sure and temperature, though the correlation was rather weak. The weakness of the correlation was attributed to the pores in the specimens. The maximum relative permeabilities of cores made without annealing ranged from 30 to 110, while those of cores made with annealing ranged from 900 to 1,400. However, the greater permeabilities of the annealed specimens were not associated with noticeably greater densities.

The major practical result of the investigation was the discovery of an optimum distribution of iron-particle sizes: It was found that eddy-current losses in the molded cores were minimized by using 100 mesh (corresponding to particles with diameters ≤100 μm) iron particles. The effect of optimization of particle sizes on eddy-current losses is depicted in the figure.

This work was done by Russell A. Wincheski, Robert G. Bryant, and Min Namkung of **Langley Research Center.** *Further information is contained in a TSP (see page 1).*
LAR-15719

Cooperative Lander-Surface/Aerial Microflyer Missions for Mars Exploration

Bio-inspired principles of key functions are distilled, enabling missions to Mars using multiple microflyers in synergy with the existing surface assets to provide a robust telecommunication architecture for gathering scientific data.

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Concepts are being investigated for exploratory missions to Mars based on "Bioinspired Engineering of Exploration Systems" (BEES), which is a guiding principle of this effort to develop biomorphic explorers. The novelty lies in the use of a robust telecom architecture for mission data return, utilizing multiple local relays (including the lander itself as a local relay and the explorers in the dual role of a local relay) to enable ranges ~10 to 1,000 km and downlink of color imagery. As illustrated in Figure 1, multiple microflyers that can be both surface or aerially launched are envisioned in shepherding, metamorphic, and imaging roles. These microflyers imbibe key bio-inspired principles in their flight control, navigation, and visual search operations. Honey-bee inspired algorithms utilizing visual cues to perform autonomous navigation operations such as terrain following will be utilized. The instrument suite will consist of a panoramic imager and polarization imager specifically optimized to detect ice and water. For microflyers, particularly at small sizes, bio-inspired solutions appear to offer better alternate solutions than conventional engineered approaches.

This investigation addresses a wide range of interrelated issues, including desired scientific data, sizes, rates, and communication ranges that can be accomplished in alternative mission scenarios. The mission illustrated in Figure 1 offers the most robust telecom architecture and the longest range for exploration with two landers being available as main local relays in addition to an ephemeral aerial probe local relay. The shepherding or metamorphic plane are in their dual role as local relays and image data collection/storage nodes. Appropriate placement of the landing site for the scout lander with respect to the main mission lander can allow coverage of extremely large ranges and enable exhaustive survey of the area of interest. In particular, this mission could help with the path planning and risk mitigation in the traverse of the long-distance surface explorer/rover. The basic requirements of design and operation of BEES to implement the scenarios are discussed. Terrestrial applications of such concepts include distributed aerial/surface measurements of meteorological events, i.e., storm watch, seismic monitoring, reconnaissance, biological chemical sensing, search and rescue, surveillance, autonomous security/protection agents, and/or delivery and lateral distribution of agents (sensors, surface/subsurface crawlers, clean-up agents). Figure 2 illustrates an Earth demonstration that is in development, and its implementation will illustrate the value of these biomorphic mission concepts.

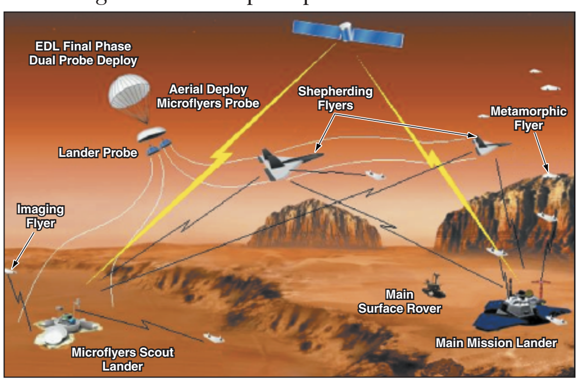

Figure 1: A **Biomorphic Mars Mission** is conceptualized here. (Note: EDL= Entry, Descent, and Landing.)

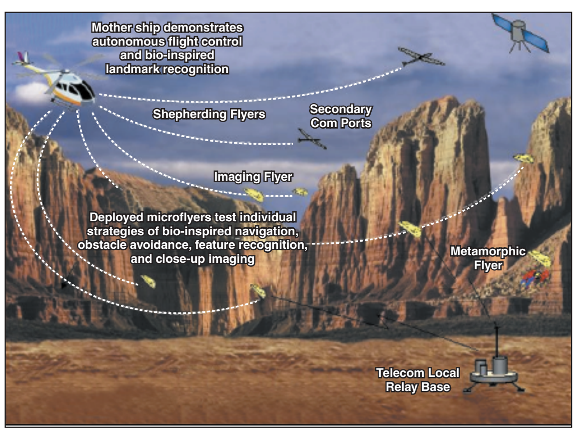

Figure 2: This is a **Conceptual Illustration of a Planned Demonstration**, "Bioinspired Engineering of Exploration Systems for MARS," to be performed at a MARS analog site on Earth. Here, microflyers work in synergy with the existing surface/aerial systems to enable new science endeavors. Multiple local comports provide a robust communication route for imagery downlink from the microflyers.

This work was done by Sarita Thakoor and Norman Lay of Caltech for **NASA's Jet Propulsion Laboratory** *and Butler Hine and Steven Zornetzer of Ames Research Center for the NASA Intelligent Systems Program. Further information is contained in a TSP (see page 1).*
NPO-30286