There are three state variables:

1. Time
2. List of current states of the wells (unknown, oil, or dry)
3. Current well being drilled

Both the strategy and the NPV from the Bickel and Smith paper were matched.

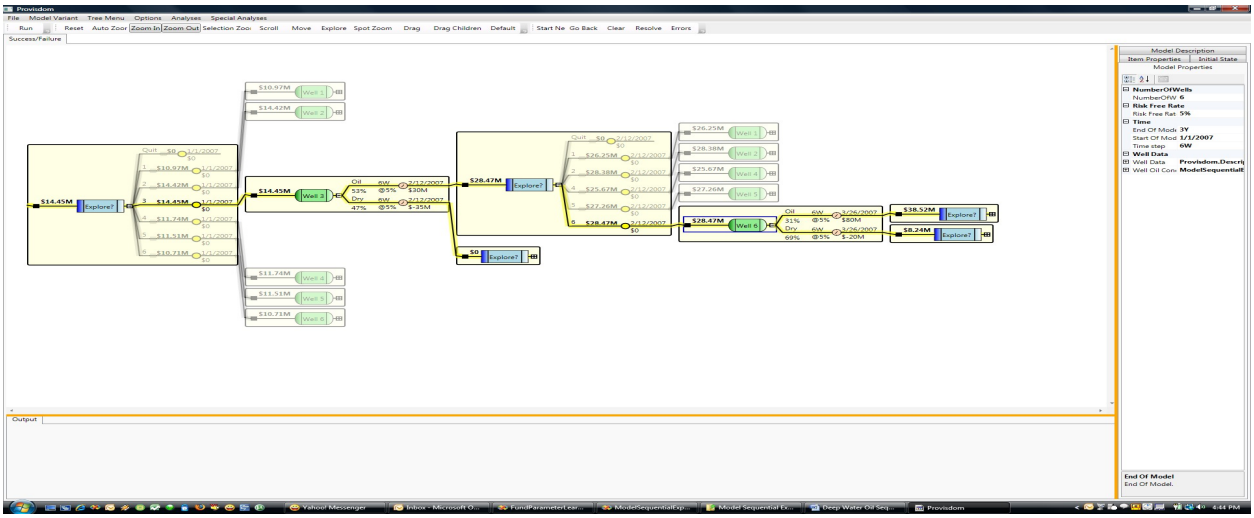
Payoffs Occur after Well Scenarios are Resolved

In the original model, the payoffs for the wells having oil or beingdry occurred one period before the resolution of the uncertainty. We built a model in which the conditional payoffs occurred after it was known whether the well had oil or was dry. This lowered the NPV from $14.403M to $14.260M.

Lowering the Risk-free Rate

Since a risk-free rate of 8.653% seems unrealistic in 2007, we lowered the rate to 5%. This change increases the NPV from $14.260M to $14.454M.

A portion of the solution is shown below.



Finally, let's examine the gradient of the NPV with respect to the unconditional probabilities:

Well	Gradient ($/%)
1	385947
2	248050
3	621619
4	-184
5	-294922
6	-255622

The gradient values tell us the numerical derivative of the NPV with respect to each quantity. We see that wells 1-3 show a positive relationship between their unconditioned probability of having oil and the NPV, while wells 4-6 have a negative relationship. To see why lowering the unconditional probability could actually increase shareholder value, consider Well 4. The unconditional probability of Well 4 having oil is equal to the probability of Well 4 having oil conditioned on wells 1-3 having oil. If we lower the unconditioned probability of Well 4 having oil without also lowering the conditional probabilities, then the probability of Well 4 having oil increases when any of wells 1-3 have oil. Therefore, we have increased the positive relationship between wells 1-3, which increases the NPV. For example, lowering the unconditional probability of Well 4 having oil from 83% to 75% increases the NPV from $14.454M to $14.758M. Of course, if we had kept the original belief that Well 4 is independent of the other wells, the gradient for Well 4 would have been zero since it is never drilled.

Model Extensions

Cost of Moving Drilling Rig

Now we'll imagine that it costs to move the drilling rig from well to well (thanks to Jim Smith for the idea). The cost of moving the drilling rig between wells is shown in the following table:

	Well 2	Well 3	Well 4	Well 5	Well 6
Well 1	$1M	$3M	$8M	$4M	$6M
Well 2		$2M	$9M	$3M	$5M
Well 3			$6M	$1M	$5M
Well 4				$4M	$6M
Well 5					$1M

Including these costs changes the optimal strategy substantially and lowers the NPV from $14.454M to $11.918M: