6. Discussion:

a. Origin of Project. An expressed need for a remote audio emplacement system.

b. Technical Approach. To use an indigenous insect-like vehicle.

c. Personnel and Funding Considerations. Key personnel (research scientists) at ATC had conducted tests on live insects, and the ROME laser technology is proprietary to LTV, which owns 80 percent of ATC. Initially, $40,000 was placed at ATC to demonstrate aerodynamic and propulsive feasibility. The effort described here was for $105,376.

d. Problems Encountered and Solutions. The entire program was a composite of unique problem-solving. In the area of aerodynamics, increased wing stiffness and performance was required to carry the additional payload and control system weight. This was accomplished by incorporating boron fiber elements in the wing. Additional performance was obtained by venting the exhaust aft to provide jet thrust. A larger engine was required to provide increased power to the wings. With the larger engine intake porting, lithium nitrate crystals (the propellant) were being ingested into the engine. This problem was solved by incorporating a thin-walled container for the lithium nitrate inside the fuel tank. Structural and weight problems regarding the airframe and on-board control systems were continually being solved throughout the program.

e. Reasons for Failure or Success. The ability of the contractor to try new materials, build an inexpensive wind tunnel, and conduct many flight tests in a fly it-fix it iterative approach to problem-solving contributed in large measure to the technical success of the program.

f. Recommendations for Further R&D and Disposition of Final Product. Though further development is required to provide for pitch control, emplacement accuracy, and the flight weight optical microphone, the concept feasibility is established. It is recommended that this additional work be done if and when a specific user/mission can be defined so that user and mission specifications can be addressed. To date, there is no final product except general feasibility of being able to achieve the intelligence objectives.

7. Coordination: Various briefings have been given, including OTS who would be responsible for user selection. As of this time, no user and/or mission has been found. The final report has been given to OTS.

Charles N. Adkins
Project Officer