



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

August 19-20, 1998  
Jet Propulsion Laboratory

# OPENING REMARKS

Peter Ulrich  
Division Director  
NASA



OPENING REMARKS  
FIRST NASA/JPL WORKSHOP ON  
BIOMORPHIC EXPLORERS FOR FUTURE MISSIONS

Dr. Peter B. Ulrich  
Director, Advanced Technology and Mission Studies Division  
Office of Space Science, NASA Headquarters

August 19, 1998

I think everyone in this room would agree that we live in interesting times. It is always tempting to predict the historical significance of the age in which we live, and, one cannot help but believe that future generations will look back at this era as a “cusp” in the history of technology. That cusp is the confluence of three formerly independent streams: space technology, biology, and information systems. In each of these fields of endeavor we have witnessed quite profound but heretofore separate and distinct revolutions. Now these fields are coming together to create a whole that will clearly exceed the sum of the parts...a revolution of revolutions, if you will.

The potential products of this confluence have an aura of science fiction and a certain amount of “giggle factor”...for example, the Micromechanical Flying Insect Project. In fact, some of these “technological alloys” force us to develop a new taxonomy, or even new words (neologisms) or combinations of words to discuss them: cyberspace, virtual reality, DNA computing, reconfigurable systems, astrobiology, holographic collaborative environments and the subject of this workshop: biomimetics and biomorphs. (Just when the public thinks they can talk science we spring a whole new vocabulary on them!) New technology used to be studied and then stored in dusty archives. Now radical technologies are being routinely, if cautiously, embraced by the most important people at NASA, the Flight System Project Managers.

I first heard the word “biomimetics” from the lips of John Anderson, who is both a visionary and leader of visionaries and who is currently fighting a courageous medical battle. He would love to be here today and we wish him all the best.

Biomimetics is a fascinating concept...the study of nature to capture and use those things that are done so well and so efficiently and, some times, so uniquely in the natural world. Space hardware engineers are becoming inspired by nature...in effect they are turning to observing flies instead of swatting at them. (the flies, at least, are happy about that!)

But, it takes more than vision to make progress. Progress is made when there is a perceived and well-articulated need, when the timing is right, and when feasibility can be demonstrated. Only then will support, both fiscal and political, become available.

Biomimetics in general, and the special topic of this workshop, Biomorphs for Exploration, appears to have a well-articulated need, they are poised to demonstrate feasibility, and the post-Sojourner era is certainly timely. Hence, I believe we can assume that fiscal and political support will now follow. NASA is committed to this endeavor. The early funding for advanced technology and mission concept development is placed in my office. It is my intention to foster growth in a wide variety of advanced concepts, including biomimetics, and in this exciting new field in particular. We plan to double our advanced concept budget in FY99.

It will be important to relate the findings of this workshop to the potential utility of these revolutionary ideas. It seems to me that this workshop and others like it are predicated on a number of themes:

- That it makes sense to marry the knowledge of the biologist with the skills of the engineer;

- That nature is smart (evolution through natural selection guarantees that) and we have to be smart enough to learn its lessons;
- We can't always just copy nature (the Wright brothers demonstrated that when they departed from the avian world and decoupled propulsion from lift...although 40 years or so later Sikorsky successfully rejoined lift and propulsion); rather we must distill and employ the essence of natural systems

Julian Vincent, who is Director of the Center for Biomimetics at the University of Reading, calls the 21st century "The Age of Materials". He points out that we are beginning to understand materials at the molecular level well enough to *make* materials from the molecule upwards, i.e. nano-fabrication. In essence, we can design a molecule on a computer and don't have to go near a chemistry bench. This knowledge allows us to carry out the distillation of natural systems for our special needs: for example, tough composites based on the morphology of wood or the composite structure of mother of pearl, the structures of the pith in plants stems or the feather shaft or deer antlers.

Biomimetics is not a new field. The structural design of the Eiffel Tower was based on the bony structure inside the head of the femur where it inserts into the hip joint. Because the bone sticks out to the side it takes the loads off center and the designer of the Eiffel tower knew this and utilized this fact. Another technology was apparently invented by a man whose large and hairy dog used to drive him crazy by running through burdock patches whose burrs were almost impossible to remove from the dog's fur. The little hooks in the burr inspired what we know now as Velcro. The Crystal Palace in Hyde Park was designed to replicate the ribbing under large water lilies that allowed these meter sized plants to float. The designer was neither an architect nor an engineer. He was an observer of water lilies.

Vincent says “Plants are magicians with cellular materials” They are also adaptive... the shape of a tree is the history of the forces which were acting on it as it grew. We already have many examples of “smart” materials: consider photochromic glass which darkens on exposure to light. In general smart systems break down into three parts : a receptor, a central processor, and an effector. Our challenge is to efficiently and effectively create” smartness” in our systems, and often nature will be our guide.

So, we in the “Space Biz” are entering an epoch when we are excited by the imperatives of advancing knowledge about space to do visionary things. We are challenged to explore distant places beyond our reach and control. The fiscal and physics constraints we face will, in Darwinian fashion, lead us to do what nature does so well...economize and minimize. Emerging from that vision, the Biomorphic Explorer will be an economic and minimalist marvel that captures the best that nature has to offer. I wish you all the best as you continue on this fascinating quest.

Thank you.