# Flavor & Fragrance Simulation
# MMP Flavor/Fragrance Applications
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# Molecular Modeling Pro Flavor Plus

1. Physical and Chemical Properties calculated from a molecular odor/flavor and fragrance modeling program

2. Applying these Properties to Develop new flavors/fragrances or to Improve on delivery or cost of existing flavors/fragrances

3. Predicting High impact flavors or aroma

4. Developing time dependent flavor profiles (burst to delay)

Applications

1. Odor and taste thresholds for food and beverage flavors

2. Thresholds for fragrances and environmental volatiles

3. Off-flavor reduction/elimination in food and beverages

4. Provide Cost advantages by optimizing ingredients

5. Currently used in fragrance industry to develop wash off applications candle fragrances and the masking of odors

6. Can be used for designing liquid/semi-solid or solid food flavors

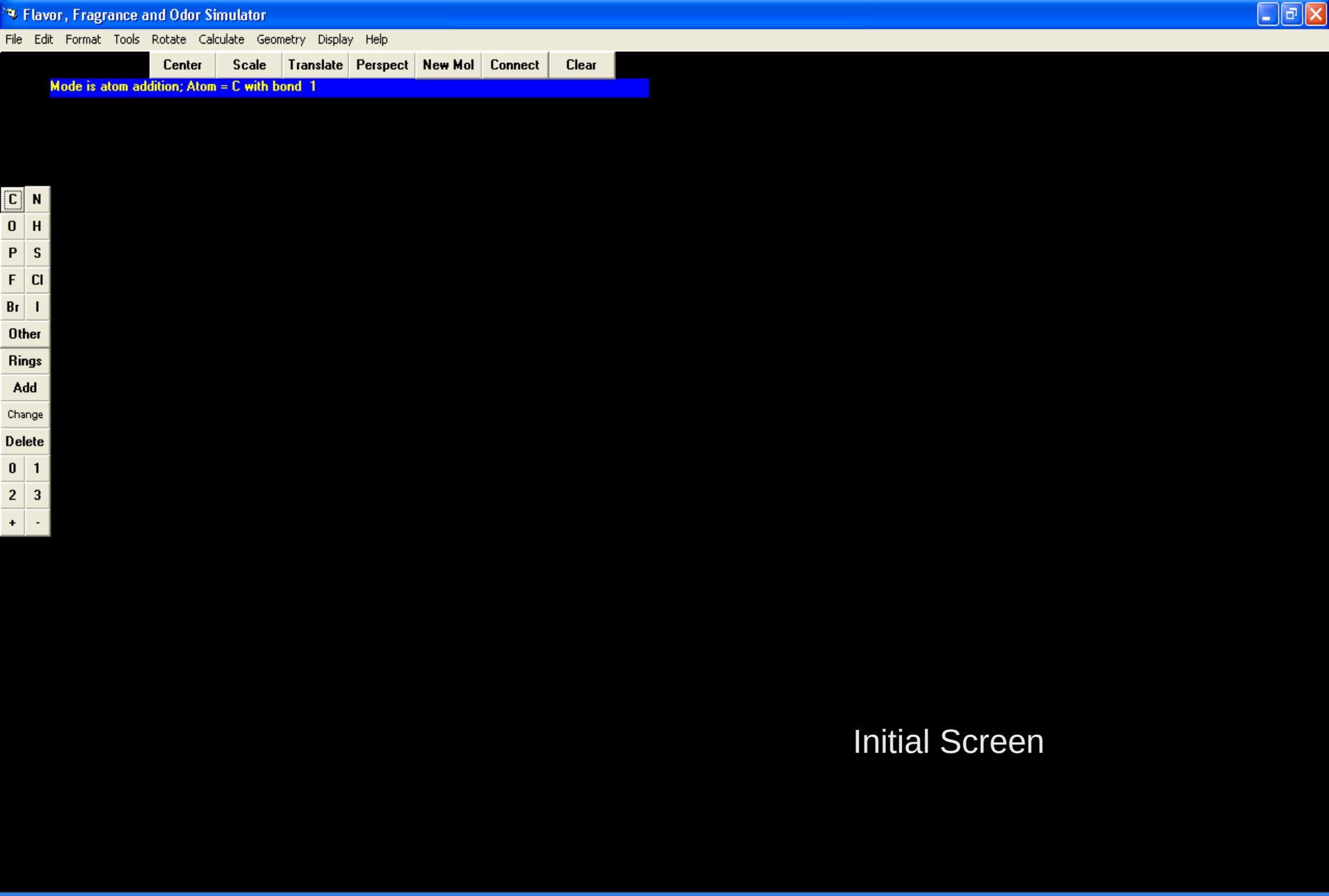
# Description of Program

1. A tour of the Flavor & Fragrance Program

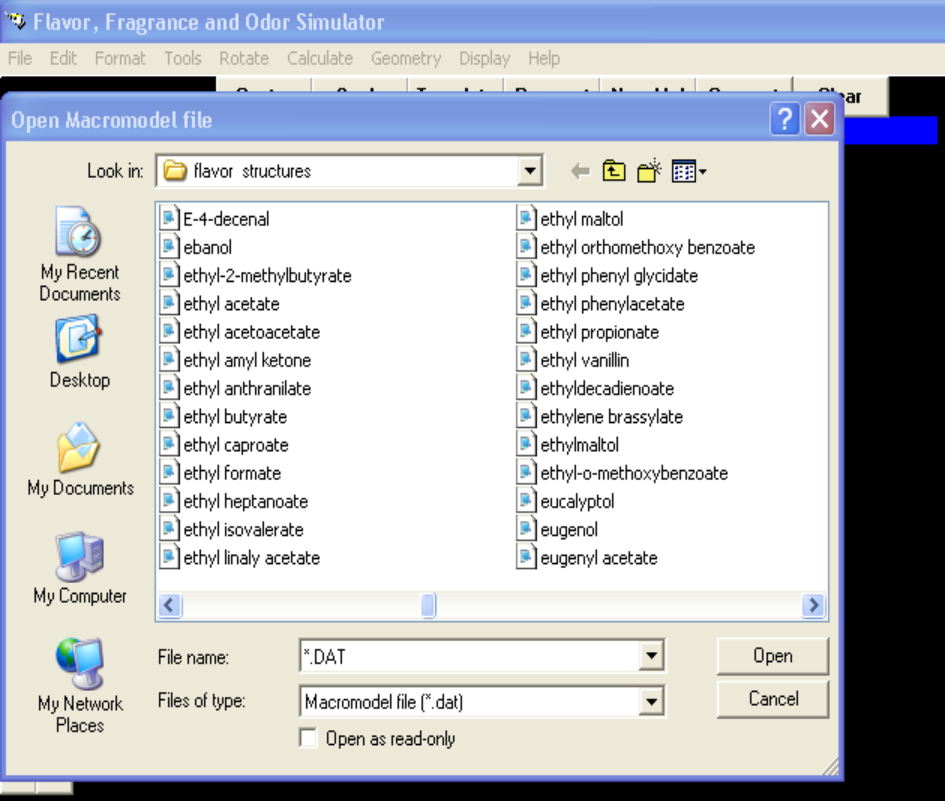
2. How to use the information for Flavor Development

3. Example of a Fragrance System and Interpretation

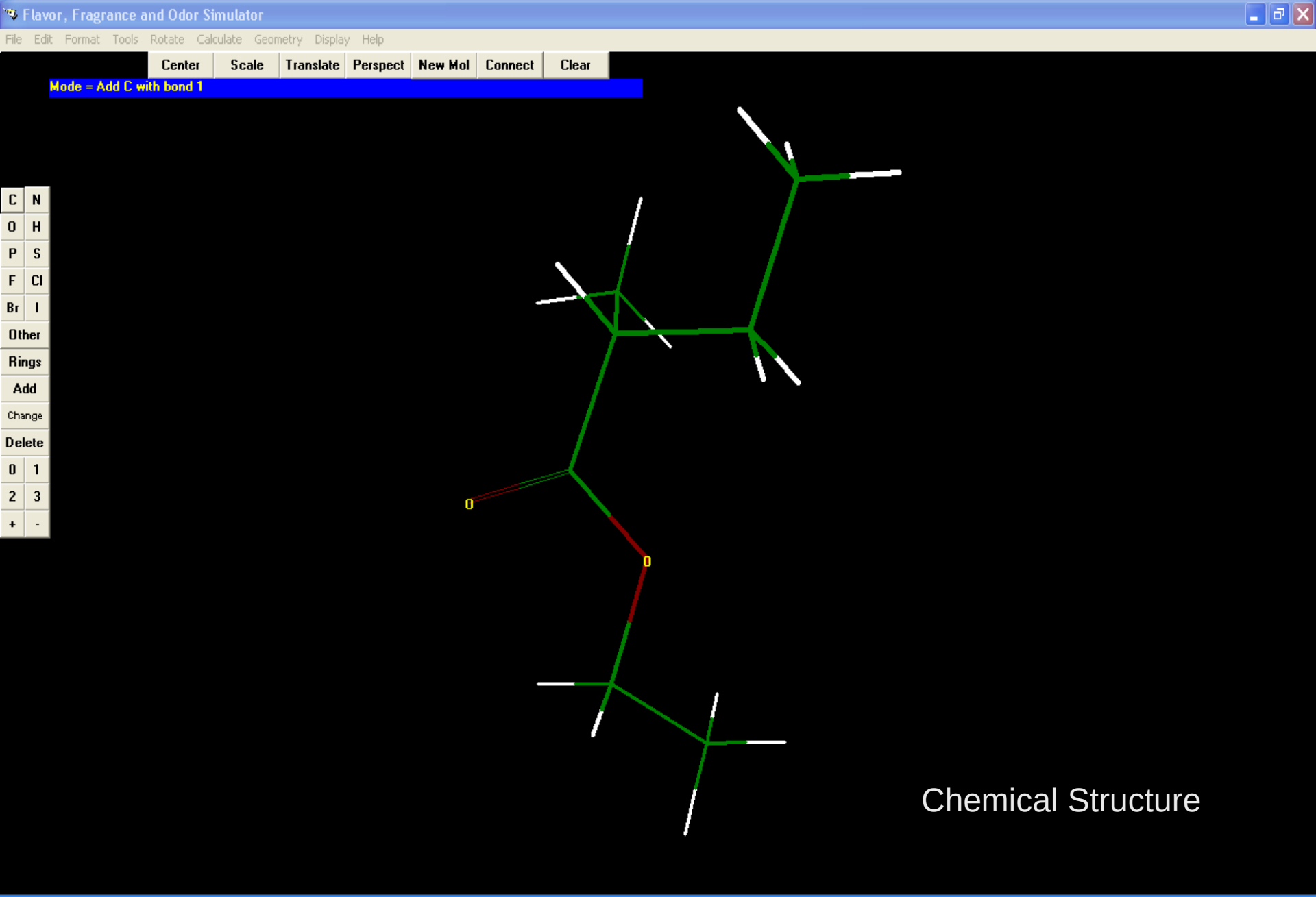
4. Conclusion



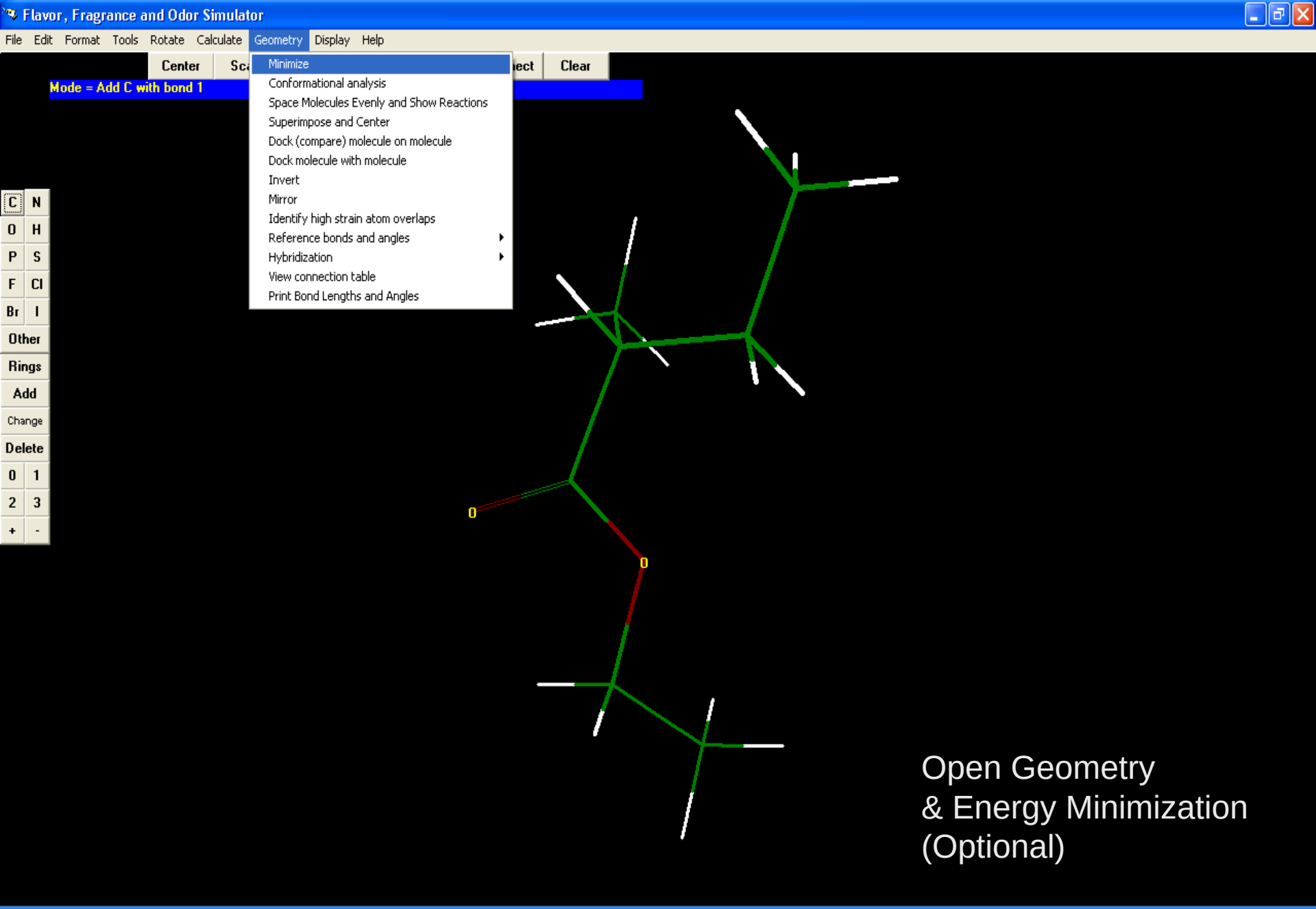

Initial Screen



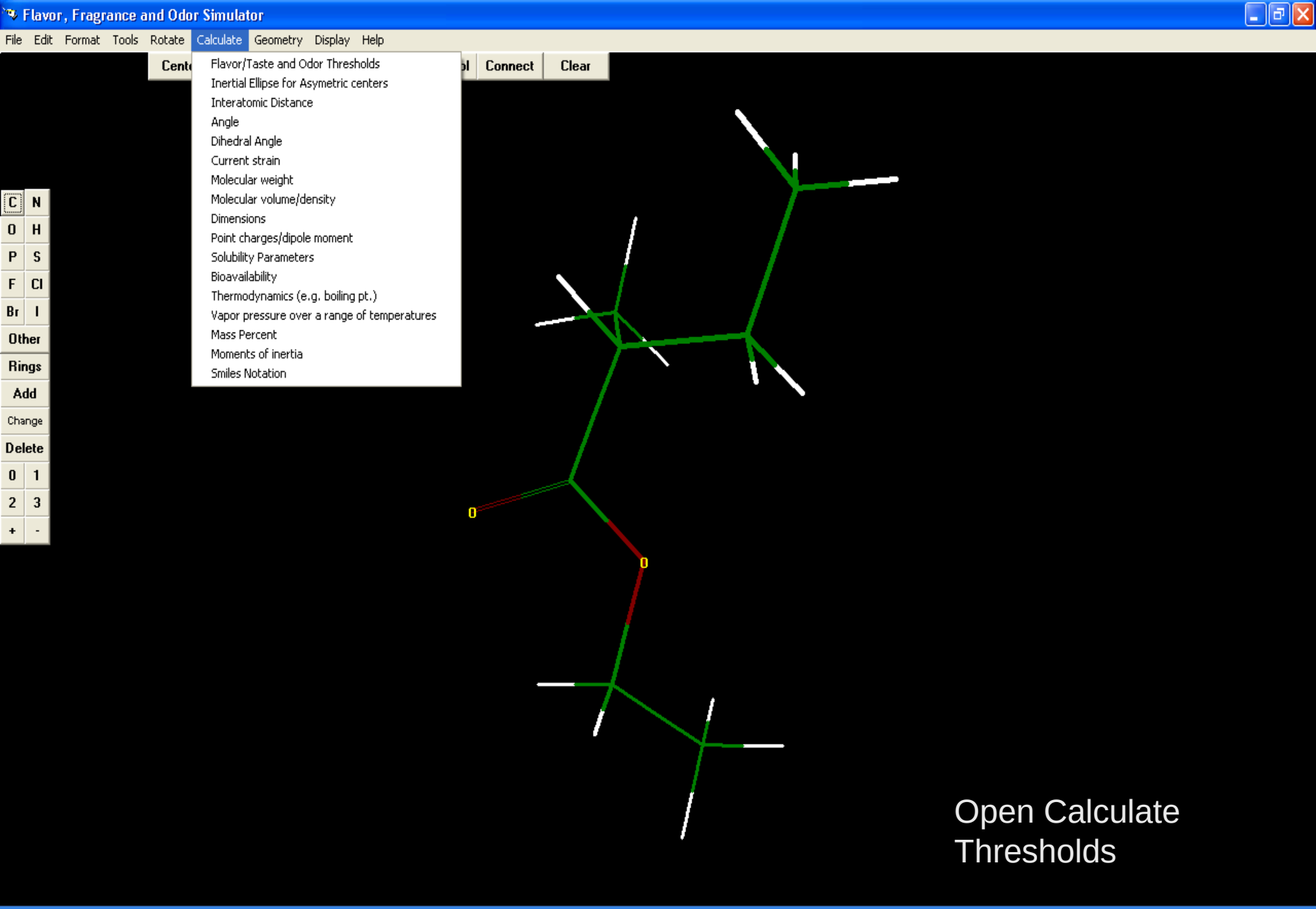

Open Database



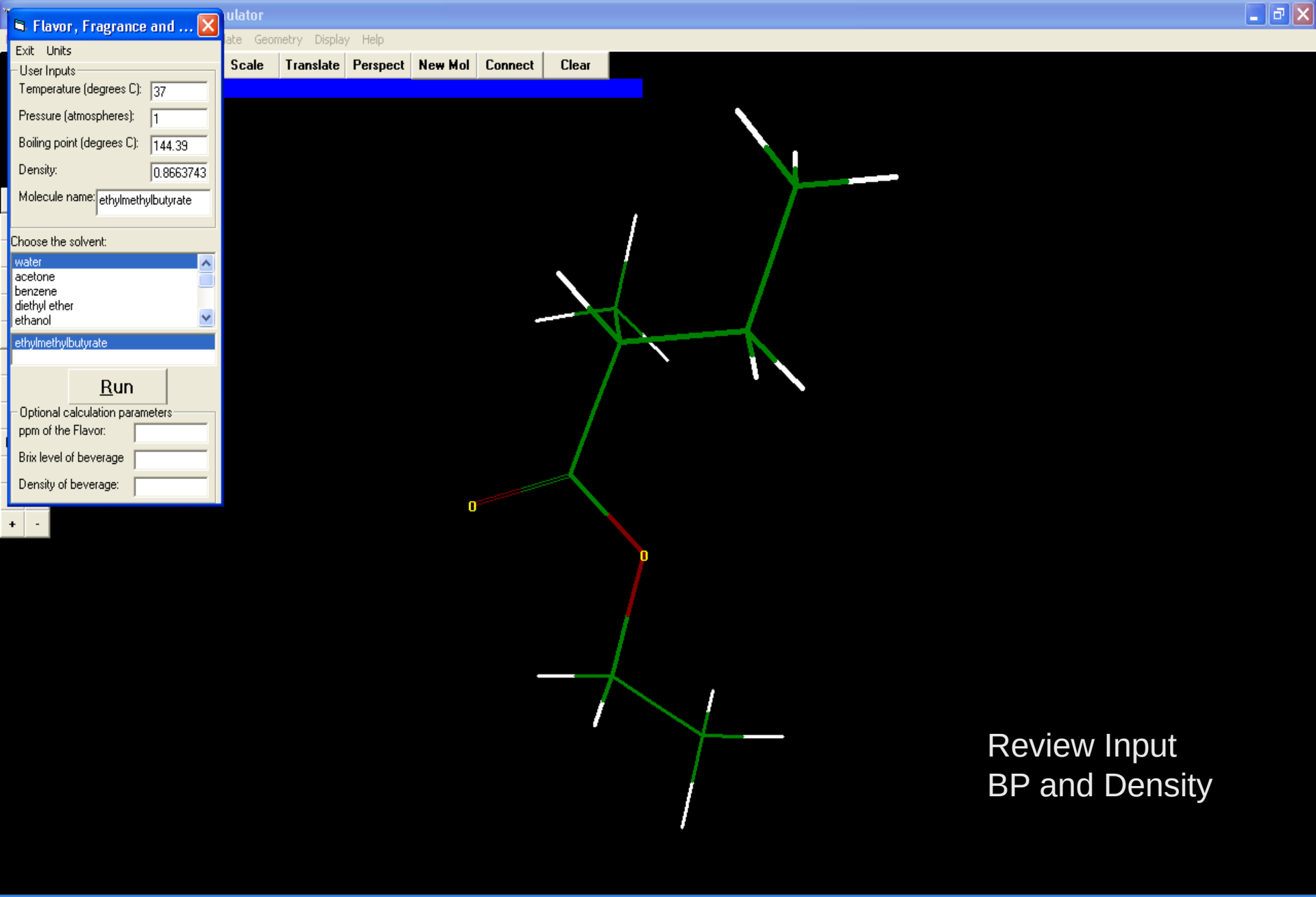

Chemical Structure



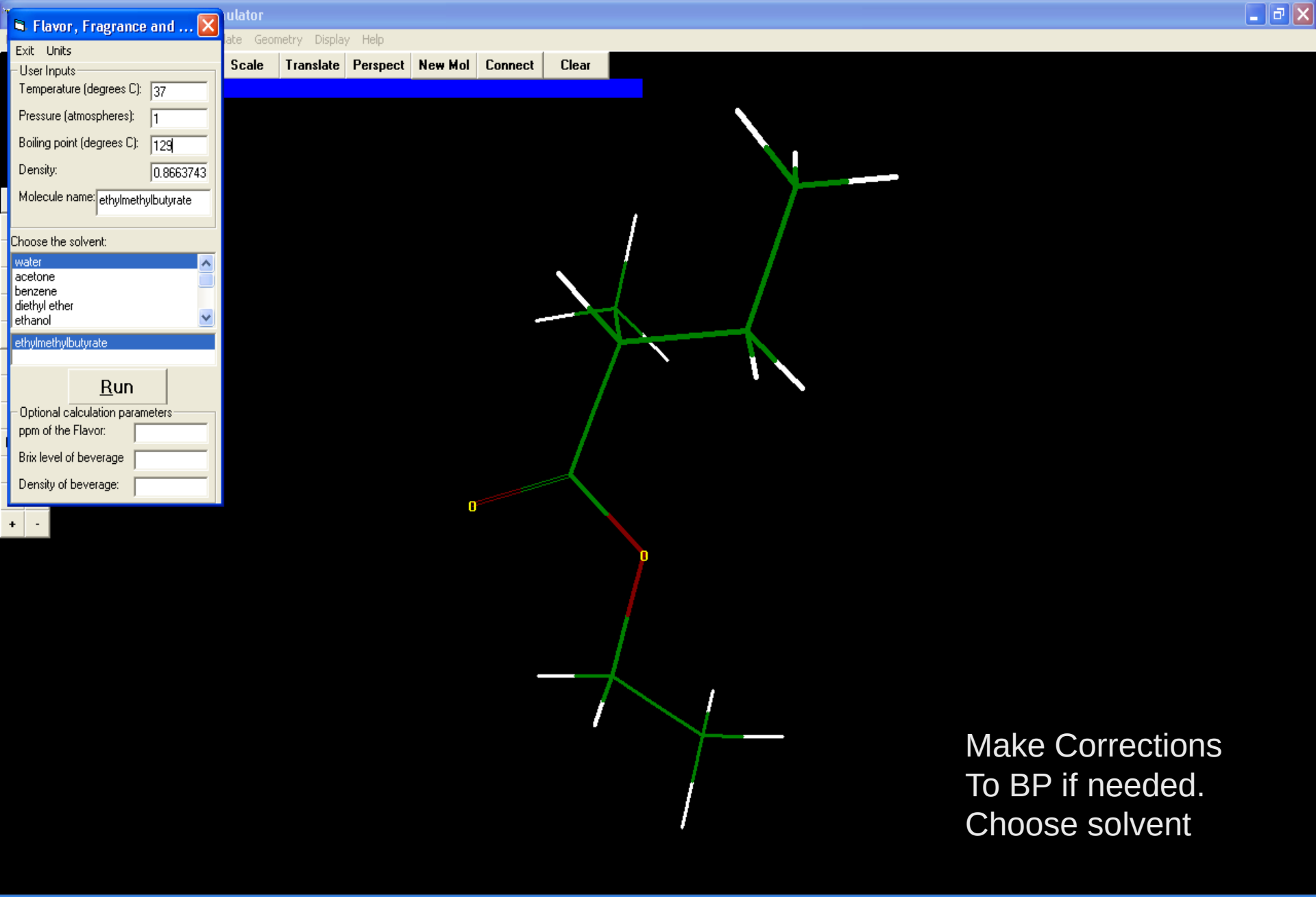

Open Geometry
& Energy Minimization
(Optional)



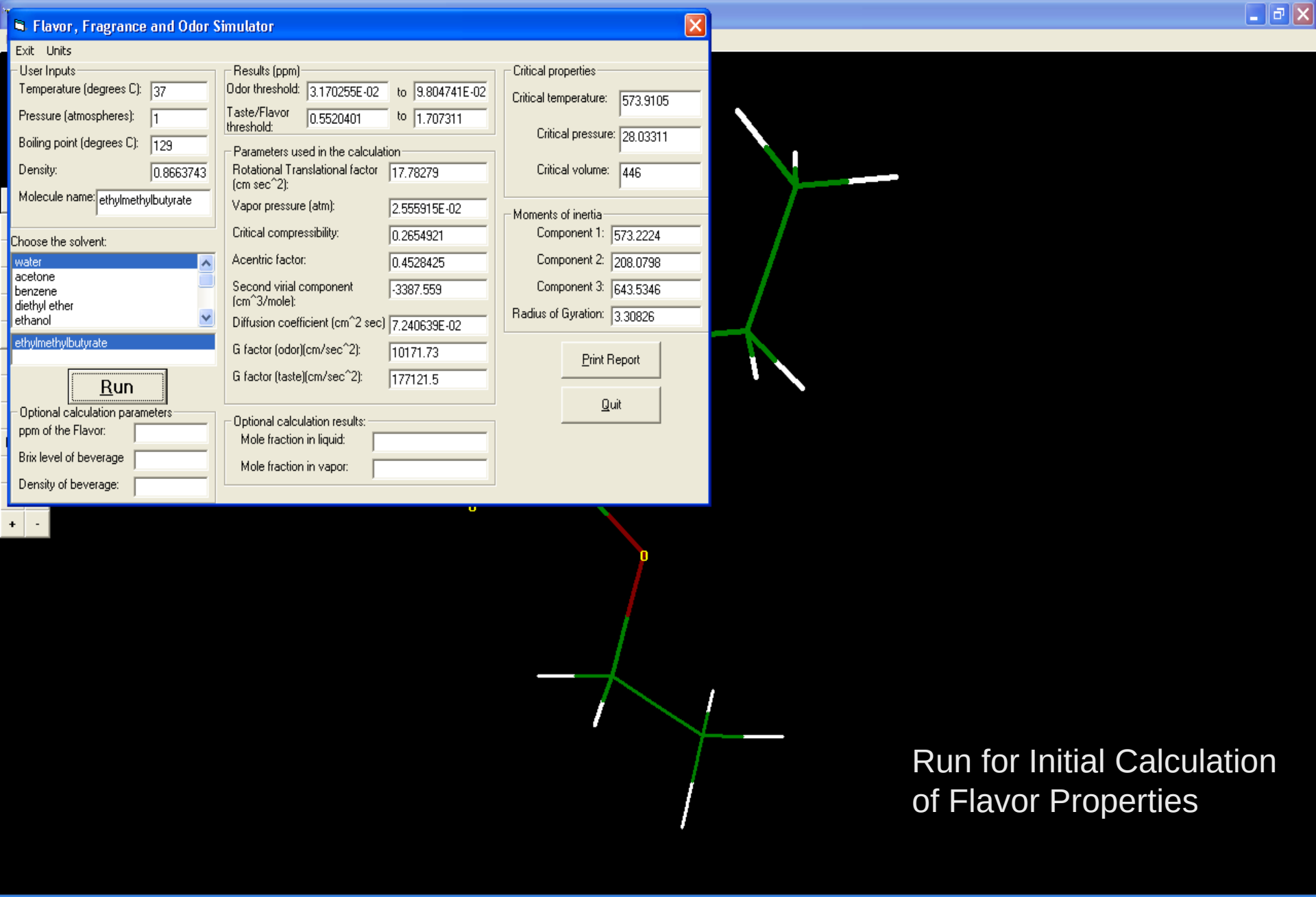

Open Calculate Thresholds



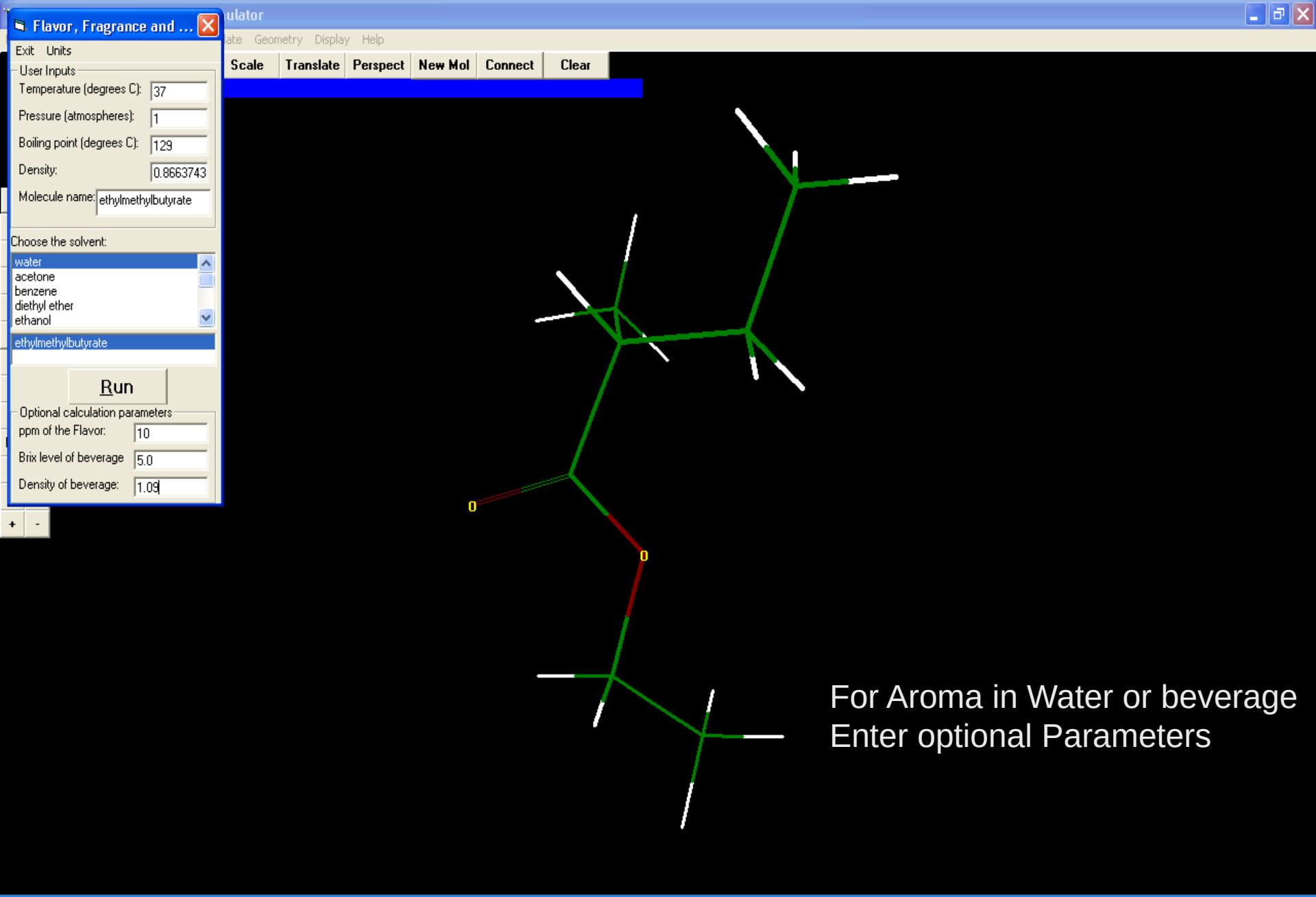

Review Input
BP and Density

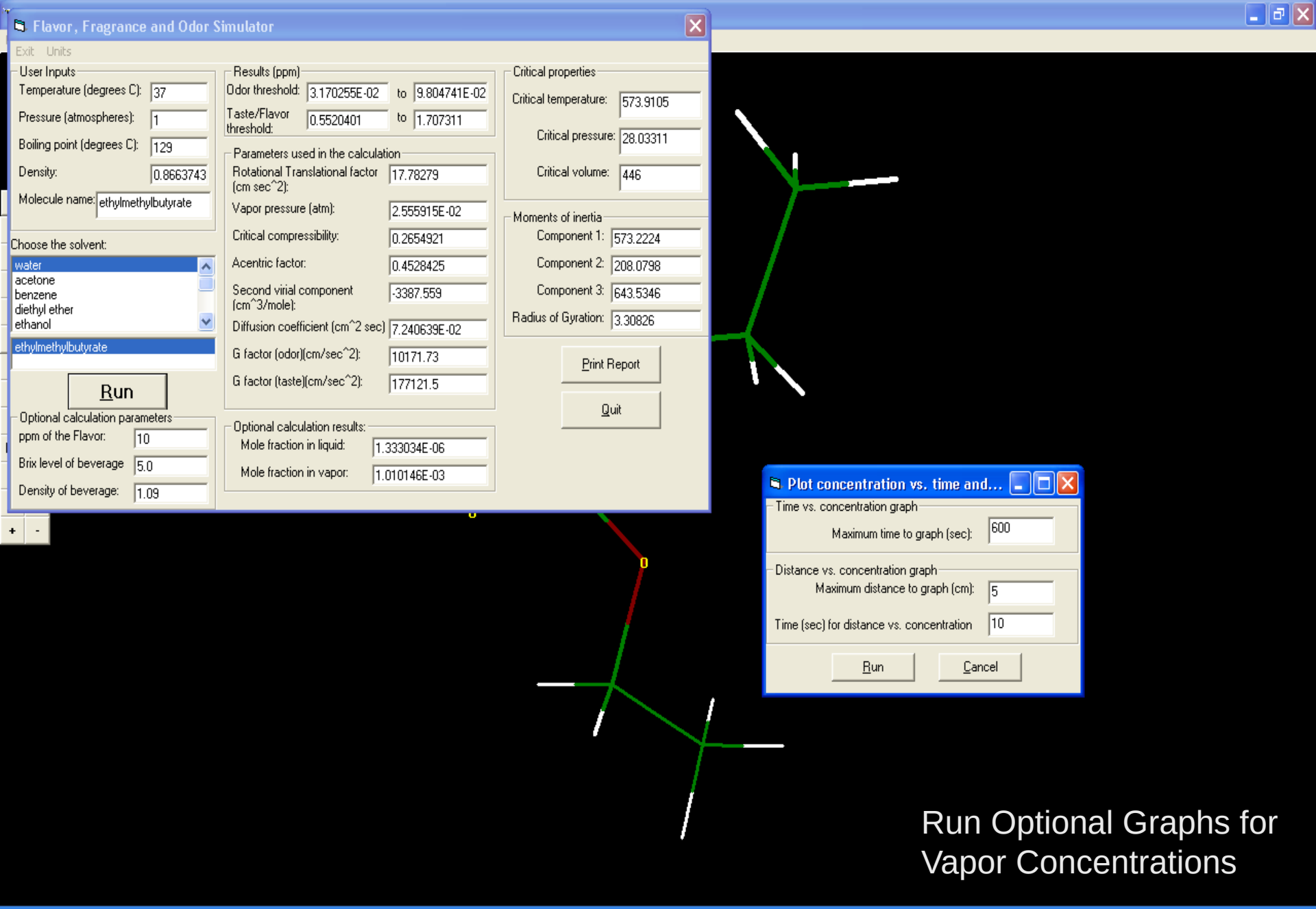



Make Corrections
To BP if needed.
Choose solvent

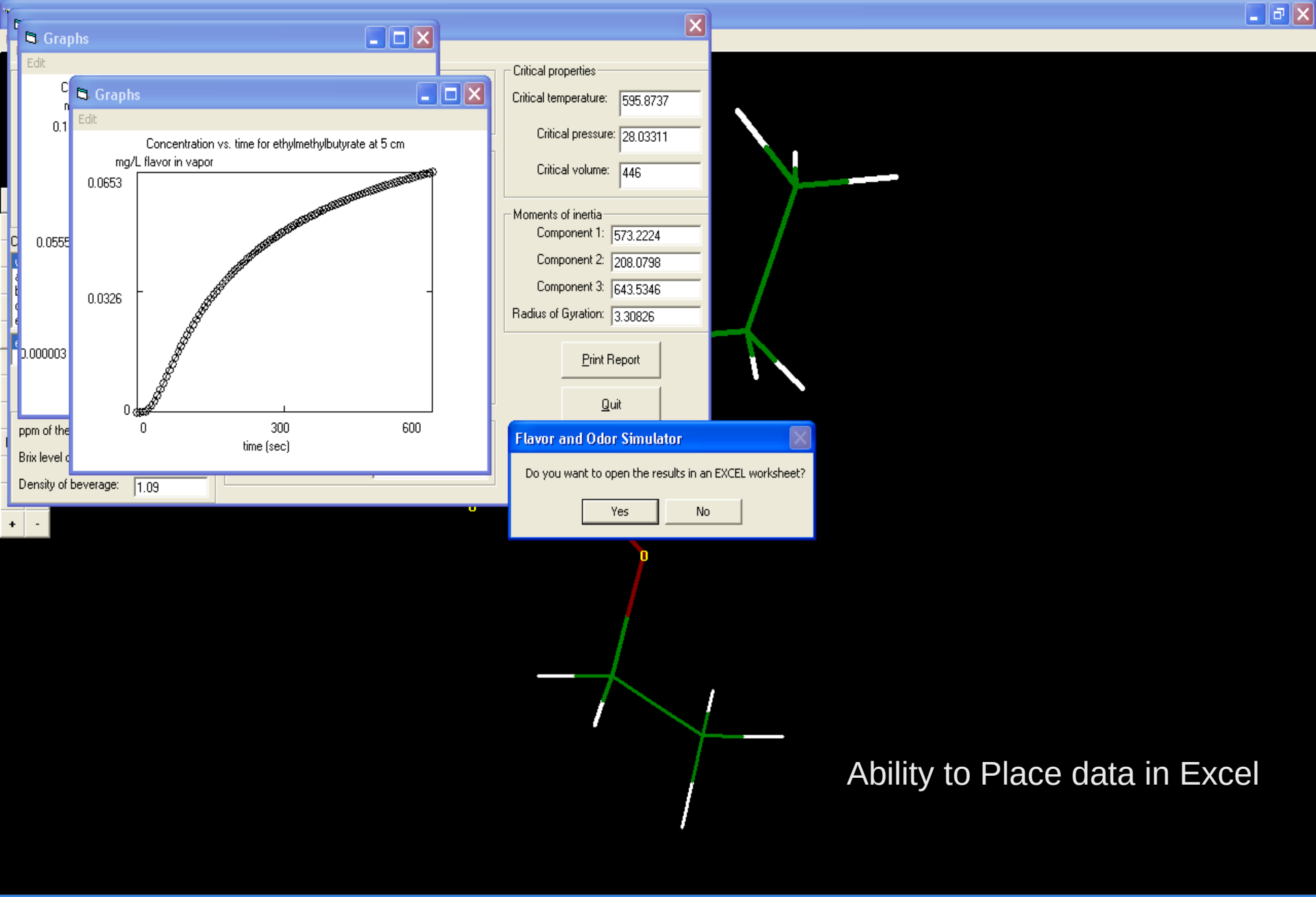



Run for Initial Calculation of Flavor Properties

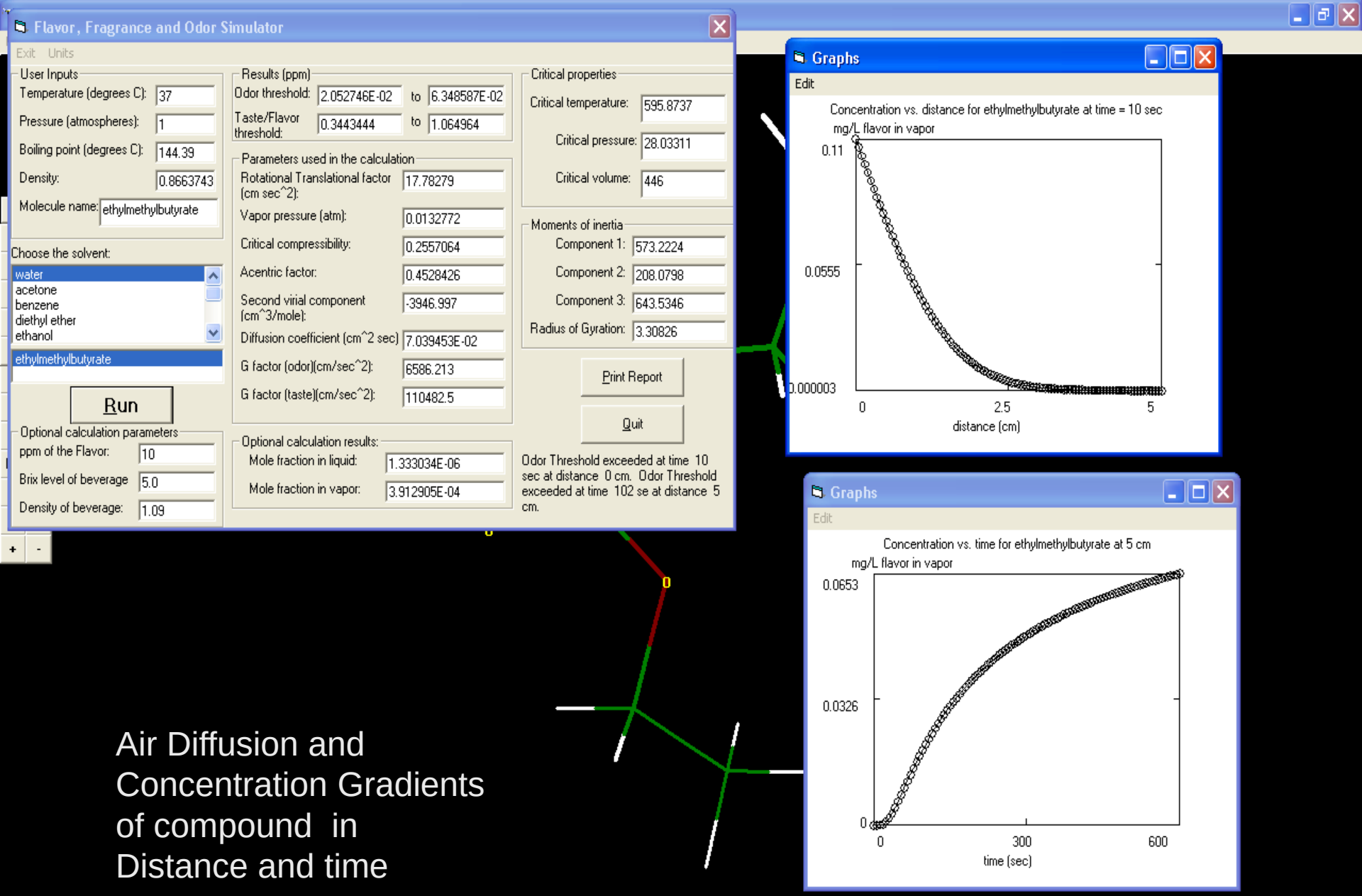

Flavor, Fragrance and ...
Exit Units
User Inputs
Temperature (degrees C): 37
Pressure (atmospheres): 1
Boiling point (degrees C): 129
Density: 0.8663743
Molecule name: ethylmethylbutyrate
Choose the solvent:
water
acetone
benzene
diethyl ether
ethanol
ethylmethylbutyrate
Run
Optional calculation parameters
ppm of the Flavor: 10
Brix level of beverage 5.0
Density of beverage: 1.09
Scale
Translate
Perspect
New Mol
Connect
Clear
O
O
For Aroma in Water or beverage
Enter optional Parameters



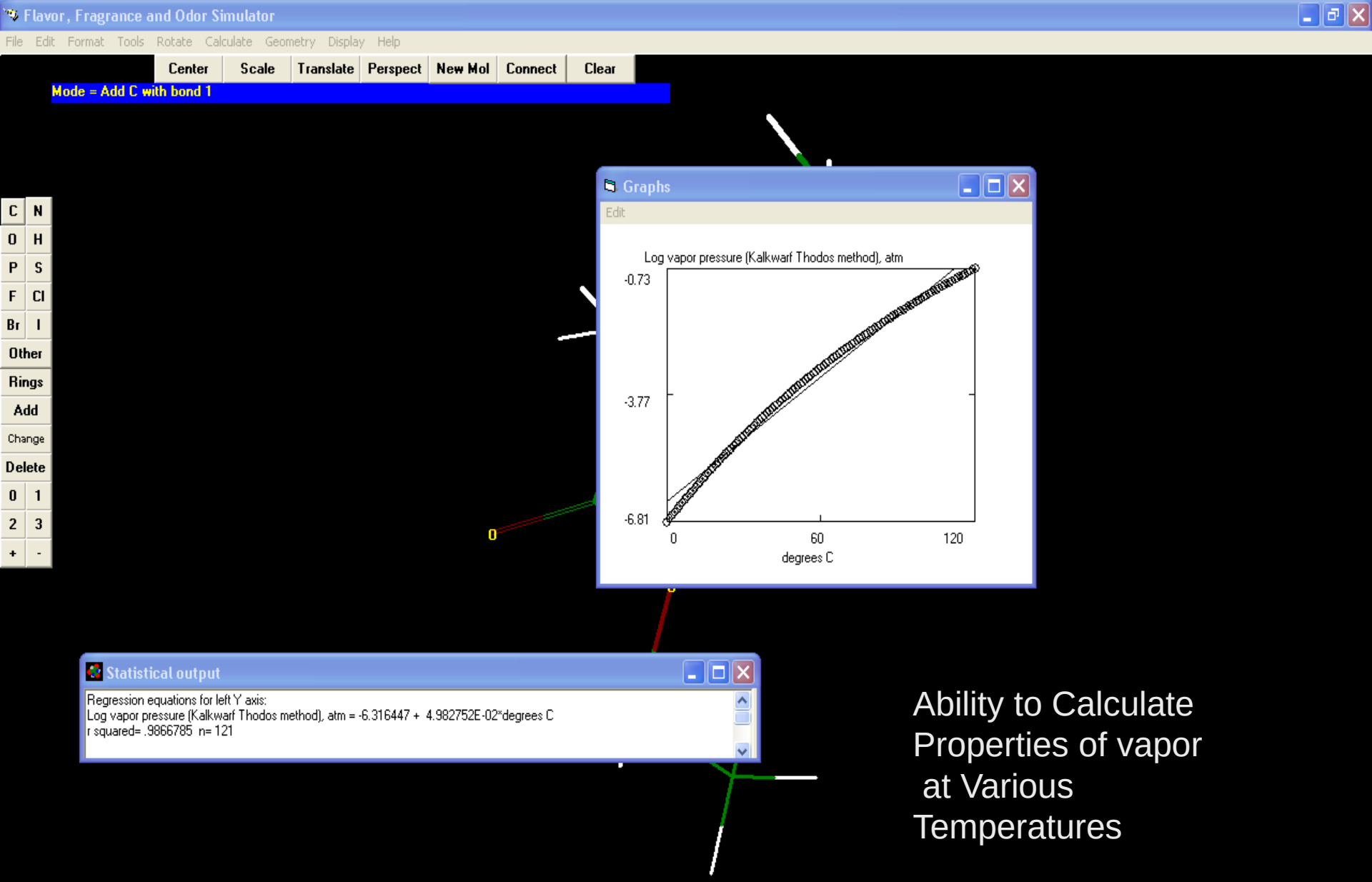

Run Optional Graphs for Vapor Concentrations



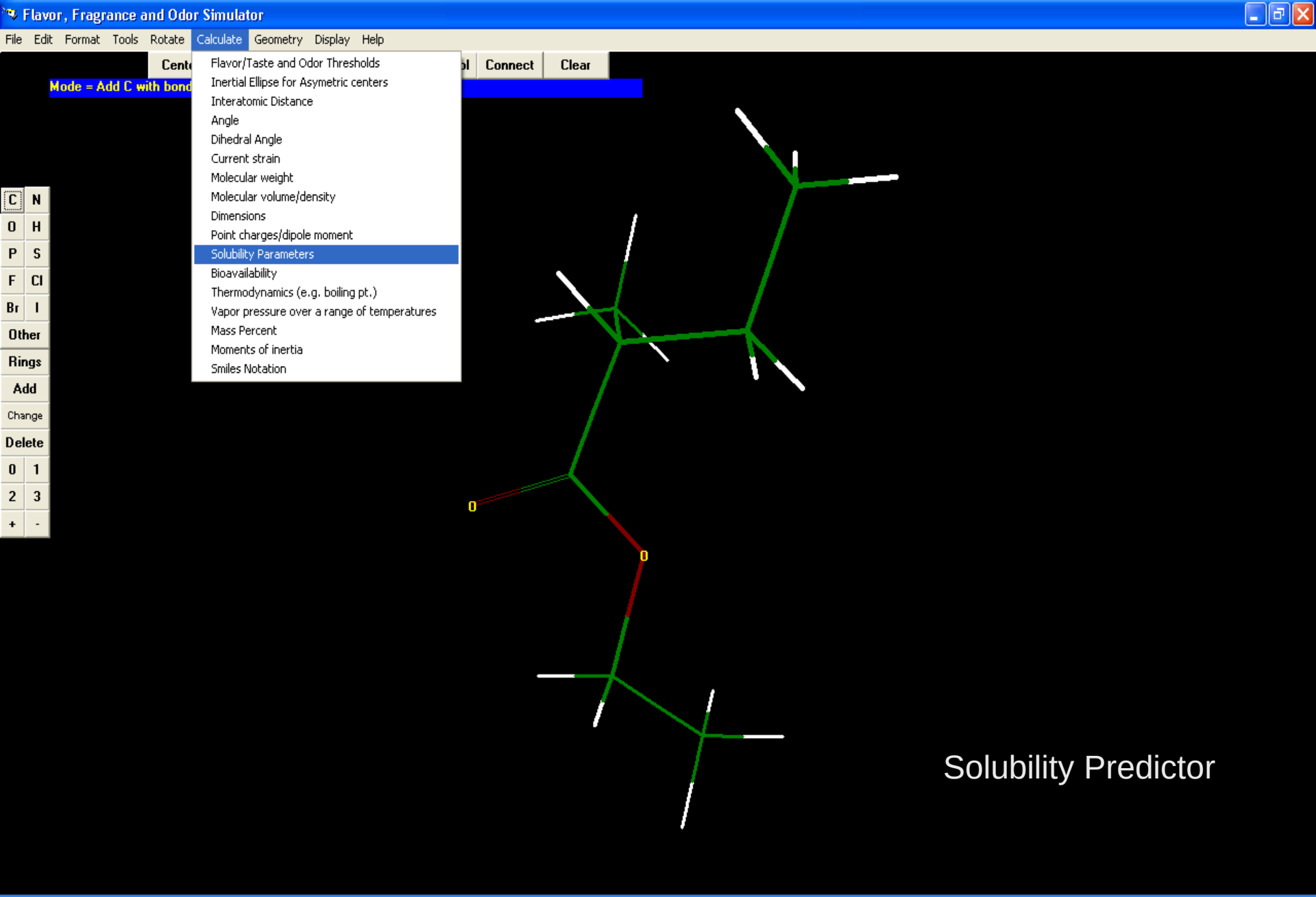

Ability to Place data in Excel



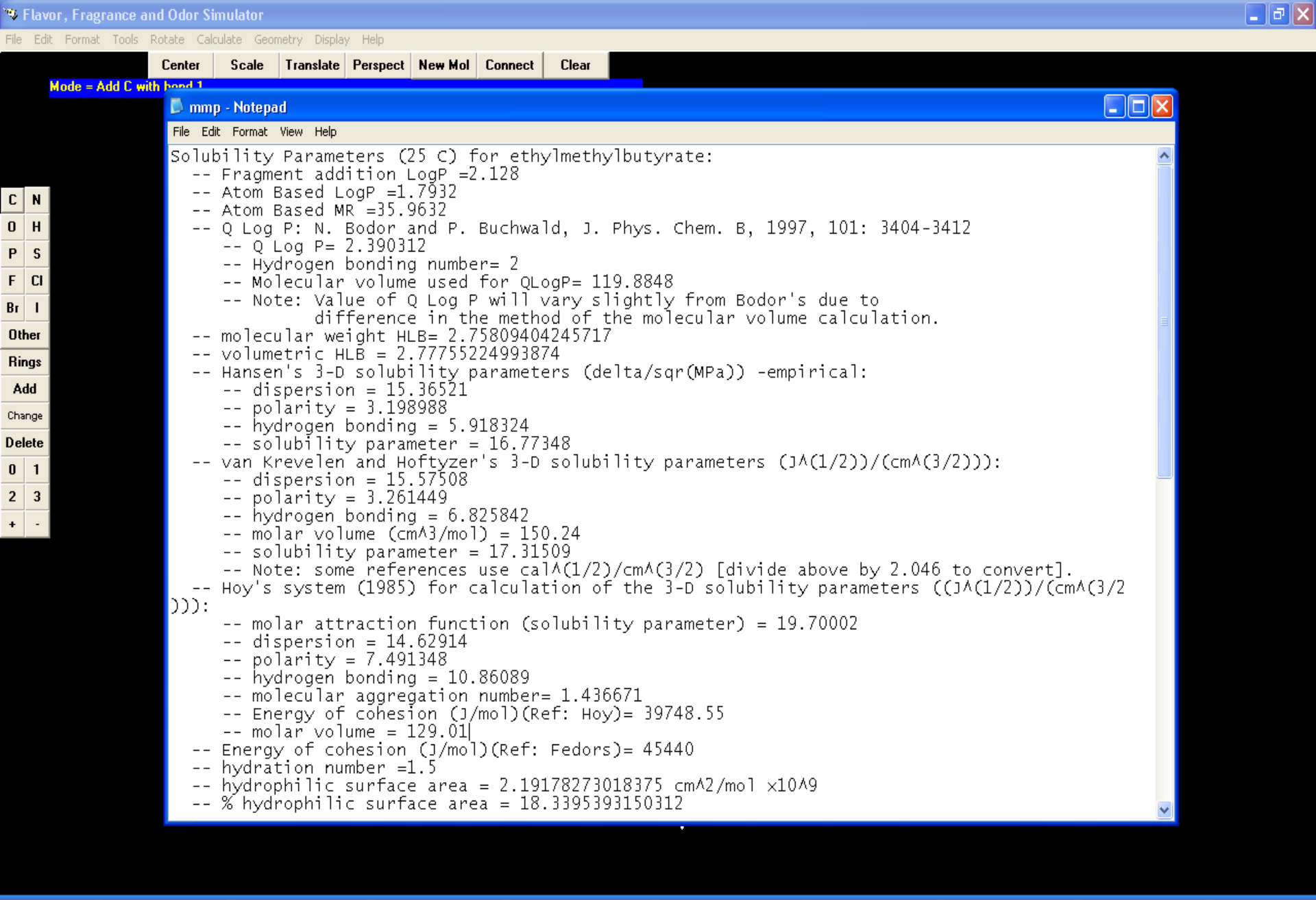

Air Diffusion and Concentration Gradients of compound in Distance and time




Ability to Calculate Properties of vapor at Various Temperatures




Solubility Predictor






# Sample Calculation

# Definition Aroma -

- Optimal release of flavor compound based on releasing media and physico-chemical properties of the flavor.
- These properties can be measured experimentally, defined empirically or calculated using physical properties.
- Define “Aroma” or “optimized release values” as the value of a calculated release pressure of a flavor out of water (or a chosen specific food or solution) per time.
- Water release pressure is the product of the diffusion coefficient X G factor (odor) X odor threshold (ppm)

# Predictive Importance of Aroma Release Values

- Release accurately predicts the release order in time of materials in a multi-flavor system

- Release can be calculated for any flavor/fragrance. Multiply release by parts added and order from highest to lowest.

- Ability to group materials in release order to further control aroma hedonics and engineer consumer perception.

- Ability to design new flavors and hedonics

Example For a System of Flavors/Fragrances
Predicting the Aroma on Dilution with Water

Calculation of total release pressure, and
Impact on release using 50 flavor/fragrance components

The following slides show odor predictions:

1. Order of release of 50 components from a mixture at a given composition based on order of magnitude changes in release pressure

2. The order is of undefined time but usually represents 5 second intervals

3. Within each order is a major impact component

4. Odor impact calculation for each component can be determined by running optional graphs of vapor concentration and comparing concentration in vapor with respect to odor threshold.

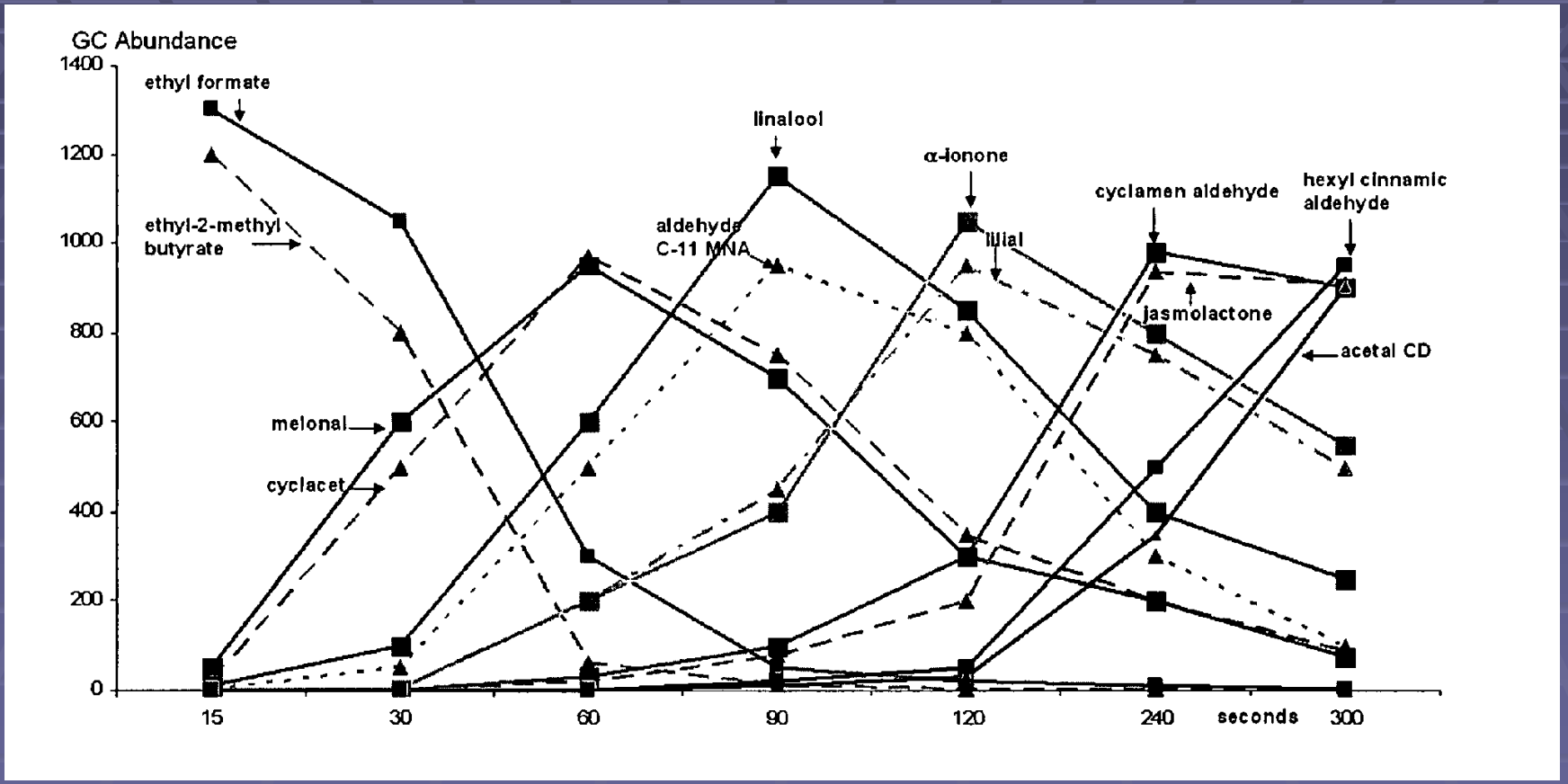
Example Calculation of Release and Total Release
And Ordering of 50 Fragrances in Order of release:
Colors represent magnitude change in total release
Initial release 0 seconds to 20 seconds

| | parts | clogP | B.P. | Water Release Value Ω | Ω x Qty | % | Ω x % |
|---|---|---|---|---|---|---|---|
| d-LIMONENE | 2 | 4.83 | 174.00 | 12.89011949473 | 25.780238989 | 0.023781213 | 0.306542675 |
| ETHYL BUTYRATE | 0.1 | 1.77 | 121.95 | 70.55231284335 | 7.055231284 | 0.001189061 | 0.083890978 |
| ETHYL 2-METHYLBUTYRATE PUR | 0.1 | 2.26 | 129.00 | 55.94787687423 | 5.594787687 | 0.001189061 | 0.066525418 |
| MANZANATE | 0.1 | 2.76 | 156.32 | 5.90364669599 | 0.590364670 | 0.001189061 | 0.007019794 |
| LI | 9 | 3.28 | 198.50 | 0.03077016006 | 0.276931440 | 0.107015458 | 0.003292883 |
| DI OL | 3 | 3.60 | 192.00 | 0.06353152707 | 0.190594581 | 0.035671819 | 0.002266285 |
| TF | 0.3 | 2.67 | 189.16 | 0.33000000000 | 0.099000000 | 0.003567182 | 0.001177170 |
| FC (CIS) | 0.1 | 3.13 | 196.74 | 0.58404016932 | 0.058404017 | 0.001189061 | 0.000694459 |
| CI | 0.2 | 1.61 | 156.00 | 0.25661199021 | 0.051322398 | 0.002378121 | 0.000610254 |
| BE | 1.3 | 2.08 | 216.00 | 0.03934973997 | 0.051154662 | 0.015457788 | 0.000608260 |
| CI FCC | 0.7 | 3.56 | 225.00 | 0.05793558671 | 0.040554911 | 0.008323424 | 0.000482222 |
| VE | 2.5 | 4.42 | 239.00 | 0.00971745877 | 0.024293647 | 0.029726516 | 0.000288866 |
| AL | 0.5 | 3.67 | 210.00 | 0.04323356349 | 0.021616782 | 0.005945303 | 0.000257037 |
| AL | 0.5 | 2.08 | 214.00 | 0.04188905618 | 0.020944528 | 0.005945303 | 0.000249043 |
| CI ETATE | 0.1 | 2.61 | 198.00 | 0.18024312711 | 0.018024313 | 0.001189061 | 0.000214320 |
| ET | 2.9 | 3.87 | 220.00 | 0.00418909839 | 0.012148385 | 0.034482759 | 0.000144452 |
| BE ATE | 0.5 | 2.57 | 222.00 | 0.02298313800 | 0.011491569 | 0.005945303 | 0.000136642 |
| FRUCTONE | 0.3 | 1.30 | 207.99 | 0.03465057668 | 0.010395173 | 0.003567182 | 0.000123605 |
| LIFF | 0.1 | 2.48 | 184.78 | 0.10283040388 | 0.010283040 | 0.001189061 | 0.000122272 |
| DIH OL | 0.2 | 3.10 | 201.00 | 0.03596706525 | 0.007193413 | 0.002378121 | 0.000085534 |
| IONONE BETA PURE | 0.9 | 3.96 | 239.00 | 0.00733636218 | 0.006602726 | 0.010701546 | 0.000078510 |
| DI INYL AC | 1 | 3.44 | 250.00 | 0.00445927024 | 0.004459270 | 0.011890606 | 0.000053023 |
| VE | 0.1 | 4.42 | 237.00 | 0.01121131905 | 0.001121132 | 0.001189061 | 0.000013331 |
| TE | 0.1 | 4.34 | 239.87 | 0.01009611655 | 0.001009612 | 0.001189061 | 0.000012005 |

# Continued Release values of 50 Fragrances at 20 and 25 seconds

| | parts | clogP | B.P. | Water Release Value Ω | Ω x Qty | % | Ω x % |
|---|---|---|---|---|---|---|---|
| FL | 2.5 | 1.65 | 243.05 | 0.00018830080 | 0.000470752 | 0.029726516 | 0.000005598 |
| TE | 0.1 | 3.33 | 218.00 | 0.00450287663 | 0.000450288 | 0.001189061 | 0.000005354 |
| O) | 0.01 | 2.31 | 226.46 | 0.03278790317 | 0.000327879 | 0.000118906 | 0.000003899 |
| UI | 0.6 | 3.90 | 238.50 | 0.00052269564 | 0.000313617 | 0.007134364 | 0.000003729 |
| FL | 0.3 | 3.91 | 260.00 | 0.00099601267 | 0.000298804 | 0.003567182 | 0.000003553 |
| AL PROPIONAT | 0.3 | 4.12 | 265.27 | 0.00094605475 | 0.000283816 | 0.003567182 | 0.000003375 |
| HE EHYDE | 15 | 4.90 | 308.70 | 0.00001630285 | 0.000244543 | 0.178359096 | 0.000002908 |
| GA NE | 0.3 | 2.38 | 266.88 | 0.00058484054 | 0.000175452 | 0.003567182 | 0.000002086 |
| GAMMA UNDECALACTONE | 0.3 | 3.06 | 260.00 | 0.00047556253 | 0.000142669 | 0.003567182 | 0.000001696 |
| alpha-DAMASCONE | 0.1 | 3.62 | 260.00 | 0.00136091601 | 0.000136092 | 0.001189061 | 0.000001618 |
| MAC ; 719 | 3 | 2.83 | 296.58 | 0.00004273000 | 0.000128190 | 0.035671819 | 0.000001524 |
| HEL | 1.4 | 2.51 | 286.03 | 0.00002808947 | 0.000039325 | 0.016646849 | 0.000000468 |
| ADC | 0.4 | 5.35 | 286.90 | 0.00008031443 | 0.000032126 | 0.004756243 | 0.000000382 |
| BEI | 0.2 | 1.08 | 205.40 | 0.00015965114 | 0.000031930 | 0.002378121 | 0.000000380 |
| BAC | 1.5 | 5.14 | 276.69 | 0.00002111182 | 0.000031668 | 0.017835910 | 0.000000377 |
| GAL | 10 | 6.06 | 345.00 | 0.00000288325 | 0.000028832 | 0.118906064 | 0.000000343 |
| HEC | 15 | 2.90 | 307.00 | 0.00000139777 | 0.000020967 | 0.178359096 | 0.000000249 |
| SAI | 1.3 | 5.15 | 275.79 | 0.00001362896 | 0.000017718 | 0.015457788 | 0.000000211 |
| DAMASCENONE | 0.03 | 4.04 | 275.64 | 0.00049168874 | 0.000014751 | 0.000356718 | 0.000000175 |
| C/ | 0.03 | 2.43 | 266.07 | 0.00019327221 | 0.000005798 | 0.000356718 | 0.000000069 |
| AI | 0.03 | 4.76 | 345.00 | 0.00004104660 | 0.000001231 | 0.000356718 | 0.000000015 |
| ET SYLATE | 4.3 | 4.71 | 333.00 | 0.00000028348 | 0.000001219 | 0.051129608 | 0.000000014 |
| O) ALS | 0.4 | 1.48 | 292.20 | 0.00000261059 | 0.000001044 | 0.004756243 | 0.000000012 |
| VE ; | 0.1 | 5.36 | 340.00 | 0.00000452415 | 0.000000452 | 0.001189061 | 0.000000005 |
| E) AL | 0.2 | 6.15 | 344.80 | 0.00000149013 | 0.000000298 | 0.002378121 | 0.000000004 |
| ME E | 0.1 | 2.84 | 319.79 | 0.00000000324 | 0.000000000 | 0.001189061 | 0.000000000 |

# Graph of Odorant Residence Time in Headspace According to their Release Values




Reference: Perfumes for Rinse-Off Systems U.S. Patent 7,446,079 B2

# Odor Evaluation of 50 component mixture and Hedonic Progression from Water

Water Release Order Predicts

Citrus tangerine

Green floral apple

Floral

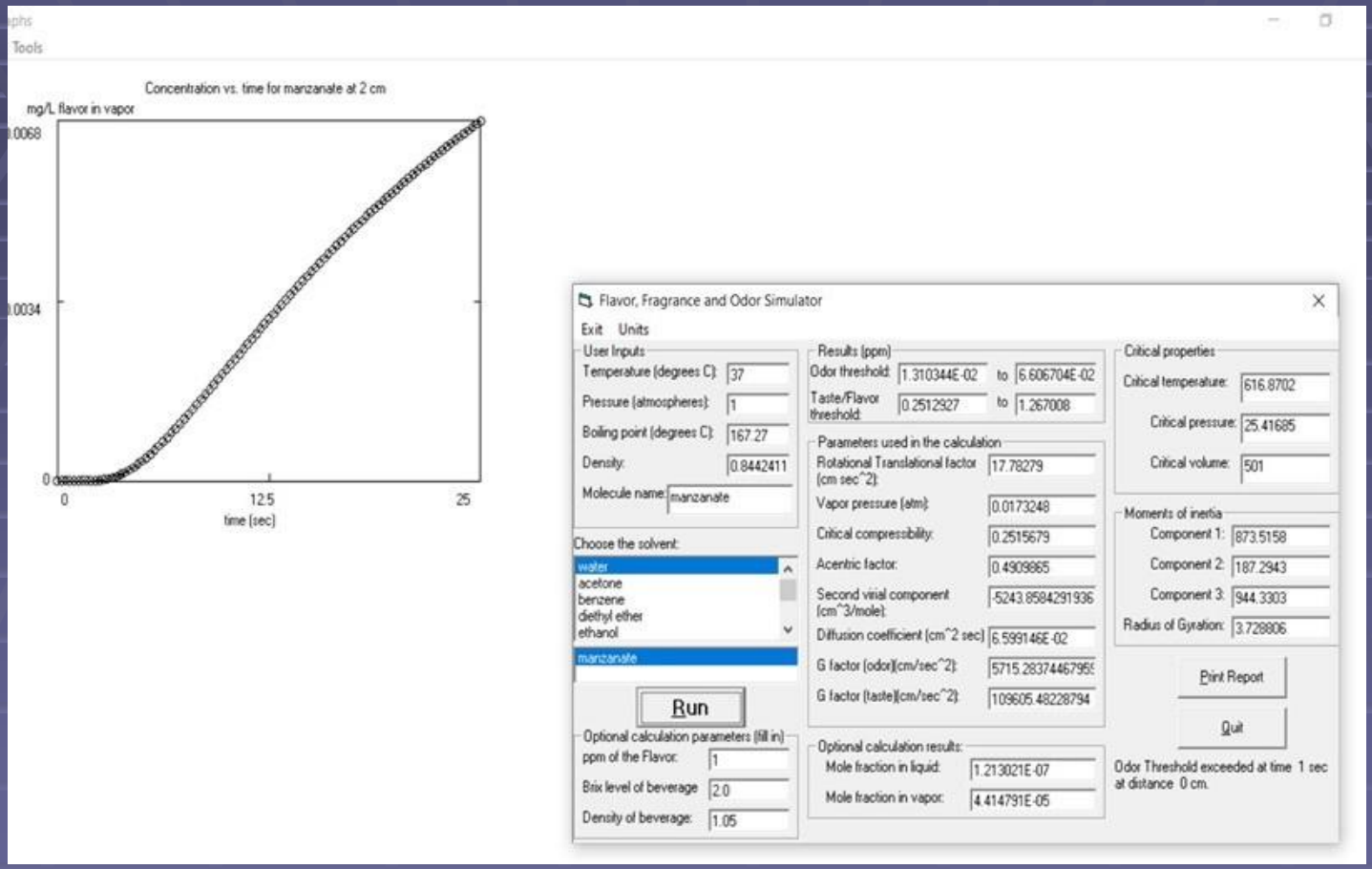
Peach tropical, papaya

Floral musk

Evaluation Comments:

"*A lot of pop, tropical fruity citrus, grapefruit citrus blend, green, cassis, floral amber*" -
"*Cucumber floral aldehydic, apple, rose*"
"*Floral, fresh citrus grapefruit orange, musk, floral peach woody*"

# Predicting Odor Impact within a Release Group




Compare Concentrations in Headspace at 25 seconds with Odor Threshold to Calculate an Odor Index (0.0068/0.0131 = 0.519)

# Rationale for Flavor Design

- Values for total water release are quantity related:

$$Release_{final} = (parts\ in\ formula) \times Release$$

- Able to move up and/or down the defined "release" depending on the composition in formula and value of Release: dynamic and flexible design of flavors within a specific formula

- Able to predict residence time or duration of aroma by overdosing on specific release or compounds within certain release group

- Better control of aroma profile and ability to focus on the hedonic fingerprint of certain release times by engineering the previous and/or targeted ones – I.e. burst or fresh release perception of certain notes or change of hedonic impression of the released flavor after a certain time

# Computer Applications in Flavor/Fragrance Design

Capabilities for Criteria for Success:

- Optimize aroma or water release formulations using predicted properties
- Engineer flavor aroma character according to calculated release profiles
- Cost considerations and economical advantages can be predicted
- Predict odor indices related to ODT in air and in liquid
- Program can be applied to water/emulsion systems, flavor burst, and with off-flavors or other systems requiring flavor modeling

See-US Patent 7446079B2 for more details