1046-05-859 **Matthew Crawford*** (matthew.crawford@students.olin.edu), Franklin W. Olin College of Engineering, Olin Way, Needham, MA 02492, and **Caitlin Greeley**, **Bryce Lee**, **Mathav Kishore Murugan** and **Sarah Spence Adams**. *Multilevel and Multidimensional Hadamard Matrices.*

Hadamard matrices are square $\{\pm 1\}$ matrices with mutually orthogonal columns, and they have a variety of applications in modern communications systems. We examined generalizations of Hadamard matrices, such as *multilevel* and *3-dimensional (3D)* Hadamard matrices. Multilevel Hadamard matrices allow entries to be any integer. A 3D Hadamard matrix of size $n \times n \times n$ can be viewed as a stack of n 2D Hadamard matrices of size $n \times n$ in which certain substructures must be mutually orthogonal. We looked to combine these ideas into 3D Multilevel Hadamard Matrices (3D MHMs), which we believe to be a new development.

Few constructions for multilevel Hadamard matrices were previously known, none of which could guarantee the desirable property that the constructed matrix contains n distinct integer entries, each appearing exactly once per column. We discovered a construction technique for $n \times n$ multilevel Hadamard matrices which guarantees this property for all n. We also proved the existence of $n \times n \times n$ 3D MHMs by discovering a method to construct 3D MHMs from 2D multilevel Hadamard matrices. We expect that these orthogonal matrices may prove useful in communications systems, as their 2D analogs already have. (Received September 12, 2008)