Molecular Machinery Gallery

Beware of the stroboscopic illusion!

If molecular machines actually moved as shown in the animations below, they wouldn't work. Don't blame the simulation or the design, though. The problem is that the standard way to render video frames creates a stroboscopic illusion of jerky motion. Atoms typically vibrate hundreds of times per frame, but standard frames capture the position of each atom at a single instant, as if seen by the flash of a stroboscope. This creates the illusion that the atoms all vibrate at the frame rate, which is far too close to the frequency of the machine's moving parts. This gives the false impression that the machine parts are moving at nearly thermal speed, comparable to the speed of sound. At that speed, even if the machine worked, friction would be intolerable.

MarkIII(k) Planetary Gear

Description:
This is the MarkIII(k), a nanoscale planetary gear designed by K. Eric Drexler. A planetary gear couples an input shaft via a sun gear to an output shaft through a set of planet gears (attached to the output shaft by a planet carrier). The planet gears roll between the sun gear and a ring gear on the inner surface of a casing. This animation was rendered with Qutemol by reading PDB files from a NanoEngineer-1 molecular dynamics simulation. A section of the casing atoms have been hidden to expose the internal gearing assembly.

Author:
K. Eric Drexler
Nanorex, Inc.

Read more... SRG-Ic

Description:
This is the SRG-Ic, a parallel-shaft speed reducer gear designed by Mark Sims. It was modeled and simulated entirely using NanoEngineer-1. This assembly includes a pinion gear, an output gear, and a silicon carbide casing which includes a pair of coupled bushings (front and back). The goal of the SRG-I was to create a simple speed reducer gear with as few atoms as possible.

Author:
Mark Sims
Nanorex, Inc.

Read more... SRG-II

Description:
This is the SRG-II. It was modeled and simulated entirely using NanoEngineer-1 (Alpha 6). The goal of the SRG-II was to create a robust nanoscale gear complete with a casing and extended connector shafts. As you can see, the SRG-II looks every bit like a speed reducer gear.

Author:
Mark Sims
Nanorex, Inc.

Read more... SRG-III

Description:
This is the SRG-III. It was modeled and simulated entirely using NanoEngineer-1. A hybrid of the SRG-I and SRG-II, it is the first molecular gear train ever designed. With 15,342 atoms, the SRG-III is the second largest nanomechanical device ever modeled in atomic detail.

Author:
Mark Sims
Nanorex, Inc.

Read more...

Drexler-Merkle Differential Gear

Description:
This is the Drexler-Merkle Differential Gear. It was modeled and simulated entirely using NanoEngineer-1. This molecular differential gear was designed by K. Eric Drexler and Ralph Merkle sometime around 1995 while together at Xerox PARC.

Authors:
K. Eric Drexler
Nanorex, Inc.
Ralph C. Merkle
Georgia Tech University

Read more... Neon Pump

Description:
This is the Neon Pump. It was modeled and simulated entirely using NanoEngineer-1. This NanoEngineer-1 molecular dynamics simulation of the neon pump took over 8 hours to complete on a Dell laptop (Pentium M, 2.0GHz and 1GB RAM).

Authors:
K. Eric Drexler
Nanorex, Inc.
Ralph C. Merkle
Georgia Tech University

Read more... Small Bearing

Description:
This is the Small Bearing. It was modeled and simulated entirely using NanoEngineer-1. This small bearing was designed by K. Eric Drexler and can be found on page 298 of his book Nanosystems: Molecular Machinery, Manufacturing and Computation.

This MD simulation of the small bearing is perfect for the beginner. It includes two components and only 206 atoms, so the simulator can spit out fun animations like this one quickly. It is a great way to get some experience using rotary motors in NanoEngineer-1 to drive devices.

Author:
K. Eric Drexler
Nanorex, Inc.

Read more... Strained-shell Sleeve Bearing

Description:
This is the Strained-shell Sleeve Bearing. It was modeled and simulated entirely using NanoEngineer-1. This is the strained-shell sleeve bearing from Nanosystems (page 296) designed by K. Eric Drexler and Ralph Merkle while they were working together at Xerox PARC The model comprises two molecular components; the inner shaft and the outer sleeve and contains a total of 2,808 atoms.

With practice, an experienced user can create this bearing in 10-15 minutes. NanoEngineer-1 includes an extrusion tool for creating rods and rings from a molecular fragment (called a chunk in NanoEngineer-1).

Author:
K. Eric Drexler
Nanorex, Inc.

Read more... Universal Joint

Description:
This is the Universal Joint. It was modeled and simulated entirely using NanoEngineer-1. A universal joint is a joint in a rigid rod that allows the rod to 'bend' in any direction. It consists of a pair of ordinary hinges located close together, but oriented at 90° relative to each other.

Authors:
Mark Sims
Nanorex, Inc.
K. Eric Drexler
Nanorex, Inc.
Ralph C. Merkle
Georgia Tech University

Read more... ESP Image

Description:
This is the ESP Image. The ESP Image is a jig type in NanoEngineer-1 that allows the user to visualize the electrostatic potential of points on a plane. NanoEngineer-1 uses Nano-Hive's MPQC ESP Plane plug-in to calculate the electrostatic potential. This screenshot shows the ESP Image jig used to calculate and display the electrostatic potential of a cytosine molecule.

Author:
Mark Sims
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Read more...