

After version 5.5 of the CONSIDEO MODELER (including OLAP MODELER and PROCESS MODELER) improved the possibilities of qualitative modeling, allowing to draw conclusions from just rough assumptions, version 6.0 adds a major feature to quantitative modeling: Monte Carlo Simulation.

This may sound a bit technically but with the MODELER it just means that you have a very easy way to foresee the likelihoods of developments depending on the likelihoods of the values of any number of factors within our models. Until now you had to decide for each scenario what value for each of the factors should have. Now you can assume the likelihoods of values of a certain range of values and the MODELER calculates with as many scenarios you want the possible outcomes of the model. You see the most likely outcome and the best and worst cases and their likelihoods. This, of course, is of use within the MODELER as well as the OLAP MODELER and the PROCESS MODELER.

New with version 6.0 next to the usual improvements on stability:

- with Monte-Carlo Simulations based on the use of random values and the distribution of likelihoods of certain values you can run as many simulations you need to get as a result:
 - a spaghetti-diagram showing the possible outcomes of a factor
 - through the context menu of any plot of a spaghetti diagram you can see the combination of values that led to this outcome
 - a histogram of a factor shows the likelihoods of the different outcomes
- you can view the descriptions of diagrams within their header
- with the new diagram type 'Selected Values' you can choose points of time as columns showing the values of selected factors in rows. This is a very common view of data within business applications.
- you can highlight those rows
- as an alternative to slider manipulators you can now choose a list of parameters
- you can choose the number of decimals to be shown within tables in the cockpit
- you can alter the sequence of cockpits within the Cockpit Explorer via drag and drop

In the following we describe the use of the new Monte-Carlo feature. We are sure that if you do any quantitative modeling of future developments, of risks, of strategies, of projects and processes you will need this great feature. Already with just a few factors in your model that you cannot be sure what value they will have in reality, the number of possible outcomes might become astronomically high. With Monte-Carlo you can easily approximate the most likely developments. In other words: Whenever your model is based on assumptions you should consider the use of the Monte Carlos feature.

Example of Quantitative Modeling with use of the Monte Carlo Simulation

The following model you may already know as an example for the previous versions of the MODELER. The challenge this model addresses is the question, how much money we have to invest into marketing to trigger a word of mouth effect. There are two assumptions made within this model: The first, that it takes 1.5000 EUR to convince the first customers. And second that every tenth customer recommends another customer every month. Though both assumptions seem quite likely the values may also vary.

First the older description of the model before we added Monte Carlo:

How much do we need to invest in marketing

For our new product we have to spend about 1.500 EUR for marketing for each new customer, for ads, exhibitions and the like.

On the other hand we can assume that every tenth customer recommends a new customer every month - called word of mouth effect.

The profit of each sold product is 500 EUR.

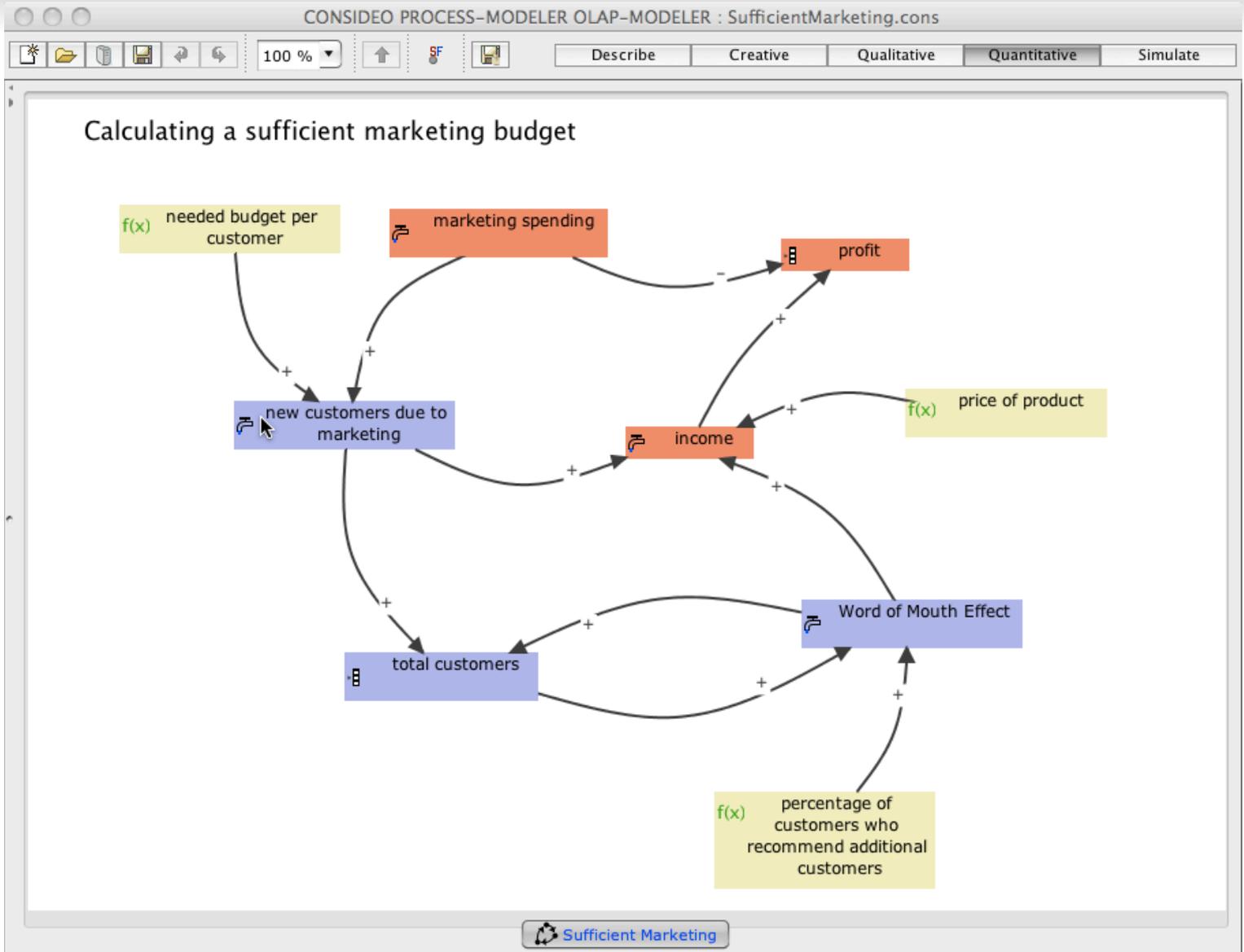
Now the question: How much do we have to invest into marketing to gain a profit of at least 100.000 EUR after two years?

The model to this situation

The task of this model is to choose the right formula. However before looking at the model on the next page you might try to model it for yourself? If you want you even might try a solution with Excel?

There is more than one solution to this exercise. You will even find some sophisticated solutions to this under the keyword 'Bass-Model', e.g. within J.D. Sterman's book Business Dynamics.

Similar exercises you will also find within the template 'practice quantitative modeling' in our MODELER-SHOP.



To choose level factors ¹ (total customers, profit) should be easy.

The values for the input factors (prices of product, time until customers ..., needed budget per customer) you will find on the next page in the simulation cockpit.

Marketing spending is a graphical function also shown in the cockpit.

You may now try to create the formula for the other three factors before you turn to the solution on the next page.

¹ Level factors you get by choosing "Type..." from a factor's context menu. Level factors are e.g. the amount of material, your budget, your costs, the motivation of employees etc., all factors that are filled or lowered over time.

new customers due to marketing:

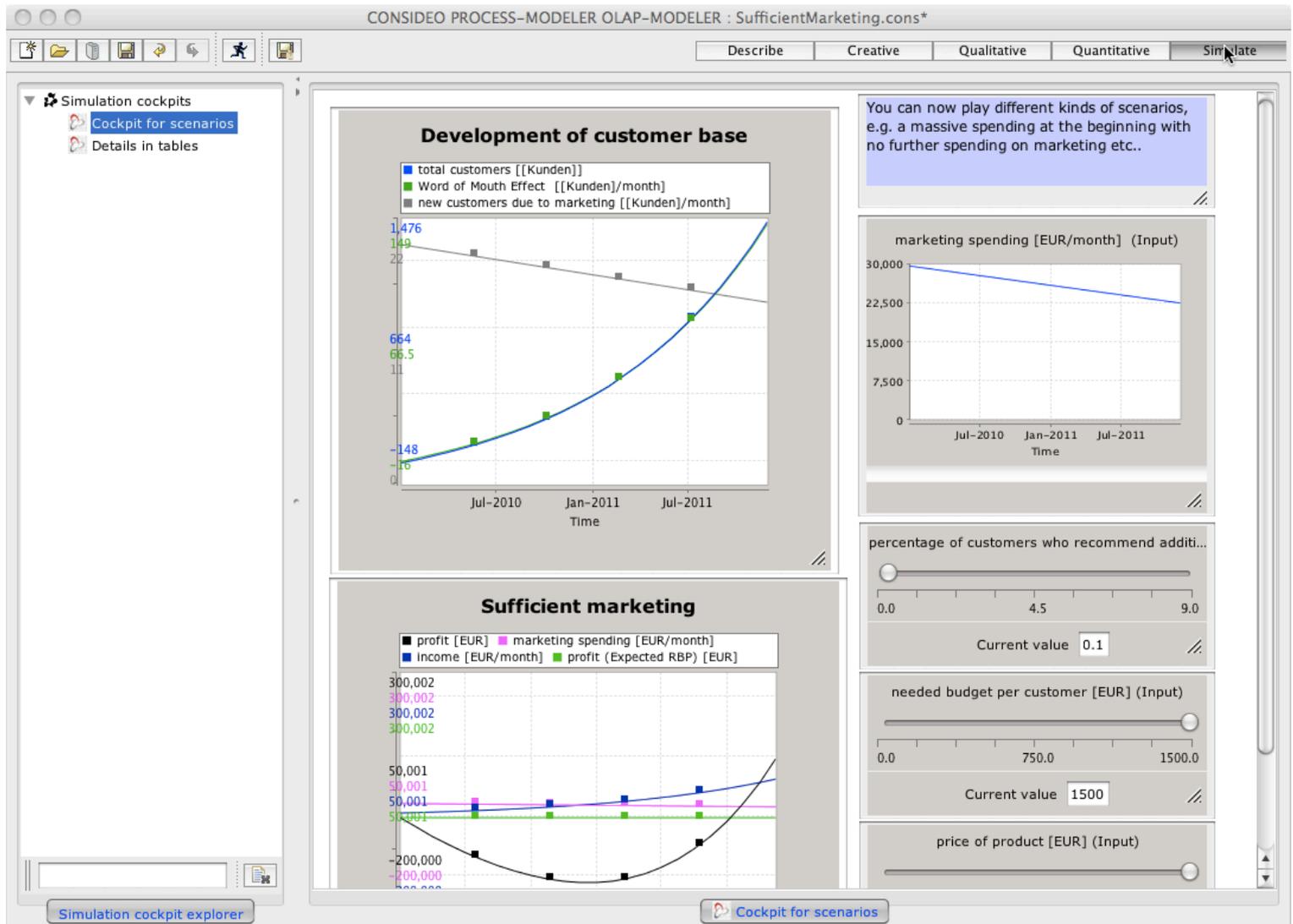
$$[\text{marketing spending}] / [\text{needed budget per customer}]$$

Income:

$$([\text{Word of Mouth Effect}] + [\text{new customers due to marketing}]) * [\text{price of product}]$$

Word of Mouth Effect:

$$([\text{percentage of customers who recommend additional customers}]) * [\text{total customers}]$$

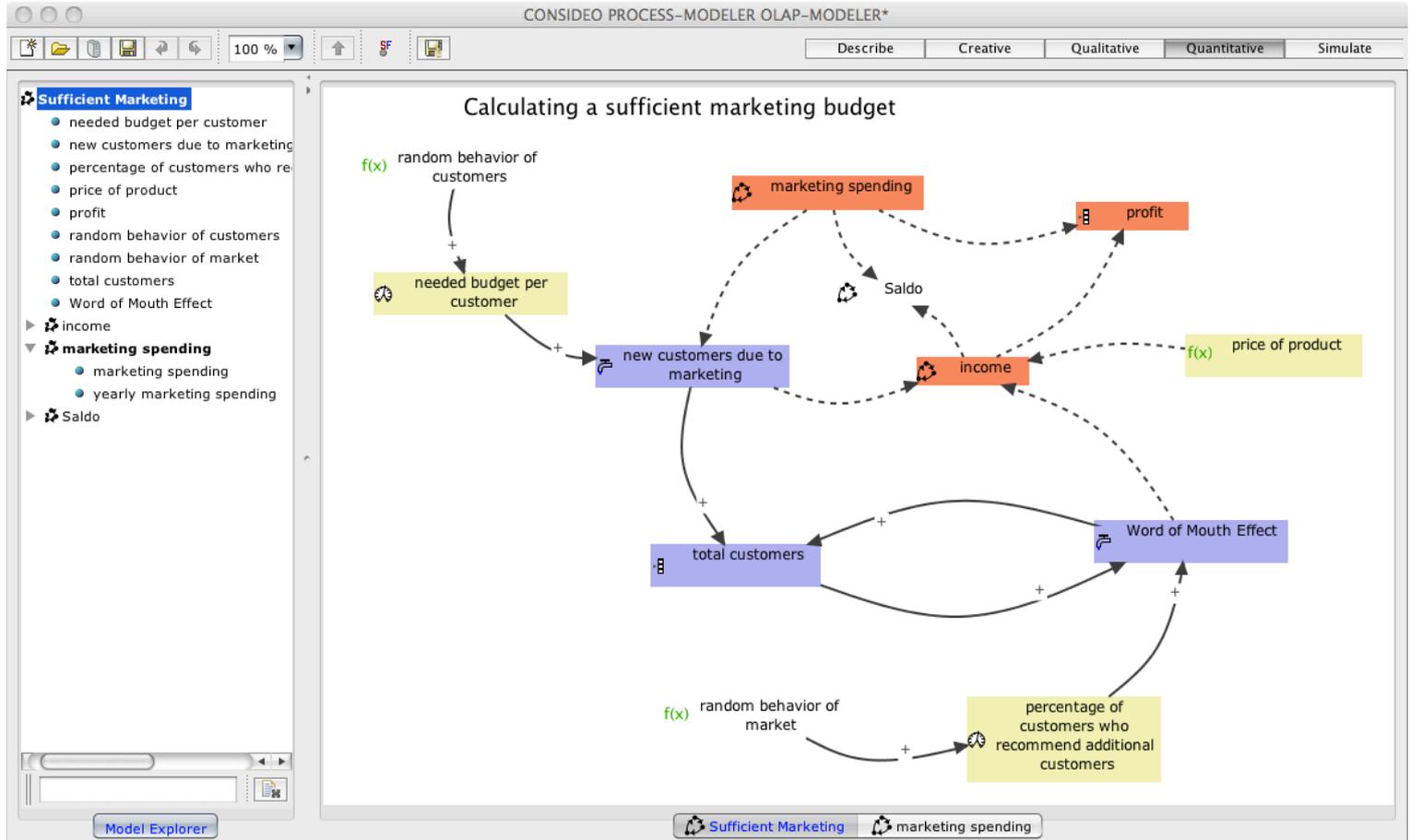


It's impressive how important a mighty spending at the beginning is. Without you will have few chances to gain momentum on your market. When the black line crosses the green one you will start making profit.

Let's now add Monte Carlo:

Using Monte Carlo Simulation to approximate all the possible outcomes

The simulation shown so far shows just the outcome for the case that every tenth customer recommends the product and that for 1.500 EUR they gain a new customer. If we want to simulate those values being just likely with a certain deviation of an average value we have to add factors with the formula random().



Random means with every simulation run the factor will have an equally random value between 0 and 1.

To get an unequally likely value for our two factors we use as a kind of trick the MODELER's chart editor. To get a Gaussian distribution for example we tell with the chart editor that for different ranges of values the random factor can deliver for the current factor a certain chosen value. In the following picture the most of the possible random values have a result around 1.000. Values nearing 0 on one end and 2.000 on the other hand are the result for only very few random values and therefore they are very unlikely.

If this sounded too technical just copy such a factor from one of our example models and reuse it within your models.

The screenshot shows the CONSIDEO PROCESS-MODELER OLAP-MODELER interface. The main window displays a simulation model titled "Calculating a sufficient marketing budget". The model includes variables like "needed budget per customer", "marketing spending", and "profit". A dialog box titled "Properties of non-level 'needed budget per customer'" is open, showing a graph and a table of dependencies.

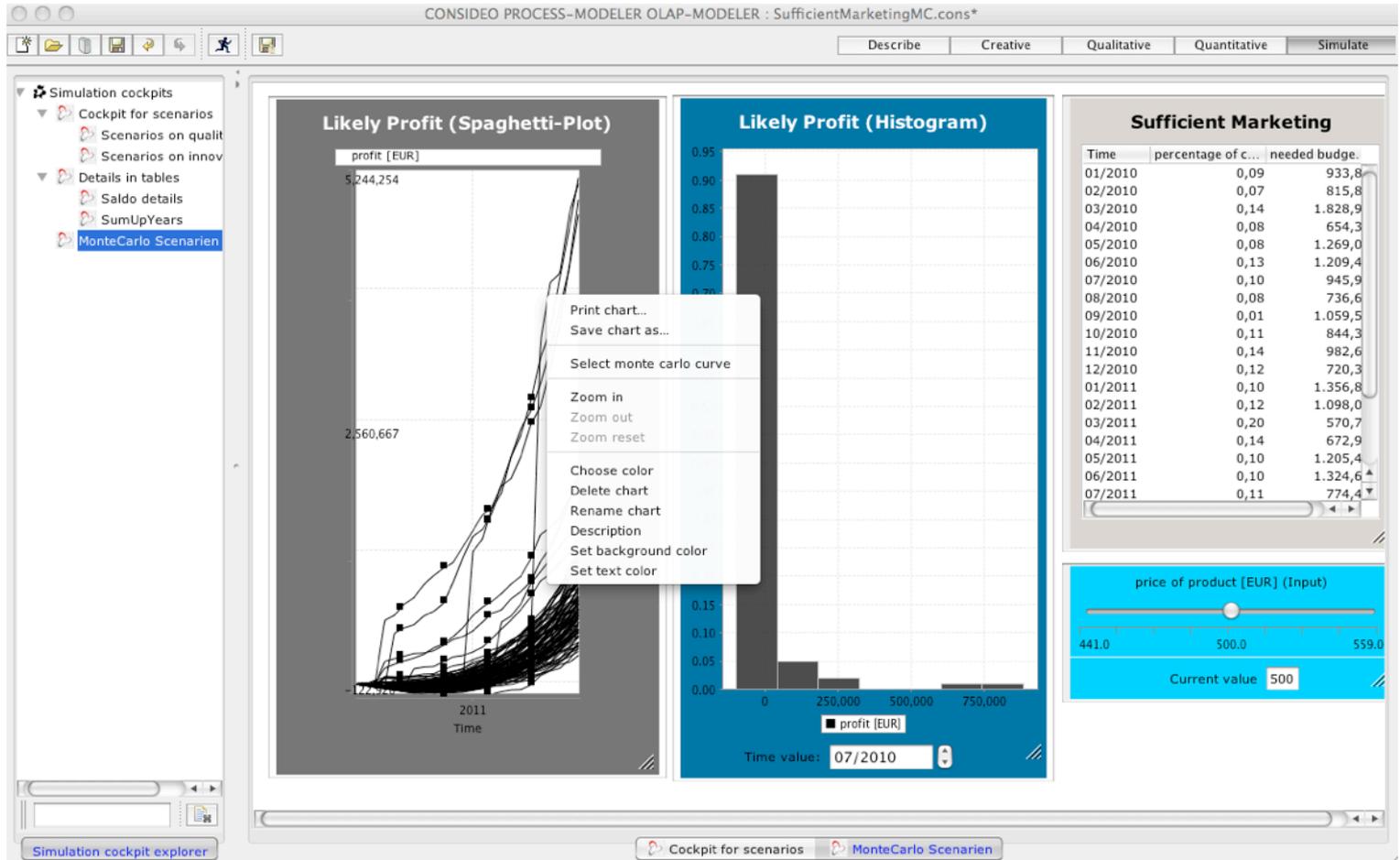
Dependencies	needed budget...
0.0	0.0
0.01	200.0
0.05	400.0
0.14	600.0
0.29	800.0
0.5	1000.0
0.7	1200.0
0.85	1400.0
0.94	1600.0
0.97	1800.0
1.0	2000.0

To see the results of our simulation we first have to activate Monte Carlo simulation within the simulation details (menu Simulation):

The "Simulation Details" dialog box shows the following settings:

- Start time: 01/2010
- End time: 12/2011
- Step size: 1
- Simple Euler method (selected)
- Runge-Kutta-2 method
- Runge-Kutta-4 method
- Path analysis (unchecked)
- Display modus: Beginning (selected)
- Ending (unchecked)
- Monte Carlo simulation (checked)
- simulations: 100
- Show dialog for simulation length (checked)

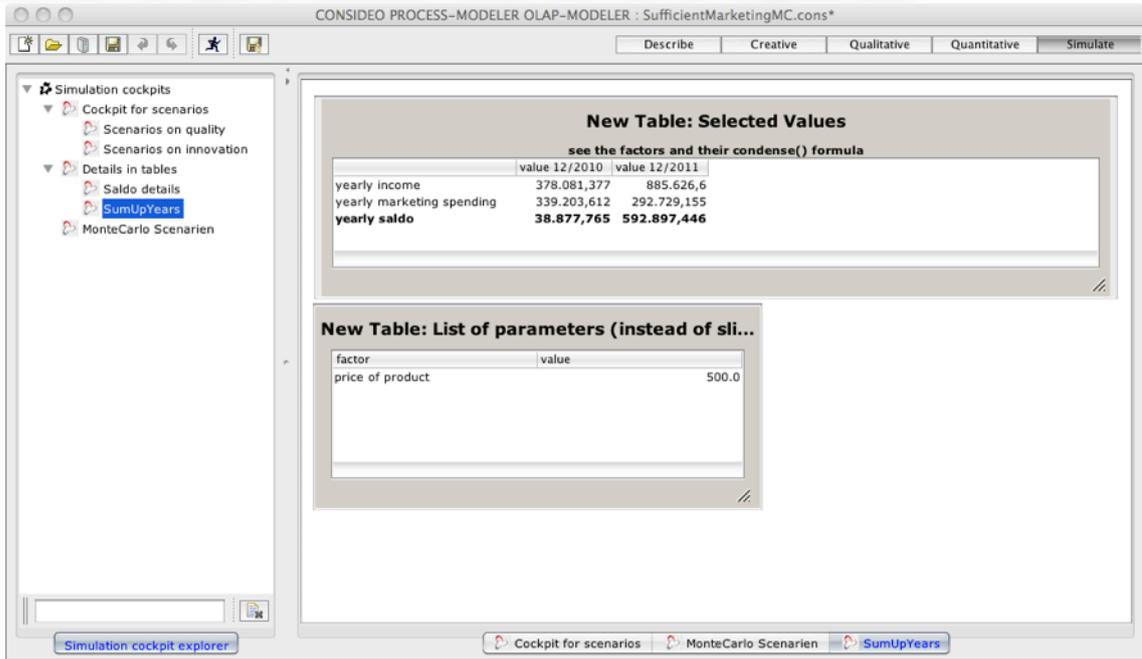
After this we can choose two additional types of diagram within our cockpit: the spaghetti plot and the histogram. Both show that for this model some very optimistic outcomes are possible but only a moderate outcome is very likely. The histogram shows, that for June 2010 a profit is quite unlikely while a deficit of has a likelihood of about 87 percent.



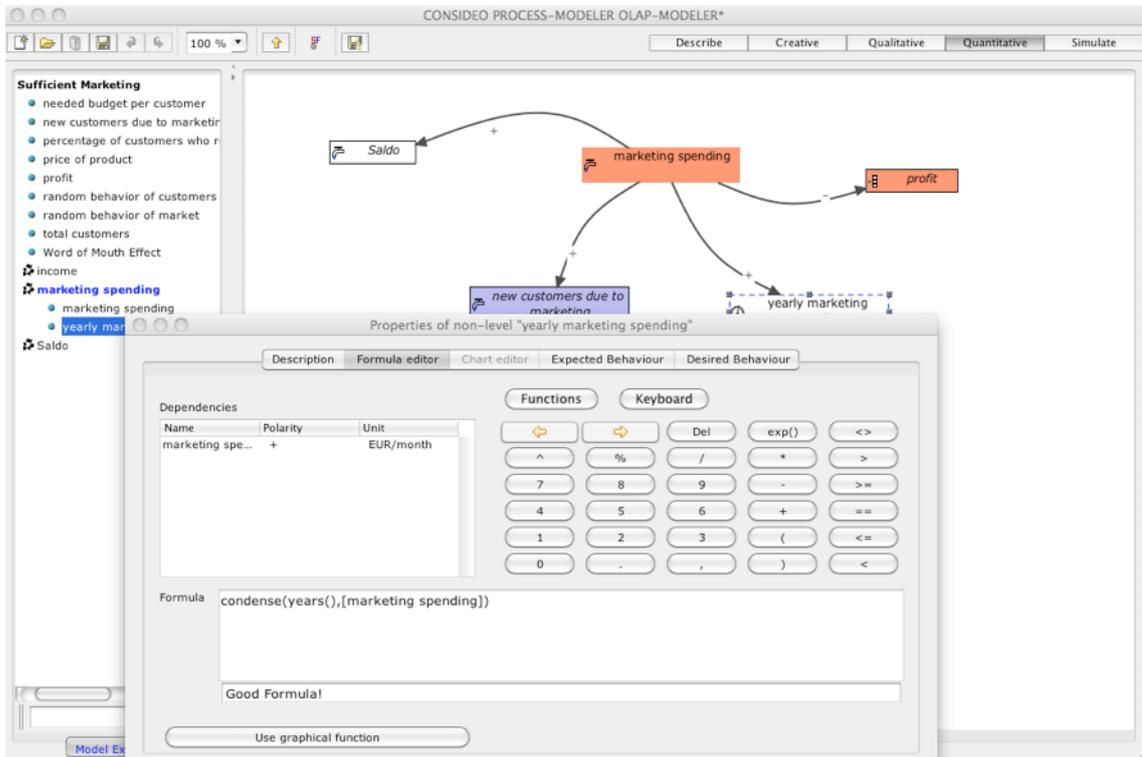
This result came after running 100 simulations. If another run of 100 simulations alters the characteristics of the results you should consider to run the simulation a thousand and more times.

You can zoom into a spaghetti plot and click the context menu of every single outcome and choose "Select monte carlo curve" to see what values led to this outcome. To see these values you have to have inserted into your cockpits a table or diagram showing them.

New with 6.0: the table of selected values and the list of parameter

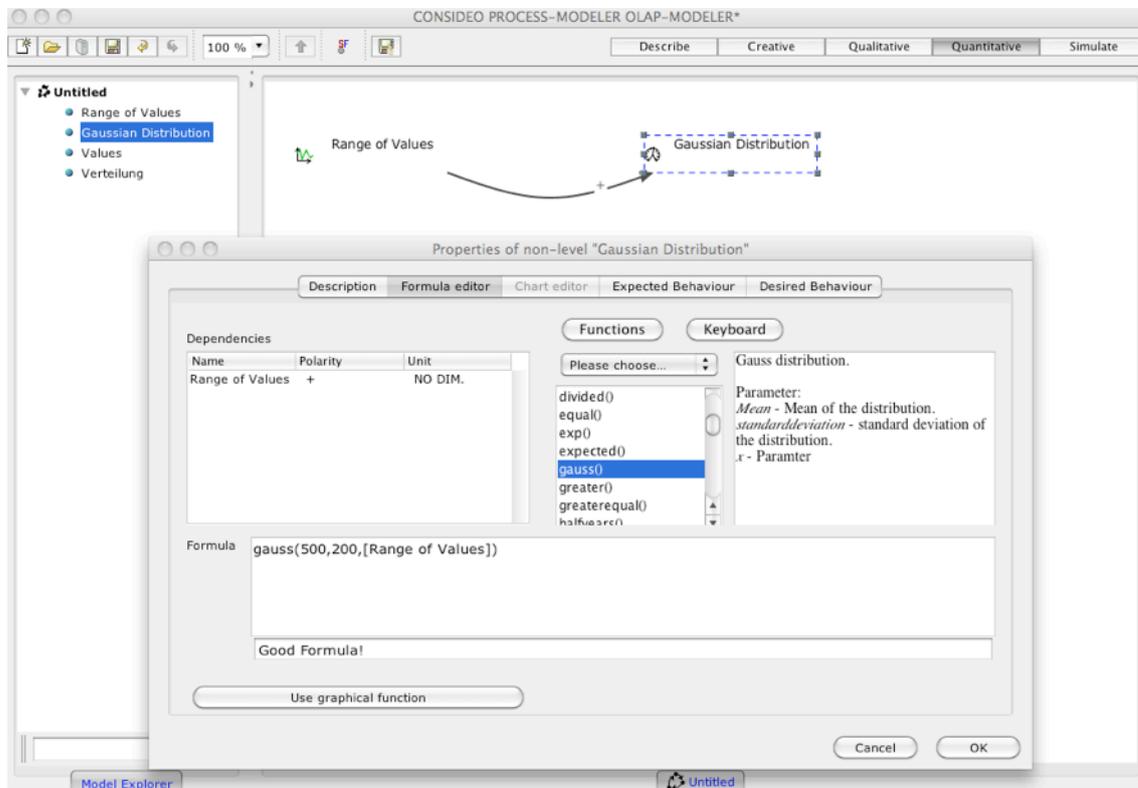
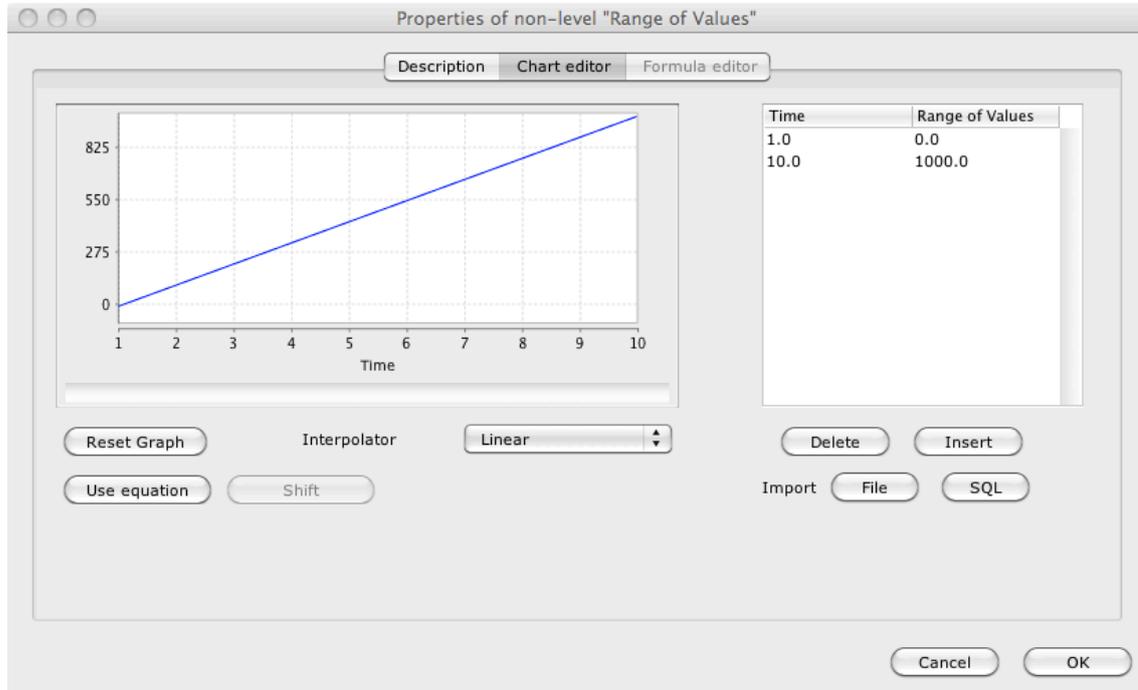


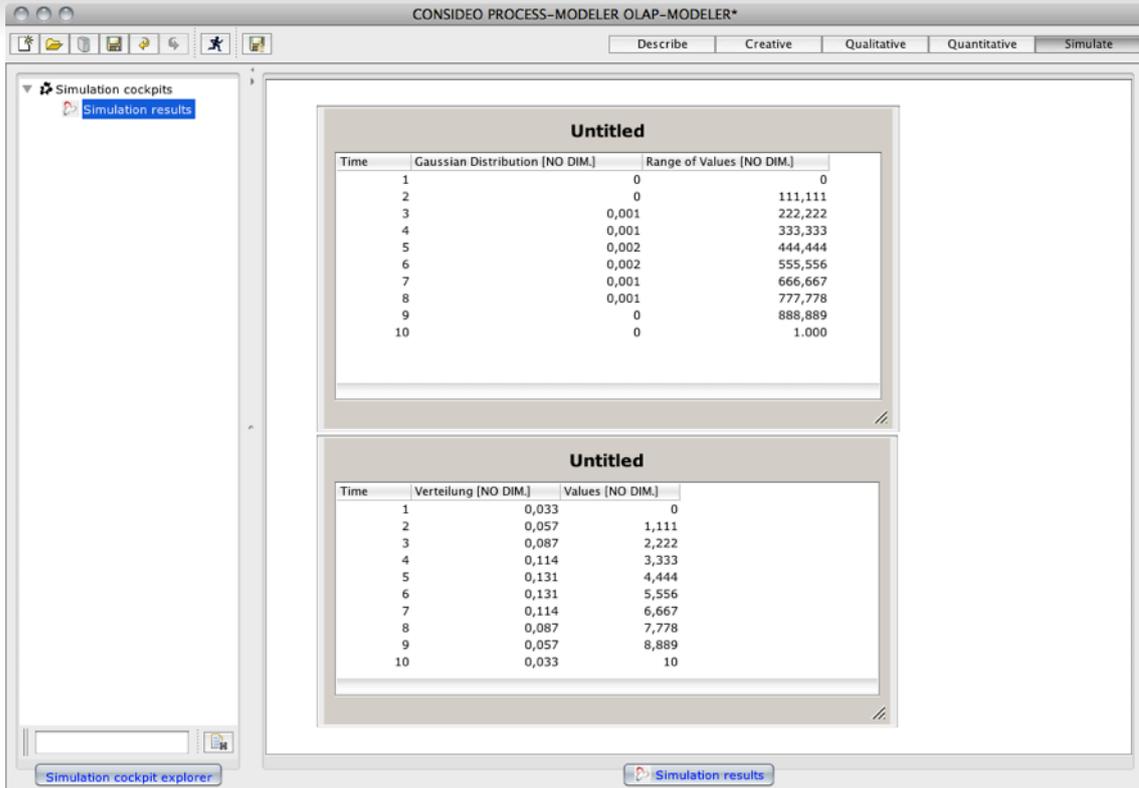
To sum up values for a certain period of time you should use the condense() formula:



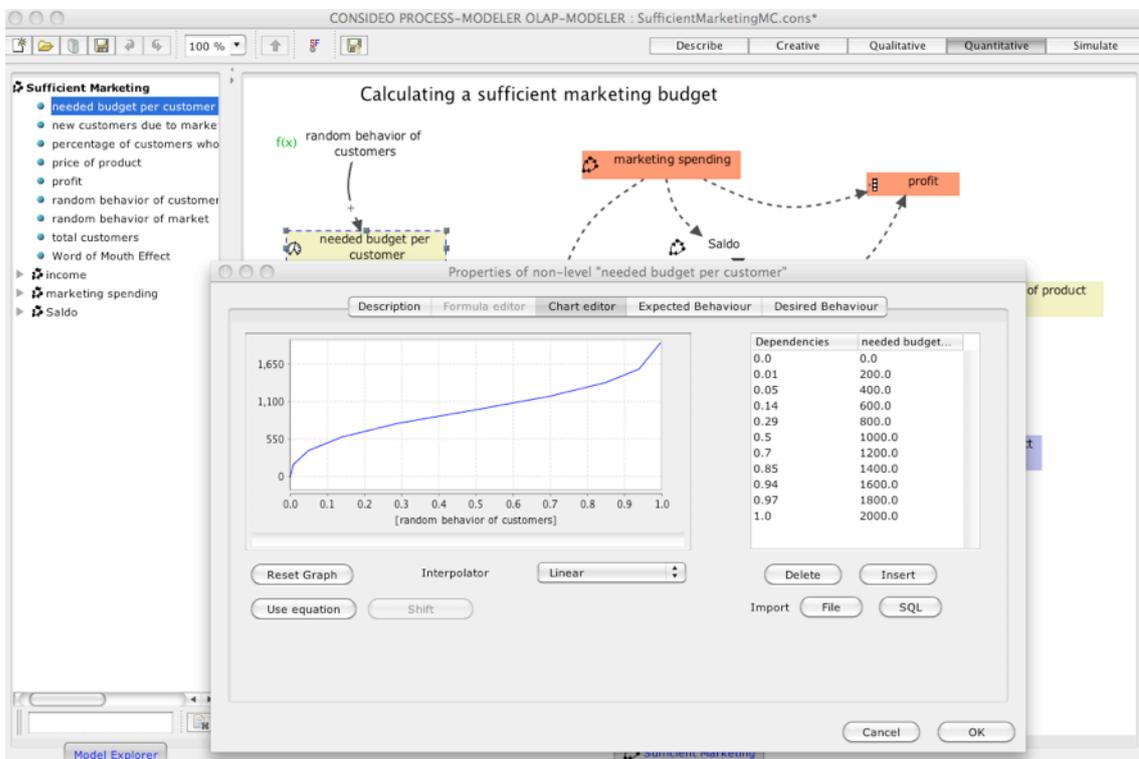
How to get e.g. Gaussian distributions

To form or alter a Gaussian distribution you may sketch in an additional model one factor representing the range of possible values and the other factor with the formula gauss() the different likelihoods of these values.





You may also copy a factor of the distribution of values from this model into your model and just alter the values to match the range you need for your model.



The dependencies values sum up the Gaussian values on the x-axis to a total of 1 (100%)