1st NASA/JPL WORKSHOP ON BIOMORPHIC EXPLORERS FOR FUTURE MISSIONS

August 19-20, 1998
Jet Propulsion Laboratory
Auditorium: 180-101

WORKSHOP PROGRAM

Wednesday
August 19, 1998

08:30 Welcome .....**Mike Sander, Director**
Technology and Applications Program, JPL
Introduction..... **Moustafa Chahine**
Chief Scientist, JPL
Opening Remarks..... **Peter Ulrich (Invited)**
Division Director, NASA
09:00 Workshop Objectives..... **Sam Gulkis**
Program Scientist, Solar System Exploration Program, JPL
09:10 Biomorphic Explorers.....**Sarita Thakoor**
Advanced Flight Systems Group, JPL
09:40 Science Applications Overview.....**Dave Crisp**
Chief Scientist, New Millenium Program, JPL

10:20-10:30 ~ Break ~

Science Applications
Session Chair: Dave Crisp, *Chief Scientist, New Millenium Program,* ***JPL***

10:30 *Biomorphic Explorers for Close-up Imaging and Acid-Scratch Tests:* **Joy Crisp, California Institute of Technology, JPL**

11:00 *Recommended Geoscience Capabilities of Biomorphic Explorers: Lessons from Pathfinder:* **Nathan T. Bridges and Timothy J. Parker, JPL**

11:20 *Exploring comets and asteroids in the 21st century*: **D. K. Yeomans and P. W. Chodas, JPL**

11:40 *Biomorphic Explorers: Innovative ideas from simple organisms:* **Kenneth H. Nealson, Astrobiology Research Element, JPL**

12:00 *The Preservation of Possible Martian Life:* **Mark Lupisella, NASA/Goddard Space Flight Center**

12:20-1:50 ~ Lunch ~

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Small Mobile Exploration Systems I
Session Chair: Bill McLaughlin*, Section Manager,*
Mission and Systems Architecture Section, ***JPL***

1:50 *The Design of "Living" Biomech Machines: How Low Can One Go?:* **Mark W. Tilden, Los Alamos National Laboratory**

2:10 *Aquatic Microbots for Distributed Robotics:* **Hugh Crenshaw, Duke University; and Charles Pell, Nekton Technologies, Inc.**

2:30 *Development of Meso-Scale Flying Robotic Insects:* **Adam Cox, Ephrahim Garcia; and Michael Goldfarb, Vanderbilt University**

2:50 *Point Designs of Mobility Systems for Mesoscale Rovers:* **Brett Kennedy, JPL and Thomas J. Wdowiak, University of Alabama, Birmingham**

3:10-3:20 ~ Break ~

Small Mobile Exploration Systems II
Session Chair: Ron Salazar, *Group Supervisor,*
Advanced Flight Systems Group, ***JPL;***
and ***Michael Goldfarb,*** *Professor,* ***Vanderbilt University***

3:20 *Advanced Systems Technology:* **Dave Collins, JPL**

3:40 *Multiple Modes of Locomotion with a Modular Reconfigurable Robot*: **Mark Yim, Xerox Palo Alto Research Center**

4:00 *Evolvable Space Systems:* **Adrian Stoica and Anil Thakoor, Center for Integrated Space Microsystems, JPL**

4:20 *The Lorpex Concept for Powerbursts:* **Kumar Ramohalli, Massimiliano Marcozzi, and Roberto Furfaro, University of Arizona**

4:40 *Autonomous Mesoscale Vehicles: Mobility and Cooperative Behavior:* **Barry Spletzer, Sandia National Laboratories**

5:00 *Design and Analysis of Elastodynamic Locomotion for Robotic Insects:* **Nicolae Lobontiu, Greg Fischer, M. Kurt Gordon, Ephrahim Garcia, and Michael Goldfarb, Vanderbilt University**

Biomorphic Explorers Component Technologies/Mechanisms and Inspiration I
Session Chair: Martin Buehler,
Senior Research Scientist, ***JPL***

5:20 *Betavoltaic Power Supplies:* **Paul E. Sims and Louis C. DiNetta, AstroPower, Inc.**

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5:40 *Piezoelectric Technology*: **Ratnakar R. Neurgaonkar, Jeffrey G. Nelson, John R. Oliver, and David C. Dewing, Rockwell Science Center**

6:00-8:30 ~ Reception: Von Karman Auditorium ~
Demonstrations Session (6.00-7.30)
&
Special Evening Talk: 7.30 pm

Evolution of Solutions: Natural and Technological
by
Paul MacCready, Founder/Chairman, AeroVironment, Inc.

Demonstrations Session (6.00-7.30)

1. **Fukuda Lab Research Activities Video,**
   Nagoya Univ, Japan
2. **Mark W. Tilden Video/Demos**, Los Alamos National Laboratory, New Mexico, USA
3. **Biomorphic Explorers Animation Video,**
   Z. Gorjian & S. Thakoor, Jet Propulsion Laboratory, Pasadena, CA, USA
4. **USC Dream Team ROBOCUP Demo,** University of Southern California, USA

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Co-operative Behavior/Implementation
Session Chair: Hiroaki Kitano*, Senior Researcher****, Sony CSL*** *&*
Sarita Thakoor, *Advanced Flight Systems Group****, JPL***

8:30 *A Vision for Biomorphic Explorers: Adaptation, Self-repair, and Evolution in Reconfigurable Heterogeneous Multi-Functional Modules with Artificial Genome:* **Hiroaki Kitano, Sony Computer Science Laboratories, Inc.**

8:50 *Small-Scale Locomotion, Intelligent Cooperation, and Energy-Efficient Computation: A Concept for Cooperating Heterogeneous Biomorphic Explorers:* **Lynne E. Parker, Venu Varma, Mark Noakes, Easo George, Ray Brittain, and William Bryan, Oak Ridge National Laboratory, Oak Ridge, Tennessee**

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9:10 *Biomimetic Coordination and Cooperation of Multiple Rovers:* **Maja Mataric, University of Southern California**

9:30 *Distributed Reconfigurable Robots:* **Nikos Papanikolopoulos, Richard Voyles, Maria Gini, University of Minnesota; Donald Krantz, MTS Systems Corporation; Sanjay Parthasarathy, HTC, Honeywell Inc.**

9:50 *CyberScout - Informationally Connected Machines*: **John Dolan and Pradeep Khosla, Carnegie Mellon University**

10:10 *From Robotic and Virtual Soccer to Space Exploration Missions*: **Gal A. Kaminka, Jafar Adibi, Rogelio Adobbati, Yaser Al-Onaizan, Ali Erdem, Stacy C. Marsella, Jay Modi, Hadi Moradi, Behnam Salemi, Wei-Min Shen, Sheila Tejada, Milind Tambe, University of Southern California; and Hiroaki Kitano, Sony CSL, Japan**

10:30-10:40 ~ Break ~

Biomorphic Explorers Component Technologies/Mechanisms and Inspiration II
Session Chair: Dave Collins, *Manager,*
Microspacecraft Systems Technology, ***JPL***

10:40 *Inspiration from Nature toward the Design of Surface-roving Biomorphic Explorers:* **R. J. Full, University of California at Berkeley**

11:00 *Piezoelectric Polymer Leg Muscle for Buglike Explorers:* **Jon Eckberg, Nels Peterson, Hugo Schmidt, Connie Streich, Bryan Tikalsky, and George Tuthill, Montana State University**

11:20 *The Next Level of Sensory-Motor Control: Inspiration from the Cerebellum:* **Christopher Assad, JPL**

11:40 *Shared Semantic Representations for Coordinating Distributed Robot Teams:* **Dac Le and Ian Horswill, Northwestern University**

12:00 *New Solid State Actuators for Biomorphic Explorers:* **Kenji Uchino, The Pennsylvania State University**

12:20-1:30 ~ Lunch ~

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Biomorphic Explorers Component Technologies/Mechanisms and Inspiration III
Session Chair: Toshio Fujita, *IPDT Leader, NMP,* ***JPL***
& ***Chris Salvo,*** *DSST (X-2000), Future Deliveries Manager,* ***JPL***

1:30 *Deep Space Systems Technology Program (X-2000: Future Deliveries and Biomorphic Explorers):* **Chris Salvo, JPL**

1:50 *Microactuators for Biomorphic Explorers: A Few Suggestions from Theory:* **Kaushik Bhattacharya, California Institute of Technology**

2:10 *Biomorphic Multisensors:* **M. G. Buehler and F. J. Grunthaner, JPL**

2:30 *Flexible, low-mass devices and mechanisms actuated by electroactive polymers (EAP):* **Y. Bar-Cohen and S. Leary, JPL; M. Shahinpoor, University of New Mexico; J. O. Simpson and J. Smith, NASA LaRC**

2:50 *Electrostrictive Polymer Artificial Muscle for Biologically-Inspired Robots:* **Roy Kornbluh, Ron Pelrine, and S. Venkat Shastri, Stanford Research Institute**

3:10 *Rotating Field Mass Spectrometer for Organic Compound Detection:* **Steven J. Smith, JPL**

3:30 *Compact Piezoelectric Ultrasonic Motors:* **Kenji Uchino and Burhanettin Koc, The Pennsylvania State University**

3:50-4:00 ~ Break ~

4:00-5:30 ~ **Panel Discussion** ~

5.30 Concluding Remarks..... **Ron Salazar & Sarita Thakoor**
Biomorphic Explorers Workshop Organizers

Panel Discussion

Panel Moderator: Dave Crisp, Chief Scientist, NMP
Panel Members:

E. Garcia ..... Program Manager (Smart Materials and Structures), DSO, DARPA
Teresa McMullen.....Program Manager (Adaptive Control, Biorobotics), ONR
Sam Gulkis..... Program Scientist, SESPD, JPL
John Beckman .....Systems Division Manager, JPL
Fuk Li .....New Millenium Program Manager, JPL
Les Deustch/Chris Salvo ..... X-2000 (Future Deliveries) Manager, JPL
Giulio Varsi.....Senior Staff to SESPD, JPL

Additionally the following panel members participated by providing input prior to the workshop:

Sam Venneri..... Chief Technologist, NASA
Steven Suddarth ..... Program Manager, BMDO
Ellison C. Urban .....Deputy Director, MTO, DARPA
Alan S. Rudolph ....Program Manager, DSO, DARPA