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Adrian Bejan	**5e. TASK NUMBER**
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13. SUPPLEMENTARY NOTES

14. ABSTRACT

This project relied on constructal theory to develop novel flow architectures for aircraft thermal management, in particular for the cooling of skins and leading surfaces of high speed aircraft, high-temperature gas turbine blades, etc. The following milestones were reached: 1. The concept of vascular architecture embedded in a wall subjected to intense heating, which showed that tree-shaped channels are more effective than parallel channels oriented across the wall, 2. The concept of bathing a volume with one stream flowing as two trees matched canopy to canopy, which showed that this dendritic architecture is dramatically more effective than parallel channels, 3. The concept of of cooling a wall with tree-shaped channels that run against the intense heating striking the wall, and 4. The concept of dendritic vascularization of a volume by using one stream. The tree-tree architecture exhibits sharp transitions toward greater complexity as the size of the bathed volume increases. These concepts are essential for future vascular design, and for "scaling up" to realistic dimensions the results obtained based on small-scale models.

15. SUBJECT TERMS

Thermal management, vascular design, constructal design, self-cooling, dendritic

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Final Progress Statement

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Adrian Bejan

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6. Program Manager:*

Dr. David Stargel

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This project relied on constructal theory to develop novel flow architectures for aircraft thermal management, in particular for the cooling of skins and leading surfaces of high speed aircraft, high-temperature gas turbine blades, etc. The following milestones were reached: 1. The concept of vascular architecture embedded in a wall subjected to intense heating, which showed that tree-shaped channels are more effective than parallel channels oriented across

9. Archival Publications (published) during reporting period:

S. Lorente and A. Bejan, Heterogeneous porous media as multiscale structures for maximum flow access, Journal of Applied Physics, Vol. 100, 2006, 114909.

A. Bejan, "Advanced Engineering Thermodynamics", 3rd ed., Wiley, Hoboken, 2006, pp. 832-834.

10. Changes in research objectives (if any):

None

11. Change in AFOSR program manager, if any:

Dr. Victor Giurgiutiu was the program manager; now the manager is Dr. David Stargel.

12. Extensions granted or milestones slipped, if any:

None

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9. Publications

S. Lorente and A. Bejan, Heterogeneous porous media as multiscale structures for maximum flow access, Journal of Applied Physics, Vol. 100, 2006, 114909.

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J. Lee, S. Lorente and A. Bejan, Transient cooling of smart vascular materials for self-cooling, Journal of Applied Physics, Vol. 105, 2009, 064904.

PhD Theses completed at Duke University during this project:

- Constructal Vascular Composites for cooling and Hating, Sunwoo Kim, August 2008.
- Constructal Vascularization for Self-Healing and Self-Cooling, Kuan-Min Wang, August 2008.