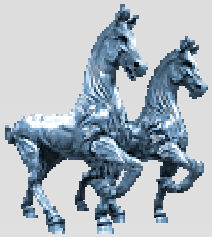


Controlled Biological and Biomimetic Systems

http://www.sysplan.com/cbs

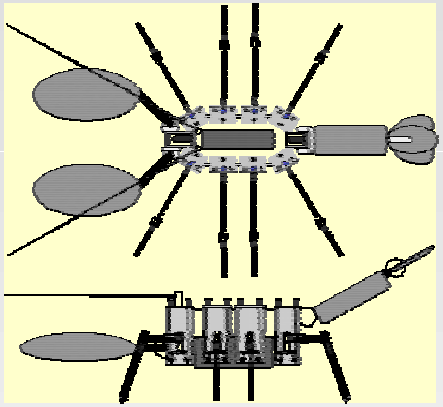
Alan S. Rudolph Ph.D, MBA

"If one way be better than another, that you may be sure is Nature's way"

- Aristotle, fourth century B.C.E

DSO

Controlled Biological and Biomimetic Systems

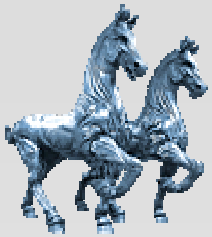


Understanding biological systems presents unique opportunities for developing new defense capabilities through mimicry, integration of living and non-living components, or direct use of complex biological systems

Controlled Biological and Biomimetic Systems

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

Biomimetics **Biohybrids** **Biosystems**



Biomimetics

Force Dynamics

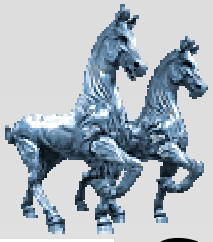
walking, running, climbing, flying

Neural Control Architectures

object investigation, spatial navigation, target location

Sensorimotor Control

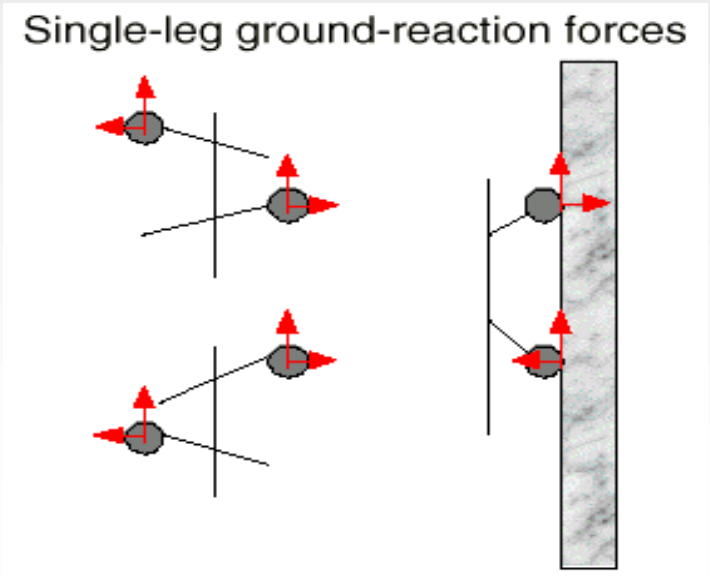
fusion of sensors and actuation, motivation to target



Force Dynamics of Climbing

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

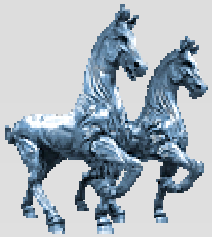
Feet are self-cleaning and use dry adhesion



Prototype leg designed, built and platform tested

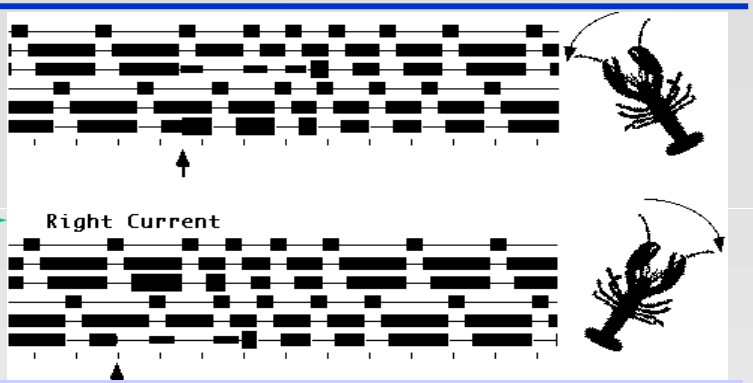
UC Berkeley/IS Robotics

DSO



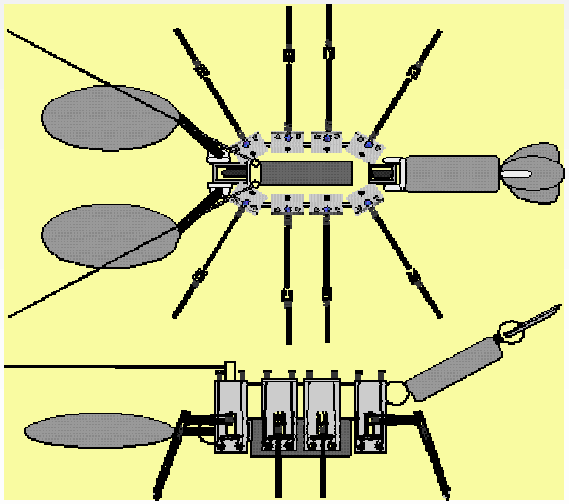
Neural Control Architectures

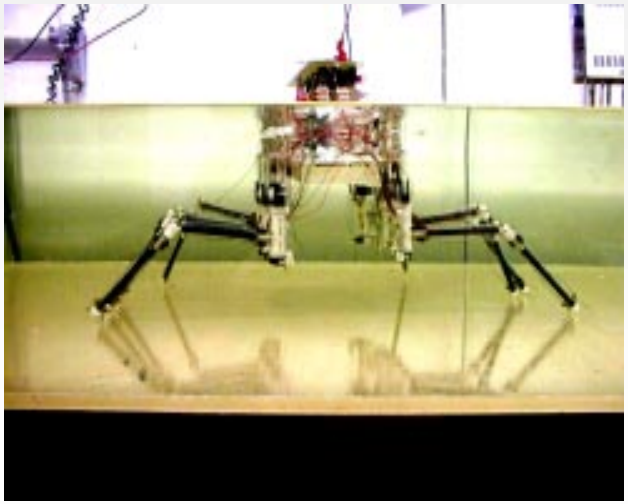
Kinematic analysis, muscle control signals

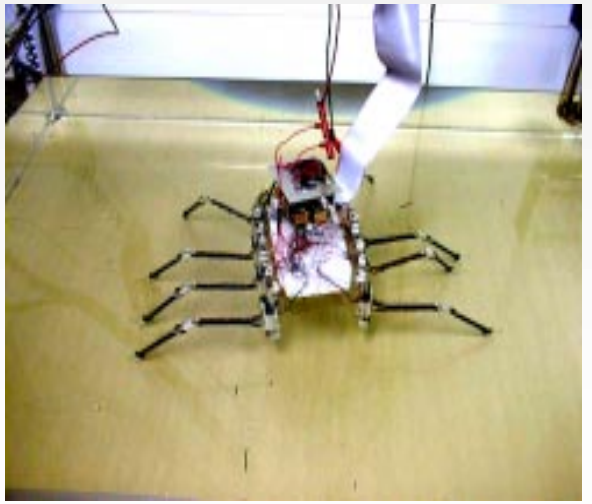


Behavioral action sequences

NEasternU/Massa Products



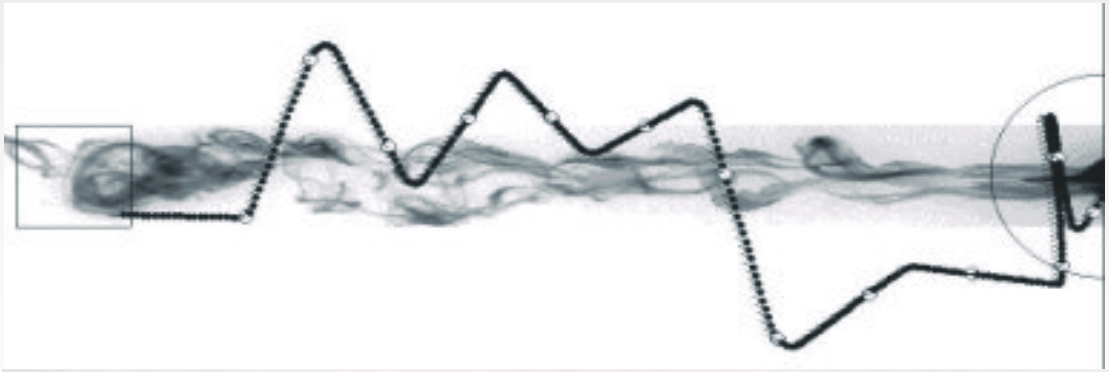


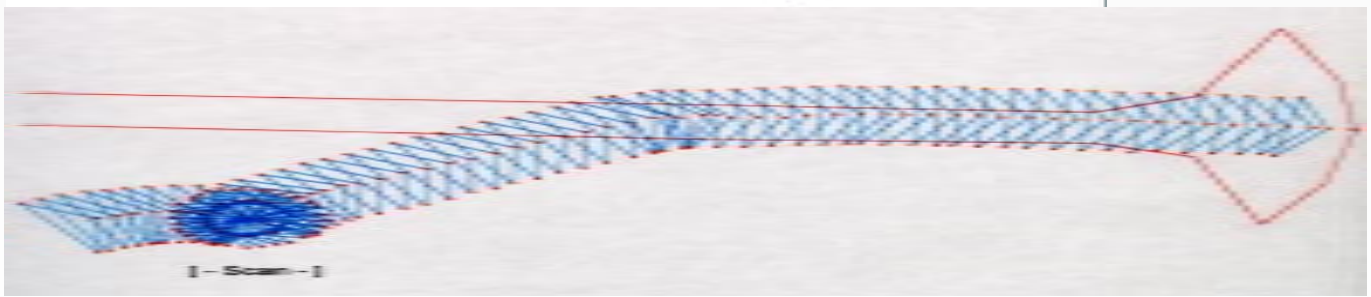


DSO

Sensorimotor Control and Navigation

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



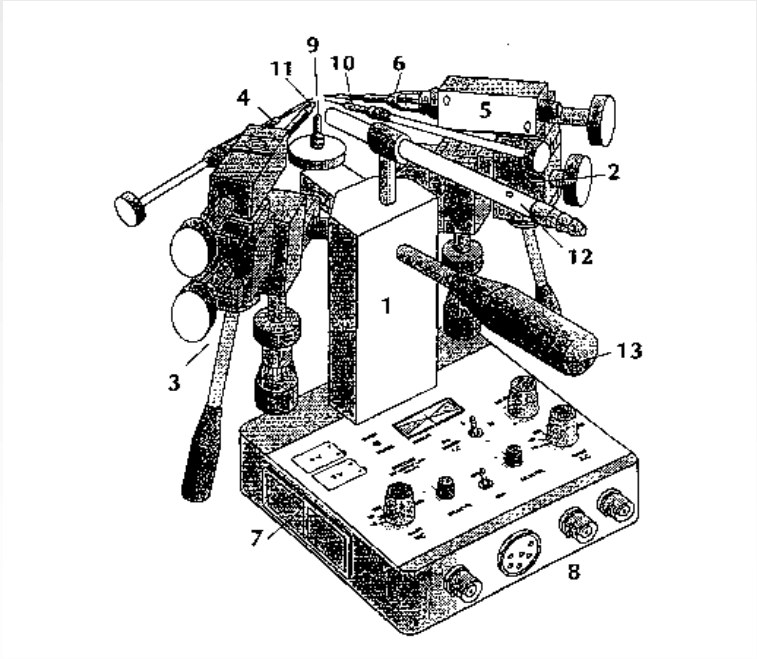


U Arizona/Tufts

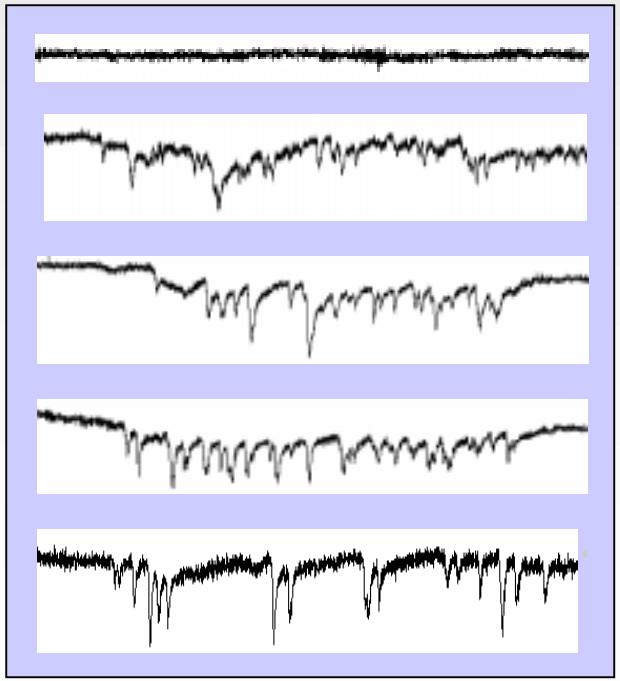
DSO

Biohybrid Systems

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

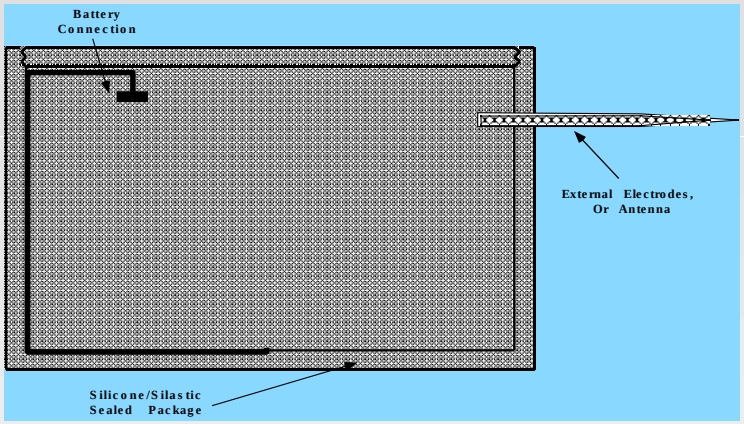


Iowa State

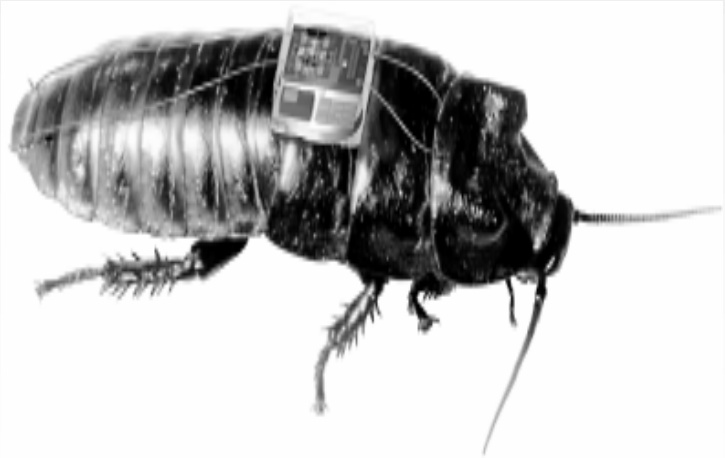


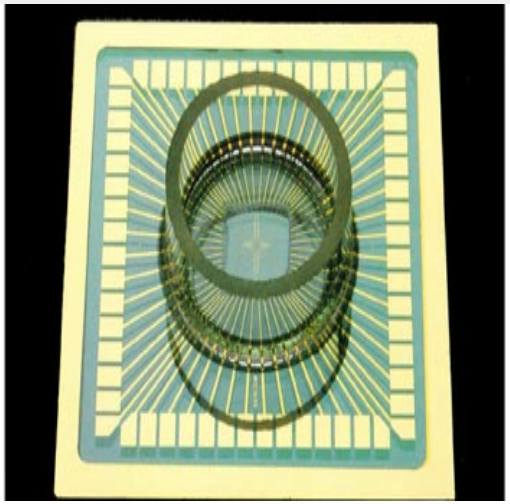
DSO

Biohybrid Systems



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

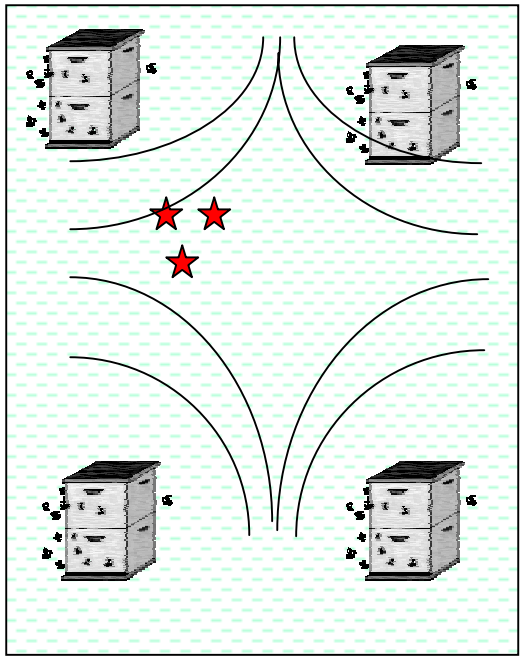




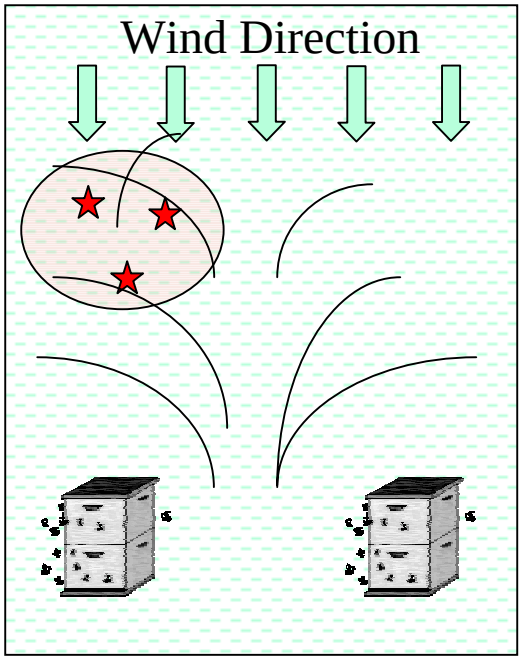
UMichigan/Duke/Plexon/USC

Target Identification Modes

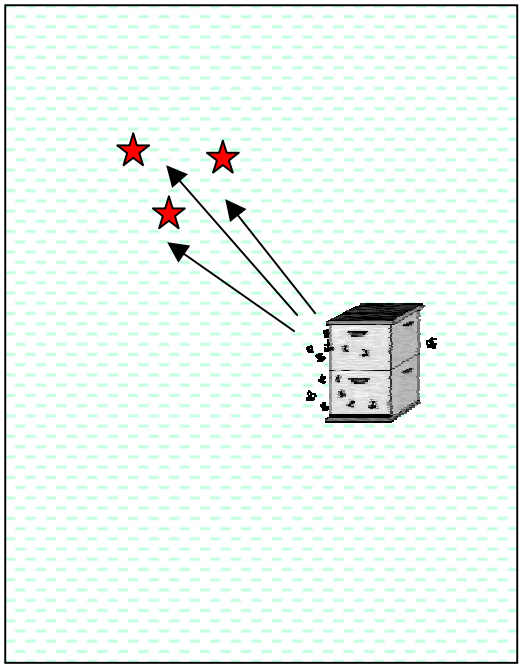
Undirected Sampling



Influenced Sampling



Directed Sampling



Target

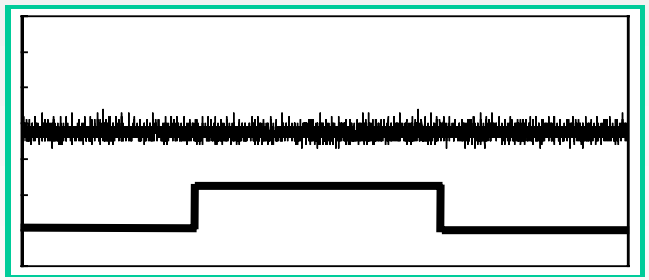
Attractant

DSO

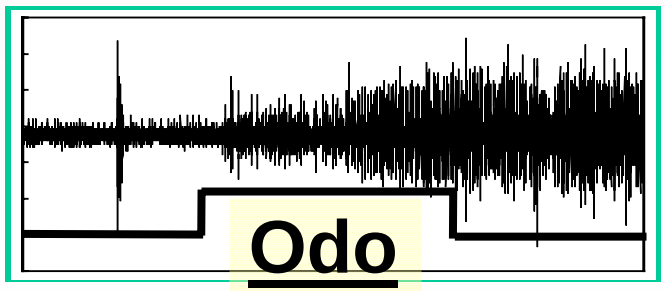
Using Organisms for Target Location

Physiological Response before and after training

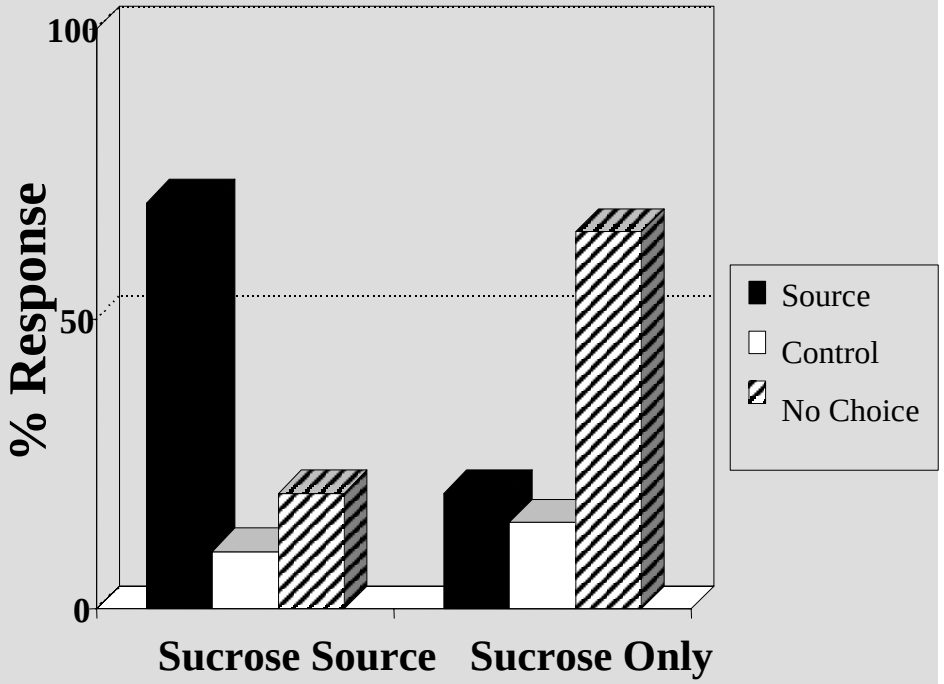
Before



Odor



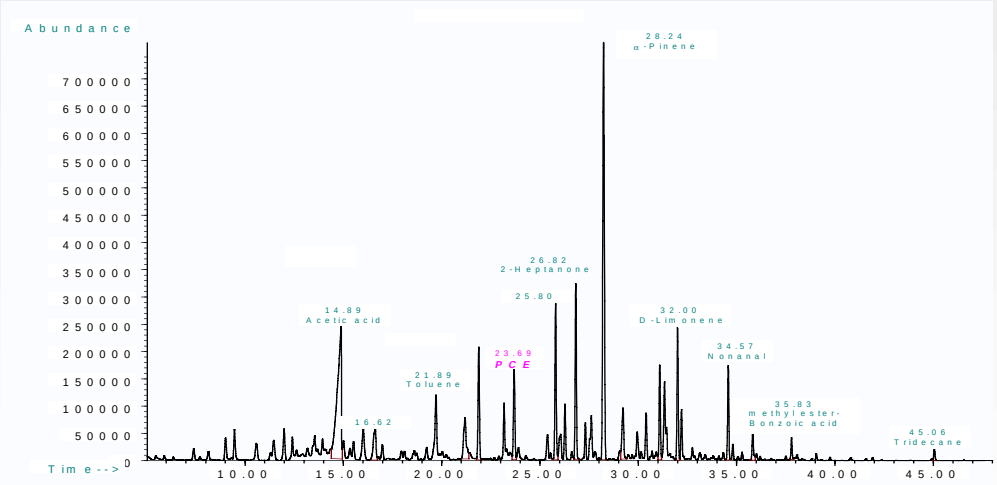
Train Organisms to UXO Compounds:2,4 DNT



Preflight Experience

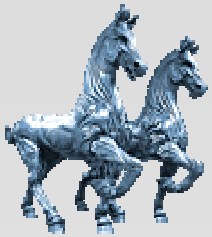
Engineering Bee Colonies

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



U Montana/EPA/USDA/CEHR

DSO



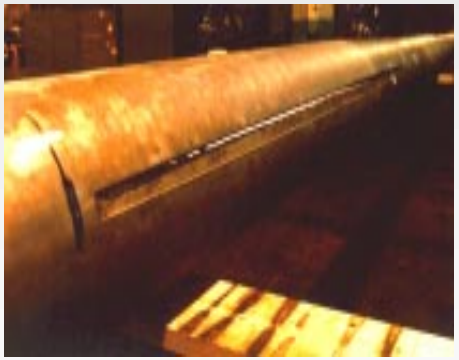
Mission Applications

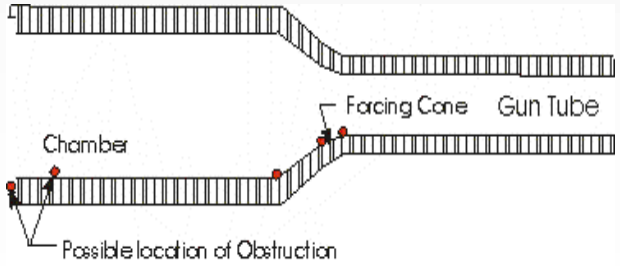
Biological Systems	•Animal Sentinels - 'Sensor Web' for situational awareness, locate suspected targets (CBW depots or plants)
Hybrid Biosystems	•Living machines -use as sensor or navigational devices
Biomimetics	•Fault tolerant locomotion and sensing •Armament neutralization

SPIKER - Non-lethal Armament Neutralization

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

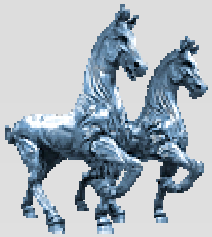
- **Implement asymmetrical controlled biological or biomimetic systems to deliver payloads and execute defects**





USA-TACOM

DSO



Controlled Biological and Biomimetic Systems

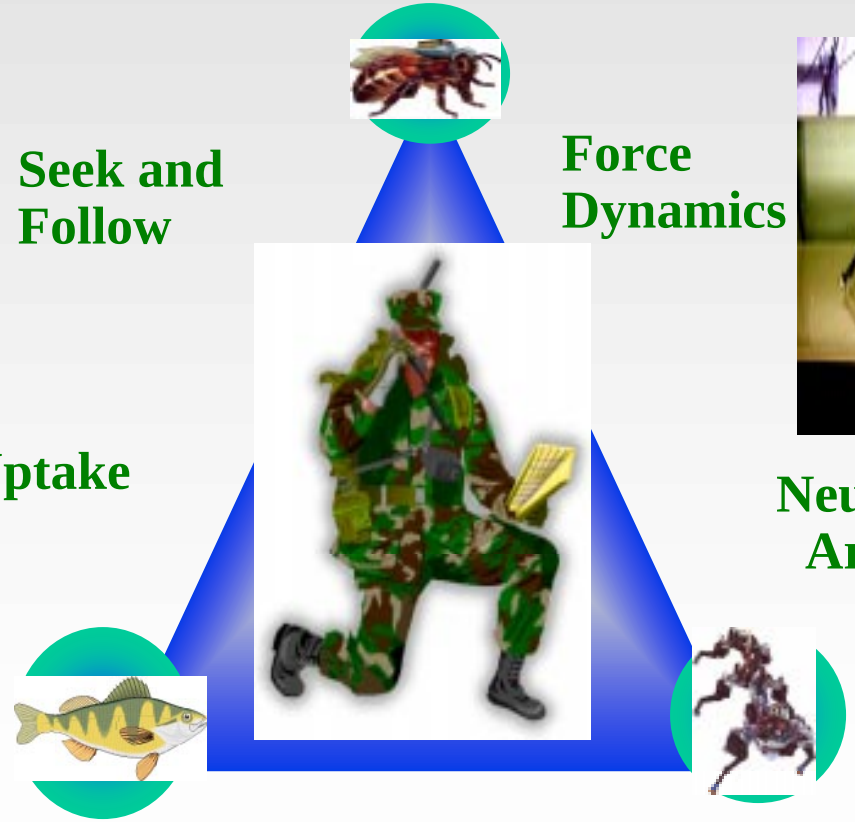
Enhancing Defense Capabilities through Life Sciences

Signals and Alarms

Chemical Analysis and Reporting

Seek and Follow

Transport and Uptake



Sensorimotor Navigation

Force Dynamics

Fault Tolerant Locomotion

Neural Control Architecture

DSO