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DNA is the genetic material of all living organisms (Picture of Eve). DNA basics: problem of DNA is that it is helical molecules with a linear, unbranched axis. Easy to design immobile branched junctions, to minimize sequence symmetry, thus not required to be linear. Sticky end cohesion: affinity, hydrogen bonding, ligation. Sticky ends are structurally well defined. Central concept of structural nanotechnology: combine branched with sticky ends to make nanotechnological constructs. High resolution/structural DNA used as bricks and mortar. Low resolution/compositional DNA used as mortar only (includes nanoparticles or long range ordering.) What is the intellectual goal of structural DNA nanotechnology? Controlling the structure of matter in 3D. Objectives of Seeman lab: Architectural control and scaffolding for nanomechanical devices. A new suggestion for producing macromolecular crystals: DNA box-like species as a host for guests. A method for organizing nanoelectronic components. Append DNA with macromolecules. Polyhedral catenanes: Cube, truncated octahedron. Construction of crystalline arrays is required for lattice design components, predictable interactions, and structural integrity. Marshmallow impaled with uncooked rotini. DX Isomers, double crossover DNA molecules. DPE, DAE, DPE, DPON DPOW, DAE+J. 2D DX Arrays, schematic of lattice containing 1DX tile and 1 DX+J Tile, matrix every 32 nanometers, seen in AFM. Progress toward three-Dimensional arrays: A 3D trigonal DX Lattice. X-ray arrays supported the trigonal structure, but only 10 A data. Made big crystals. Organizing other Species with DNA. Prototyping the control of molecular topology. Nucleic acid knot (NA) with pendent groups, pendent groups linked, polymer released from nucleic acid. Individual components, nylon coming off the DNA. Mass spec indicates success. Organizing 1.4-nm gold nanoparticles: imaged by STEM. DNA nanomechanical devices. B->Z DNA transition. Sequence dependent device, machine cycle of the PX-JX_2. System to test the device checked with AFM. Can see parallel and zigzag. DNA walking biped, have the flexible DNA walk over rigid DNA structure. Possible crosslinking products. Denaturing gel showing crosslinking results for each step. Can see the strands change as the DNA walks. Summary of results: What's next? Listed scientific challenges for this field in 2002 during last conference. Quite a few of the challenges have been successful. Organization challenges for this field: Promote the study of the control of organization of matter, to unite component disciplines of the field, increase prominence. Founding international society for Nanoscale Science Computation and Engineering, June 11, 2004, Milano Italy.