Controlled Biological and Biomimetic Systems

http://www.sysplan.com/cbs

Alan S. Rudolph  Ph.D, MBA

“If one way be better than another, that you may be sure is Nature’s way”
- Aristotle, fourth century B.C.E

DSO
Understanding biological systems presents unique opportunities for developing new defense capabilities through mimicry, integration of living and non-living components, or direct use of complex biological systems.
Controlled Biological and Biomimetic Systems

GOAL: Develop biological and biomimetic systems as mobile distributed sensors, sentinels, and delivery agents.

Biomimetics  Biohybrids  Biosystems

DSO
Biomimetics

Force Dynamics
walking, running, climbing, flying

Neural Control Architectures
object investigation, spatial navigation, target location

Sensorimotor Control
fusion of sensors and actuation, motivation to target

DSO
Gecko climbs vertically at 1m/sec, attaches to multiple surfaces.

Feet are self-cleaning and use dry adhesion.

Prototype leg designed, built and platform tested.

UC Berkeley/IS Robotics

DSO
Neural Control Architectures

Kinematic analysis, muscle control signals

Behavioral action sequences

NEasternU/Massa Products

DSO
Sensorimotor Control and Navigation

Simulation model of odor-guided target location used by moths in following chemical plumes to a source.

U Arizona/Tufts
Biohybrid Systems

- Explore the direct use of biological components
- Develop insect antennae to hand held device to detect odorant plume
Biohybrid Systems

Design interfaces for real time recording and stimulation, two way communications

UMichigan/Duke/Plexon/USC
Target Identification Modes

Undirected Sampling

Directed Sampling

Influenced Sampling

Wind Direction

* Target

○ Attractant
Using Organisms for Target Location

Physiological Response before and after training

Train Organisms to UXO Compounds: 2,4 DNT

Pre-Flight Experience

USDA/Iowa State/ORNL/UAzrizona

DSO
Engineering Bee Colonies

Use individual and social insect behavior and activity for environmental sampling and target location

U Montana/EPA/USDA/CEHR

DSO
## Mission Applications

### Biological Systems
- Animal Sentinels - ‘Sensor Web’ for situational awareness, locate suspected targets (CBW depots or plants)

### Hybrid Biosystems
- Living machines - use as sensor or navigational devices

### Biomimetics
- Fault tolerant locomotion and sensing
- Armament neutralization
SPIKER - Non-lethal Armament Neutralization

• Explore the feasibility of introducing defects into armaments that would result in non-lethal failure

• Implement asymmetrical controlled biological or biomimetic systems to deliver payloads and execute defects

USA-TACOM

DSO
Controlled Biological and Biomimetic Systems

Enhancing Defense Capabilities through Life Sciences

Signals and Alarms
Chemical Analysis and Reporting
Seek and Follow
Transport and Uptake

Sensorimotor Navigation
Force Dynamics
Fault Tolerant Locomotion
Neural Control Architecture

DSO