# 

NanoEngineer-1: An open source multi-scale molecular modeling and simulation front-end for Rosetta (*Potentially*)

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President Nanorex, Inc.

# **About Nanorex**

- Founded in 2004
- 11 employees in 4 states
- Based in Bloomfield Hills, Michigan



# Mission

 To develop open-source computational tools to support the design and development of advanced nanosystems

# NanoEngineer-1

- Open source (GPLv2)
- Mac, Windows and Linux
- Written in Python and C
- Qt/PyQt GUI framework
- GROMACS v3.3.3 integrated
- Emphasis on ease of use and 3D interactive modeling

#### **NE1: CAD for Structural DNA Nanotechnology**



#### **Double Crossover (DX) Molecule**

#### NanoEngineer-1 Reduced model







## **Triple Crossover (TX) Molecule**

#### NanoEngineer-1 Reduced model



14 nm





#### **Example: 4-Point Star Tile and Lattice**



#### H. Yan, T.H. LaBean, et al.

DNA-Templated Self-Assembly of Protein Arrays and Highly Conductive Nanowires Science 301, 1882-1884. (2003)

#### **Example: DNA Polyhedra**



## **Example: Scaffolded DNA Origami**



**Paul Rothemund** *Folding DNA to create nanoscale shapes and patterns* Nature, 440:297-302 (2006).

## **DNA Origami Folding Process**



- Scaffold strand (red)
- Staple stands (blue)
- Self-assembles into target structure

#### "Smiley face" origami (NE1 reduced model)



## First NE1 experiment design: Four hole tile



#### AFM Image of "Four hole tile" DNA origami

- All strand sequences assigned by NE1 and written to excel file
- All oligonucleotides were purchased from IDT, Inc.
- Synthesis and imaging performed by Paul Rothemund at Caltech
- First attempt worked (April, 2008)



AFM image courtesy of Paul Rothemund (Caltech)

#### **Rosetta Plug-in for NanoEngineer-1**

- This is currently a prototype
  - Not available in current release of NanoEngineer-1 (version 1.1.1)
- Demos:
  - Fixed backbone design
  - Rotamer optimization

#### Step 1: Install Rosetta (Windows version)

- Create C:\Rosetta
- Copy rosetta.exe to C:\Rosetta
- Copy the Rosetta database into C:\Rosetta\rosetta\_database



#### Step 2: Edit C:\Rosetta\paths.txt

```
Rosetta Input/Output Paths (order essential)
path is first '/', './', or '../' to next whitespace, must end with '/'
INPUT PATHS:
                                /Rosetta/
pdb1
pdb2
                                /Rosetta/
                                /Rosetta/rosetta database/
alternate data files
fragments
                                /Rosetta/
structure dssp,ssa (dat,jones) /Rosetta/
sequence fasta, dat, jones
                             /Rosetta/
                               /Rosetta/
constraints
starting structure
                                /Rosetta/
                                /Rosetta/rosetta database/
data files
OUTPUT PATHS:
                                /Rosetta/
movie
                                /Rosetta/
pdb path
                                /Rosetta/
score
                                /Rosetta/
status
                                /Rosetta/
user
FRAGMENTS: (use '****' in place of pdb name and chain)
2
                                       number of valid fragment files
3
                                       frag file 1 size
aa****03 05.200 v1 3
                                       name
9
                                       frag file 2 size
aa****09 05.200 v1 3
                                       name
```

#### Step 3: Enable Rosetta as a NE1 plug-in

- 1. Start NanoEngineer-1
- 2. Select Edit > Preferences
- 3. In the Preferences dialog, select **Plug-ins**
- 4. Check Rosetta
- 5. Check Rosetta DB
- 6. Click OK

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<b>\?</b>		ОК

#### File > Fetch > PDB from RCSB

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#### **PDB file loaded**



#### Build > Protein (new command set in development)



### **Edit Protein Display Style**



#### **Edit Rotamers**



## **Edit Residues**

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7     Any     PGAVILMFWYCSTNQDEHKR       8     Same     N			
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#### Simulation > Rosetta



#### **Rosetta Results** (designed sequence inserted into model automatically)



#### **Rosetta Results**

#### (designed sequence inserted into model automatically)



#### Compare



# **Free Download**

URL: <u>www.nanorex.com</u> Username: rosettacon2008 Password: rosettacon2008

Tutorials: <a href="https://www.nanoengineer-1.net">www.nanoengineer-1.net</a>

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## Mark Sims

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