MILESTONES & SCHEDULE

FY1

Duke(Reif): Initial design of various novel DNA tiles, including cylindrical TX tiles. Experimental demonstration and comparison of various assembly techniques for patterned 1D DNA lattices of moderate length, using techniques of unmediated algorithmic self-assembly, step-wise assembly, and directed nucleation assembly. Initial development of improved software for design of DNA nanostructures and their DNA sequences.

NYU(Seeman): Create 3D periodic assemblies with host-lattice crystals that diffract to better than 10 Å resolution.

Caltech(Winfree): Development of a mathematical/algorithmic framework for design of multi-strand DNA structures. Demonstration of improved triple-crossover and single-strand DNA tiles. Design of nucleating structures for de-multiplexing RAM lattice.

FY2

Duke(Reif): Characterization of various novel DNA tiles, and investigate the use of these and related tiles to form 2D DNA lattices and explore the feasibility of forming 3D DNA lattices.

Experimental demonstration and comparison of various assembly techniques for patterned 2D DNA lattices of modest size(64 tiles), using techniques of unmediated algorithmic self-assembly, step-wise assembly, and directed nucleation assembly.

NYU(Seeman): Improve 3D periodic assemblies with host-lattice crystals to diffract to better than 5 Å resolution. Position nucleic acids in a 2D DNA lattice. Incorporate the PX-JX_2 device into lattices to aid tying down proteins.

Caltech(Winfree): Optimization algorithms for DNA design implemented and tested.

Characterization of error rates during unmediated self-assembly and demonstration of multi-strand and single-strand tiles using RNA. Design of DNA molecular building blocks (MBBs) that can be rigidly attached to DNA lattices with a known orientation, and of unbounded binary counter (a component of demultiplexing RAM lattice).

FY3

Duke(Reif): Further development of novel DNA tiles to form patterned 2D and 3D DNA lattices. Experimental demonstration & comparison of various assembly techniques for patterned 2D DNA lattices of moderate size(512 tiles), using techniques of unmediated algorithmic self-assembly, step-wise assembly, and directed nucleation assembly.

NYU(Seeman): Improve 3D periodic assemblies with host-lattice crystals that diffract to 2.5 Å resolution or better, which is a resolution adequate for crystallography. Tie down nanocrystals from the Alivisatos laboratory in a 2D DNA lattice.

Caltech(Winfree): Assessment of model parameters used in optimization algorithms by theoretical/experimental closed-loop design-test-recalibrate cycle; addition of geometric and structural energetic terms into the design models. Theoretical classification of reliable DNA lattice motifs, using existing experimental systems and mathematical framework. Design of an unbounded binary counter (a component of the RAM circuit pattern) and characterization of error rates during unmediated self-assembly of the binary counter.

FY4

Duke(Reif): Complete development of novel DNA tiles to form patterned 2D and 3D DNA lattices. Experimental demonstration and comparison of various assembly techniques for patterned 2D DNA lattices of large size (16,000 tiles), using techniques of unmediated algorithmic self-assembly, step-wise assembly, and directed nucleation assembly.

NYU(Seeman): Further improve 3D periodic assemblies with host-lattice crystals that diffract to 2.5 Å resolution or better, to a resolution adequate for crystallography. Tie down nucleic acids, proteins, and nanocrystals from the Alivisatos laboratory in a 3D DNA lattice. Nanorobotics systems based on PX-JX_2 devices will be incorporated in 2D and 3D lattices. Attachment chemistry will be extended from periodic systems to algorithmic systems.

Caltech(Winfree): Improvement of optimization algorithms for DNA design. Theoretical classification of practical electronic circuits that can be self-assembled. Classification of structures that can be fabricated by step-wise procedures using blocking/unblocking techniques. Design and simulation of multi-step sequential assembly, of a larger structure, and of algorithmic self-assembly of full 4-bit demultiplexing RAM structure; assessment of scaling limitations due to errors and other factors. Further improvements, assessment of the technology, and commercialization.