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Alcohol Learning Lab.

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Good Governance in a Complex World

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OBJECTIVE:

During this activity, the students will develop a model that helps them to understand the speed at which rises or lowers the alochol level in the blood of a person, the time that it takes to recover for driving a car, the way the weight affects during it lasts, the different impact in the gender (male or female), the type of drink, the tolerance level, and the paticipation in consecutive sprees a person could have.

The students will also understand what happens with the absorption of the alcohol in the stomach and thru there to the rest of the body through the bloodstream before being eliminated for the liver and the kidneys. They'll discover the cause-effect cycles that underlay the problem and, how they become a part of the solution.

Keywords - Learning Labs, Social Science, Biology, Alcohol, Simulation, Model.

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INTRODUCTION

Alcohol kills five times more people than cocaine, heroin, marijuana and all the other illegal drugs together. Given the growth of current consumption between our youth and societies, there are misconceptions about the level of alcohol that results from specific patterns of consumption, due to the lack of information. To understand what's happening with the speed at wich the levels of alcohol rises or lowers in the bloodstream of a person, it may help to take better decisions, particulary in relation to drive a car. Driving a car under alcohol influence is responsible for more than 40% to 55% of accidents in the USA. It's been shown that alcohol is a decisive factor in the 50% of homicides and the 30% of suicides each year.

The use and abuse of alcohol has received an increasing interest in recent decades. The alcohol is an inhibitory drug that reduces the judgment ability even in small doses. Next, a list of some facts related to the alcohol.

1. A beer mug of 12 ounces, a wine glass of 4 ounces, or one ounce of a liquor shot, contains the same amount of pure alcohol – about a half ounce.
2. The alcohol is a depressant – a drug that slows the reflexes and hinders the judgement.
3. Alcoholism is and addictive drug – Some teenagers become alcoholics within the first six months after taking their first drink.
4. Every five seconds, a teenager has an accident, involving alcohol or drugs.
5. Driving under the alcohol influence, is the principal cause of death between teenagers.

Despite the well known risks and costs of alcohol consumption in our society, most people choose to drink alcohol in a fairly regular basis. Although public campains of the designated driver have helped to reduce the incidence of mortal accidents related to a driver under the alcohol effects. It's clear enough that drinking and driving, is still a serious problem in our society. The incidence of fatal accidents related with driving under the alcohol influence makes clear that driving and drinking is a very serious problem in our society.

If we ask ourselves how long does a frequent drinker must wait to drive. Assuming the following data from an individual male: 70 kg of weight, clasified as a low moderate drinker, with the stomach empty. If starts drinking 3 beers per hour during two hours. The total amount of time since the person starts drinking until reaches the limit of CAS to 0.08 {gr/dl} (CAS= *Concentración de Alcohol en la sangre,* Blood Alcohol Concentration) , is 425 minutes, if we substract those minutes to the two hours that the binge lasts (120 minutes). It gives us a recovery time needed of 305 minutes, equivalent to 5.08 hours.

It means that an average person of 70 kg who drinks a six of beers, must wait 5. 08 hours before driving a car if the person doesn't want to be arrested for driving drunk. If the drunk person is female, the waiting time will be considerably higer.

BUILDING THE MODEL

Any substance that enters to the body, goes first to the stomach and then to the blood system, such as alcohol. It suggests a design of a model with two sections. The alcohol accumulates in the stomach, then its absorbed from there by the body. En each of these stages, alcohol may be represented as an accumulator. There is a stream that enters to the stomach and other taht goes to the body and another that flows out the body (in this release the liver and kidneys are involved).

The flow entering by the mouth may be considered a constant while the person drinks. The cosntant is determinated for the time the person drinks. For this model, we'll choose the unit of time as "Minutes". In the following chart, the principal characteristics of an individual are shown to develop all the examples whit an analysis of sensitivity to compare weight, gender and alcohol tolerance, as the ability to participate in two binges, one after the other.

1. Male.
2. We assume he starts drinking in complete sobriety.
3. Drinks three beers per hour during two hours and then stops.
4. One beer contains 13.6 grams of alcohol.
5. Alcohol tolerance: Low moderate.

Alcohol's Basic Model.

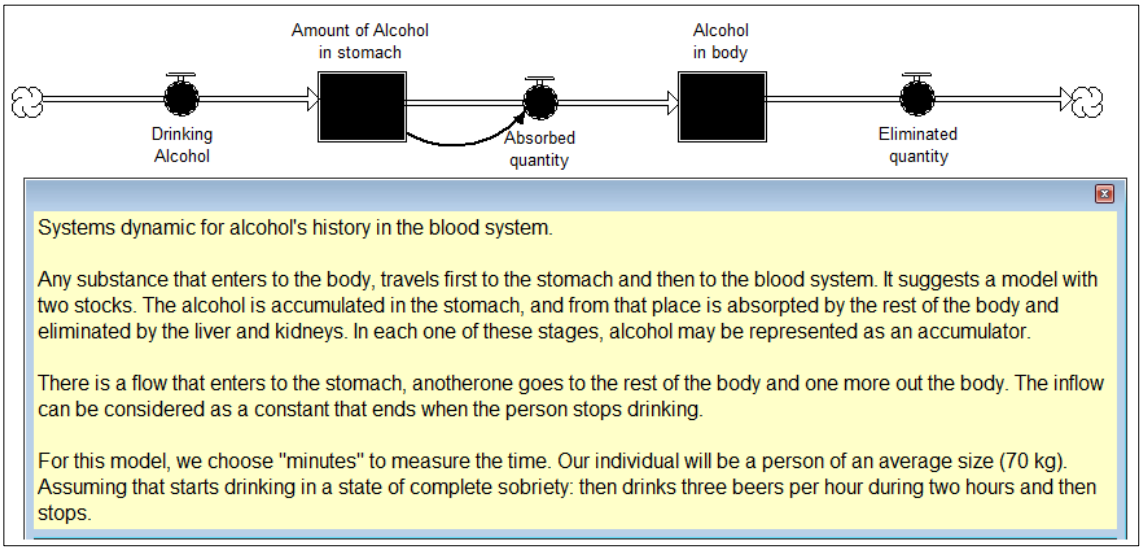


Illustration 1: Alcohol's Basic Model.

Alcohol accumulates into the stomach. An absorption process brings it to the body. The more alcohol in the stomach, the more quickly it's absorpted by the body. For now, we assume a simple or perfect absorption, where the 6.93% of alcohol in the stomach is absorpted every minute.

In the other side, the alcohol that moved from the stomach to the body, is eliminated off the body by the liver and kidneys. Here we'll also asume that the ideal process occurs with an elimination rate of the 0.6% each minute.

Exponential ideal model for the alcohol´s absorption and elimination.

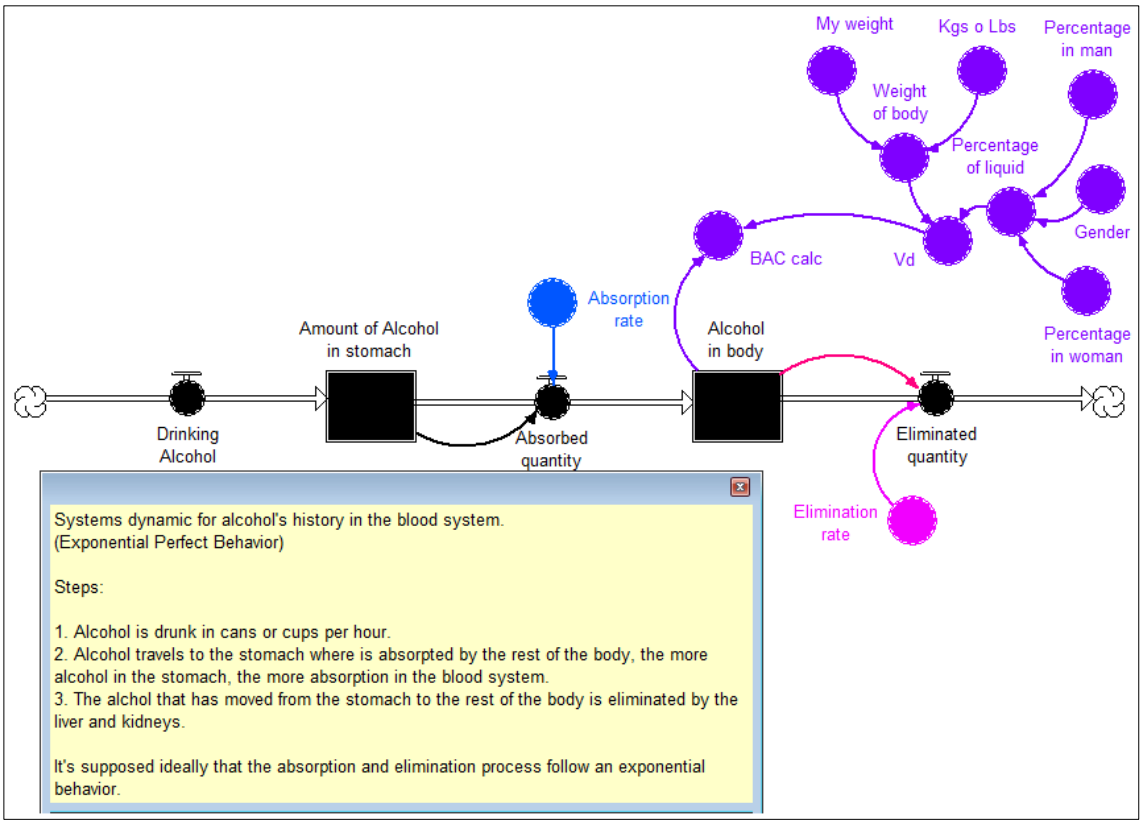


Illustration 2: Exponential ideal model of alcohol's absorption and elimination.

Determining the alcohol concentration in the blood (BAC)

The alcohol amount in the rest of the body hasn't the same concentration than in the blood. The CAS is the number of alcohol grams per unit of liquid volume in deciliters in the person. To determine the CAS, we need to know the person's weight, in kilos or pounds. On average, the 68% of weight in an adult male is liquid, in women, the average percentage is 55%. To simplify the calculations, we assume that 1 litter is approximately equal to 1 kilogram. The amount of liquid in the body is usually called volume of distribution (Vd) adn typically it is in units of deciliters (dl).

Graphic results of the ideal model for the alcohol in the body

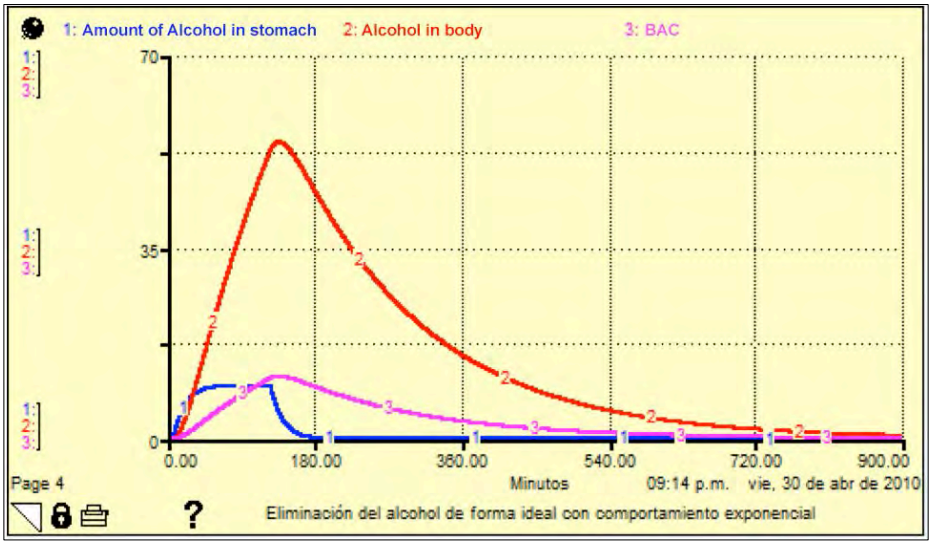


Illustration 3: Alcohol's Ideal exponential process of absorption and elimination.

Improving the calculations for the elimination of alcohol in the body.

Given the importance that alcoholism has in our society, specially for its high costs in public health, the results of the model, shown in the figure 5 have been validated by many practical experiments. Relatively to measure the behavior of the CAS in the time, taking blood samples of a person who drinks alcohol in constant time intervals. When graphing the real behavior vs. the ideal, we realize how well the model works.

In the ideal model, the CAS determination is suitable. But, the shape of the elimination's curve of alcohol in the body is incorrect. The alcohol is inusual because the experiment has shown that the elimination does not follow an exponential form. Given that alcohol is a little bit strong drug and, people frequently drink large amounts (compared to other drugs), the drug receptor cells in the body, are working at its maximum capacity during the elimination. Consequently, the part of the curve of CAS that represents the elimination, seems a linear curve. This requires a formula modification used in the elimination rate.

The investigation of alcohol elimination from the rest of the body, yielded two alternative formulas:

1. Widmark's Model.
2. Mathematic model Michaelis-Wilton.

The mathematic model Michaelis-Wilton for the elimination process of alcohol in the body depends on two new components:

1. The rate of elimination (V_{MAX}) is equal to 0.015 gr/dl/hour
2. Michaelis constant K_m is defined as 0.01 gr/dl

Note: The justification of these values, goes furthermore this story and we won't explain it here.

The elimination rate is then the Michaelis-Menton formula as follows:

$$\text{Elimination rate= } T_E = \frac{CAS * Vmax}{Km + CAS} = \text{gr/dl/Min}$$

The **eliminated amount** can be calculated multiplying this "Elimination Rate" by the distribution volume (V_d).

$$\text{Eliminated amount} = (T_e) * (V_d) = \text{gr/Min}$$

Note 1: Michaelis-Menton equation integrated in the model to correct the elimiation rate.

Note 2: The model equations are reported in the appendix "A".

Corrected Model with Michaelis-Menton equation.

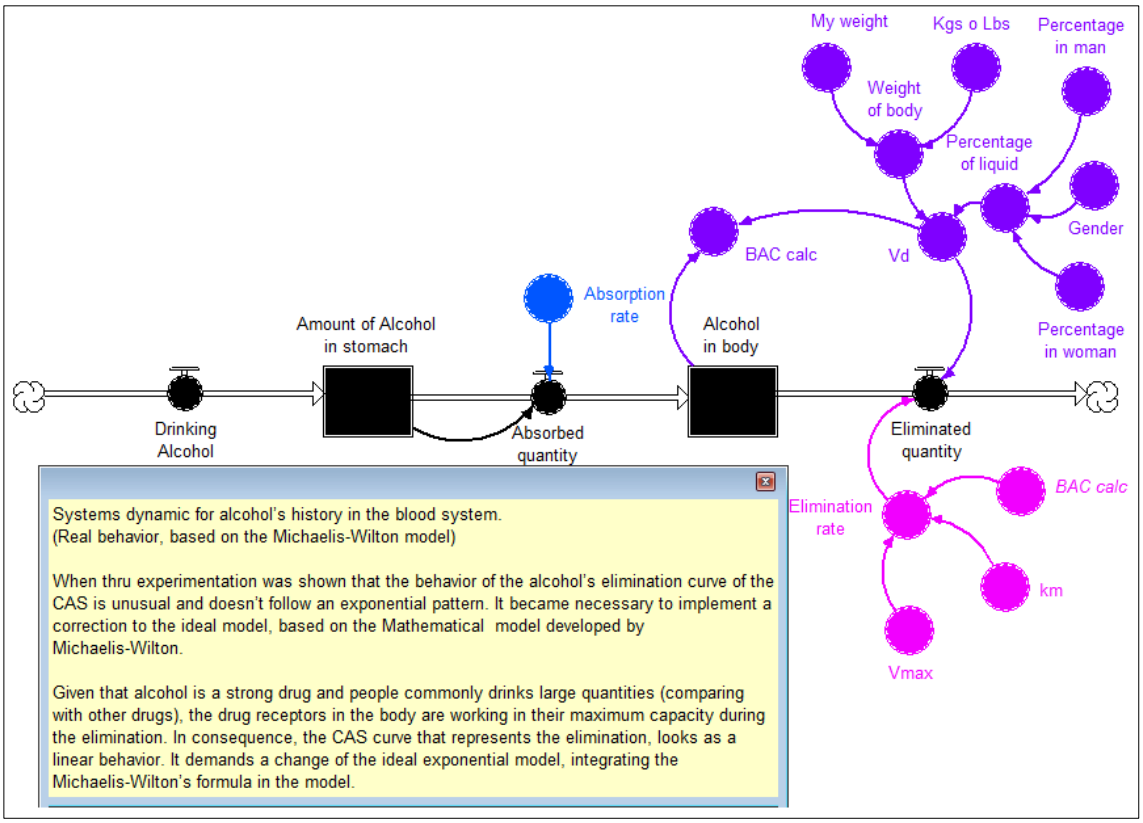


Illustration 4: Michaelis-Menton equation integrated in the model.

Corrected Model – I – Graphical Results of alcohol in the ideal body vs. the real body

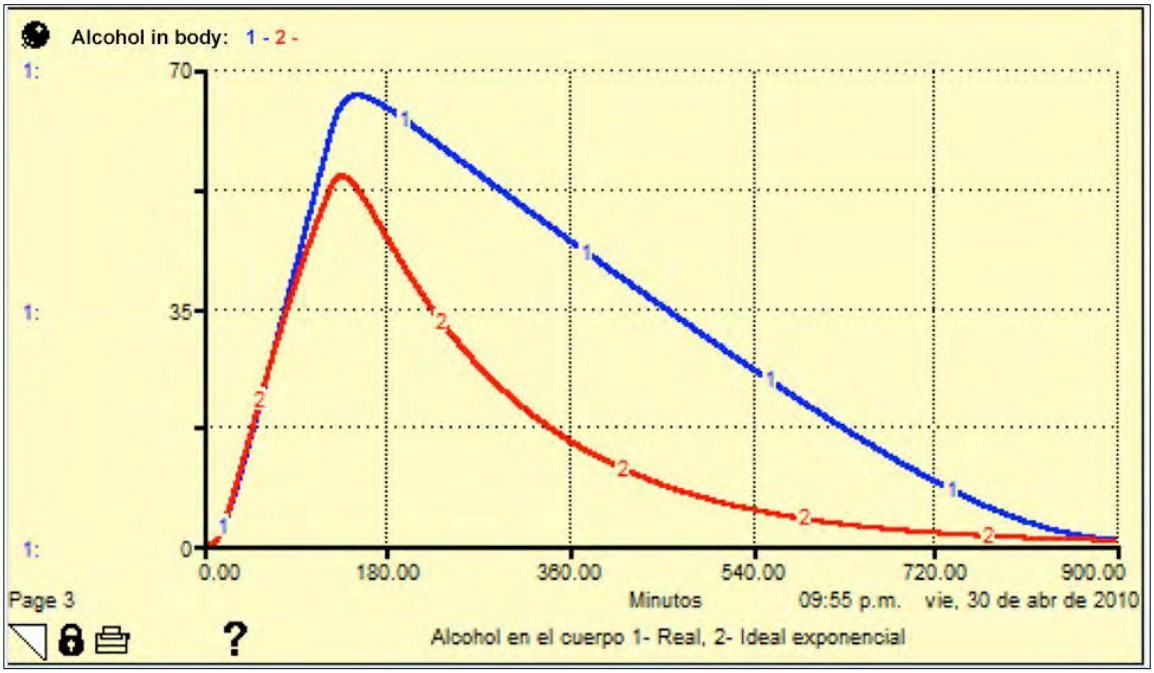


Illustration 5: Comparative graphical results of the alcohol in the body (1) vs. (2) the ideal.

Corrected Model – II – Graphical results of BAC (gr/dl)

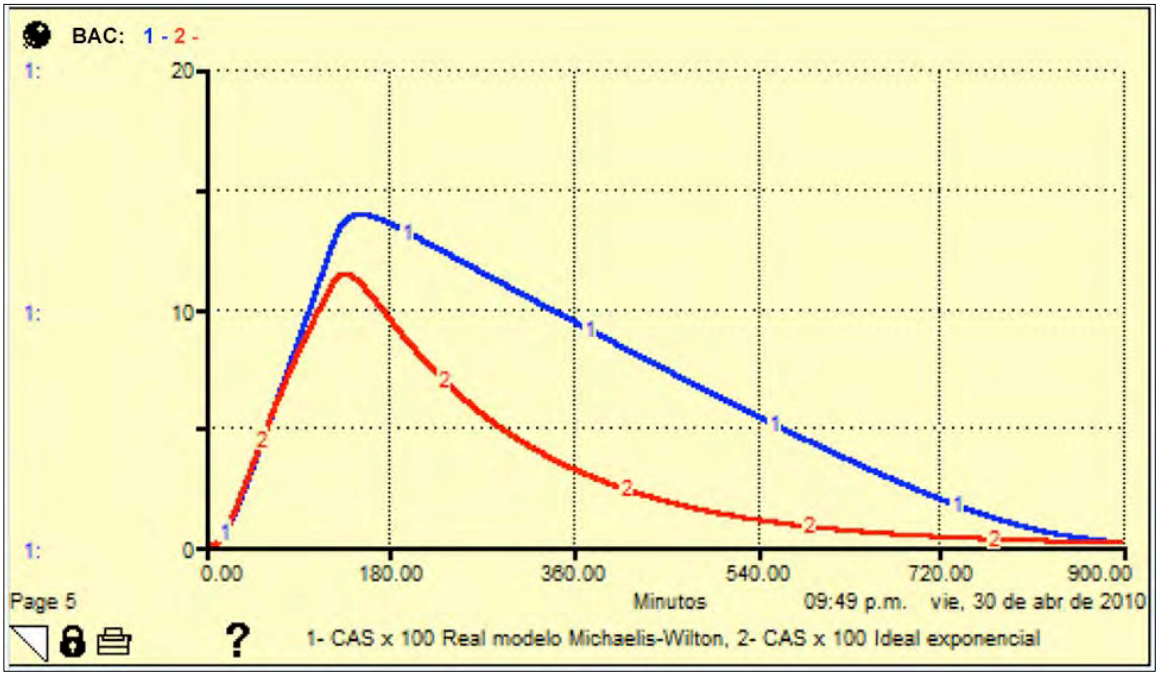


Illustration 6: Michaelis-Menton Model (1) vs, Exponential Ideal Model (2)

BAC Model – Graphical results of the corrected model.

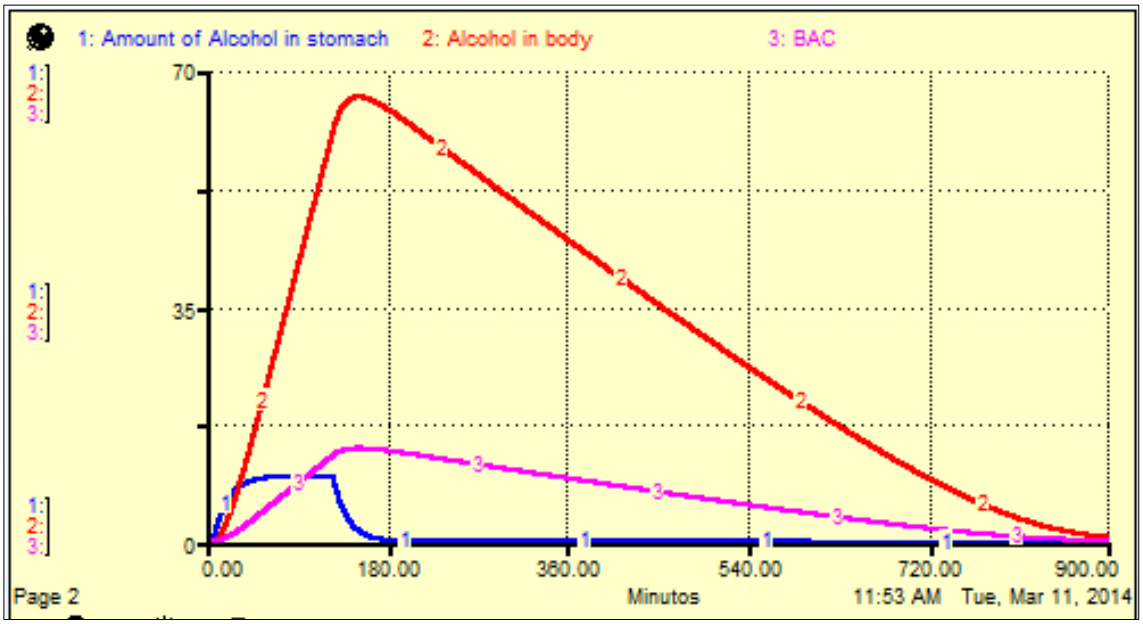


Illustration 7: (1) Alcohol in the stomach, (2) Alcohol amount in the body, (3) BAC x 100 Real

Integrating the logic to the first binge.

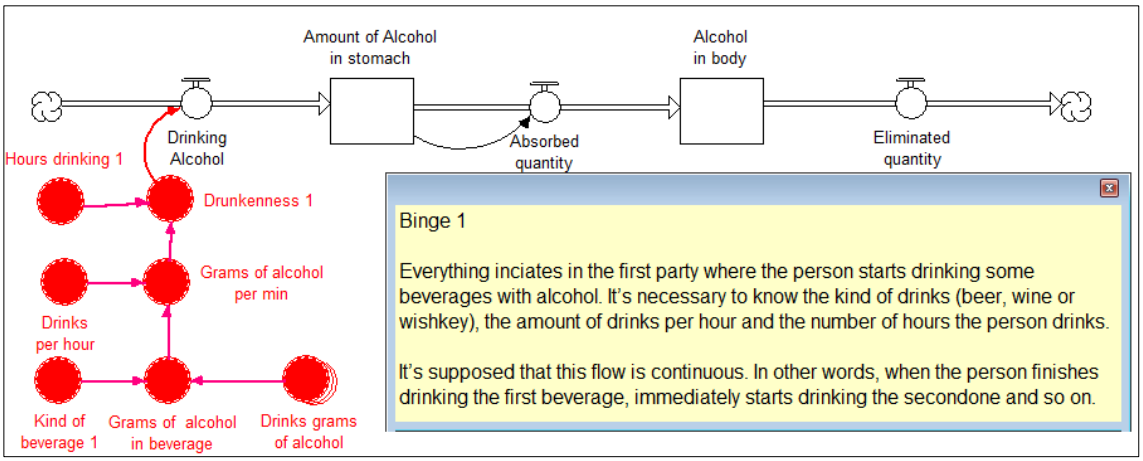


Illustration 8: BAC Model, first binge

Four variables are needed to define the data in the first binge.

1. **Type of drink 1:** The type of beverage used in the binge 1 is here defined (Ex. 1= beer, 2= Champagne, 3= wine, 4= Whiskey)
2. **Drinks per hour:** Number of drinks ingested per hour.
3. **Hours drinking 1:** Amount of hours drinking continuously.
4. **Grams of alcohol drinked:** The catalog of drinks.

Logic to manage the second binge.

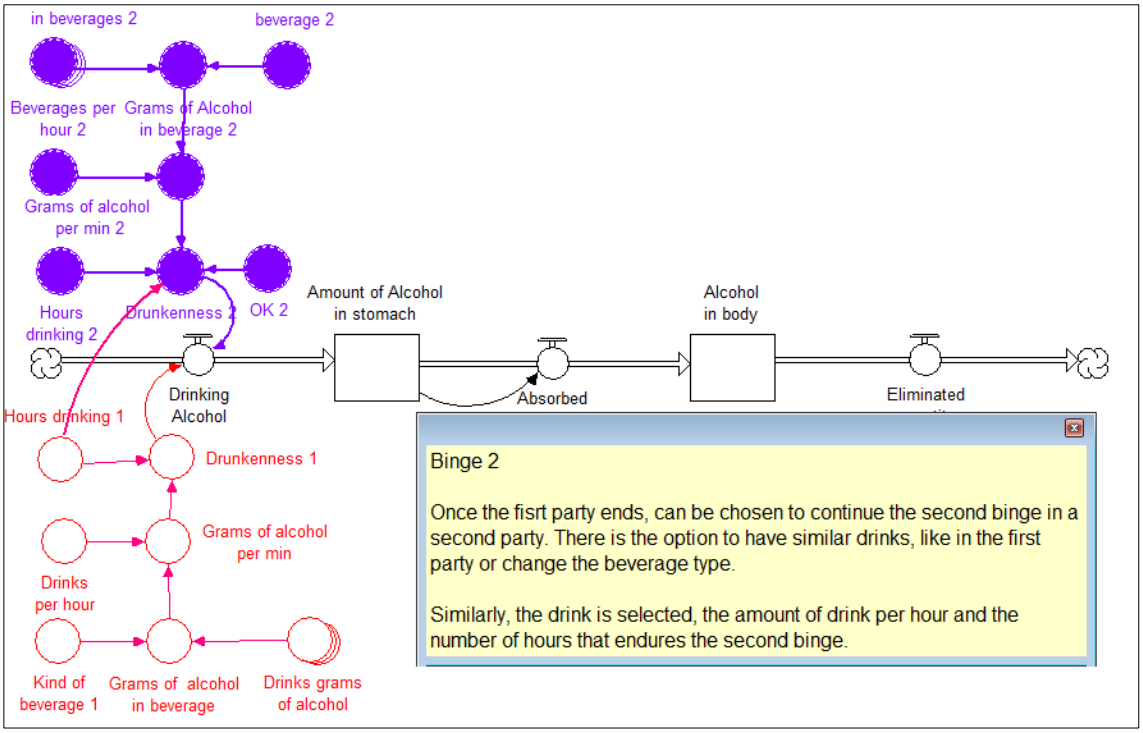


Illustration 9: Model with the logic of the second binge.

Five variables are needed to define the data of the second binge.

1. **Type of drink 2:** The type of beverage used in the binge 2 is here defined (Ex. 1= beer, 2= Champagne, 3= wine, 4= Whiskey)
2. **Drinks per hour 2:** Number of drinks ingested per hour.
3. **Hours drinking 2:** Amount of hours drinking continuously.
4. **Grams of alcohol drinked 2:** The catalog of drinks.
5. **OK 2:** 0= means that the individual participated only in the first binge, 1= means that the individual has participated in bouth binges, attending to the first bing and immediately participating in the second binge.

Improving the calculation desing of the absorption rate of the stomach.

Until now, the absorption rate was defined as one constant with a value of 6.93% /Min, in other words it's equal to 0.0693/Min. This is only correct in the case that the beer has a half-life of 10 minutes within the stomach when the stomach is empty.

In other words, the absorption rate for the beer, can be defined according the following formula:

Absorption Rate = $\frac{0.693}{Vida\ Media} = \frac{0.693}{10}$ = 0.0693 / Min. For the case when the individual drinks when the stomach is empty.

It has a mathematical breakdown that gets out of reach in this article. I'll only write the final formula, based on the exponential behavior of the absorption flow of the stomach.

Absorption Rate = $\frac{LN(2)}{Vida\ Media} \cong \frac{0.693147}{Vida\ Media}$ in units of 1/Min.

The advatage of using the half-life to calculate the absorption rate of stomach is that now we account two factors that affect this half-life. They are:

1. The firstone has to do with wether the individual's stomach has food or not. Untill now, the model assumes that there isn't food in the stomach, which is equivalent to no influence upon the half-life. However, a stomach full of food, can increase the half-life to the doble.

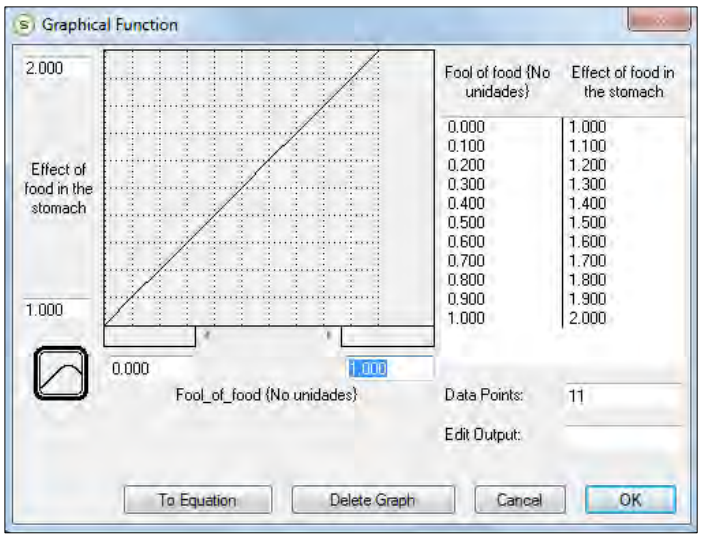


Illustration 10: Curve to match a full stomach with the Food effect in the stomach.

2. The half-life of absorption also reacts if the alcohol is carbonized as in the case of the beer, or concentrated as in the case of Whiskey, or bouth as the champagne.
    a. If alcohol is carbonized and at the same time concentrated as champagne, then the half-life is as short as a value of 5 minutes.
    b. If the alcohol isn't carbonized or concentrated as the case of the wine, then, the half-life can take a value of 20 minutes.
    c. If the alcohol is only carbonized as in the case of beer, then, the half-life is 10 minutes.
    d. For the case of Whiskey, in which the alcohol is concentrated, its half-life is also 10 minutes.

Integrating the new Abosrption Rate of the stomach to the Model.

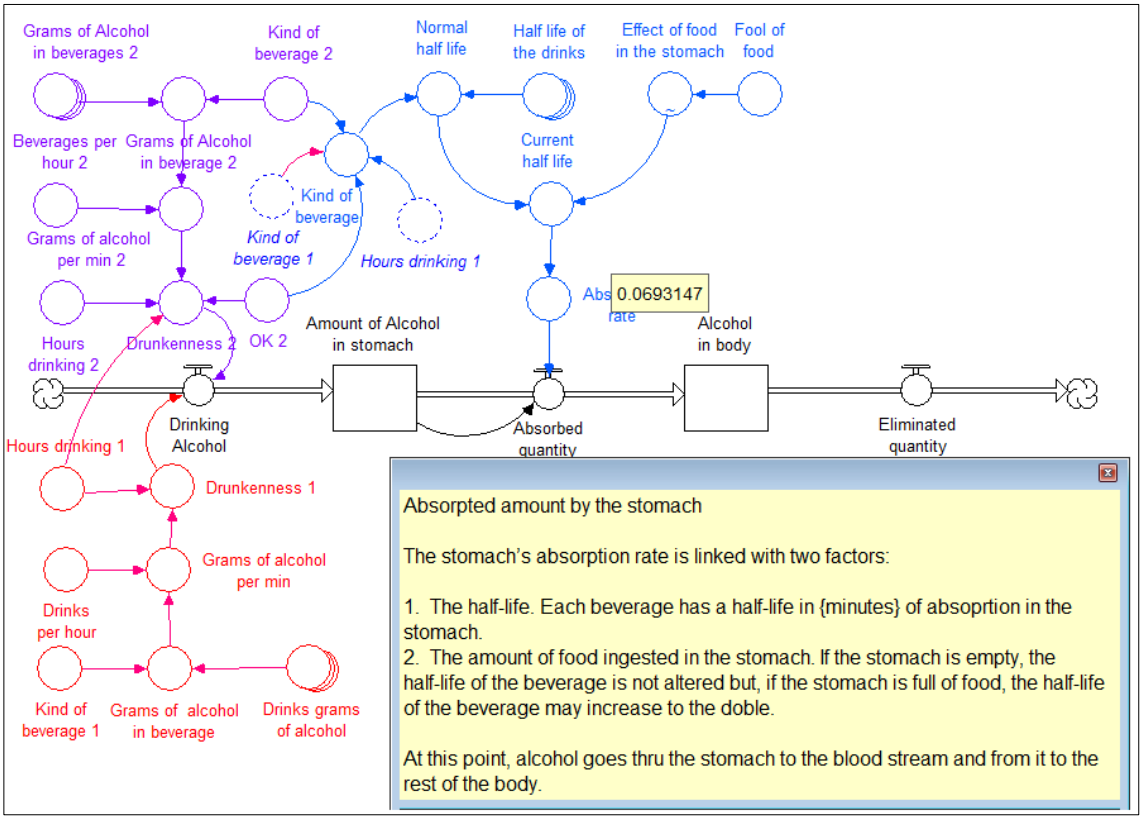


Illustration 11: New logic of the calculation for the Absorption Rate of the stomach.

Another improvement for the calculation of the elimination rate, based on the tolerance level of alcohol.

Based on the level tolerance of alcohol that some people have, for instance, those who are alcoholic (alcohol patients) the elimination speed VMAX is 0.03 gr/dl/hour, what means the double of VMAX, defined for a drinker with a moderate low tolerance level given by 0.015 gr/dl/hour.

We've defined different variables to clasify the tolerance level as shown below:

1. A rookie drinker = 0.00
2. Moderate low drinker = 0.20
3. Moderate high drinker = 0.50
4. Alcoholics = 0.80
5. Drinker type = (1, 2, 3, 4) to indicate the type of drinker.

Curve that links the tolerance level of alcohol with V_{MAX}

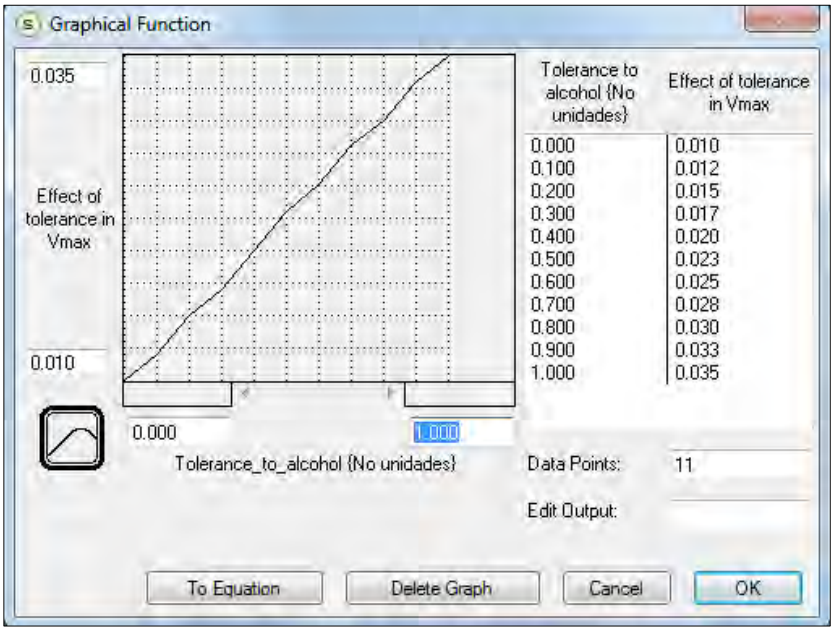


Illustration 12: Relationship between the tolerance level of alchol vs effect in V_{MAX}. (see 15)

BAC calculation (gr/dl)

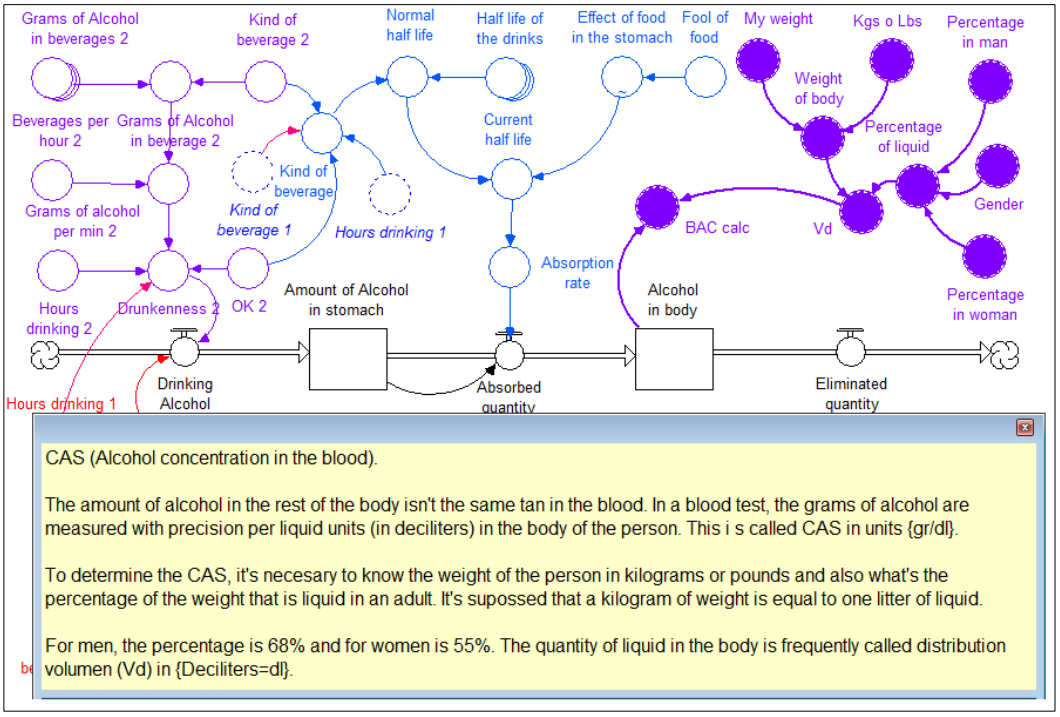


Illustration 13: Alcohol concentration in the blood.

View logic to calculate the Elimination Rate.

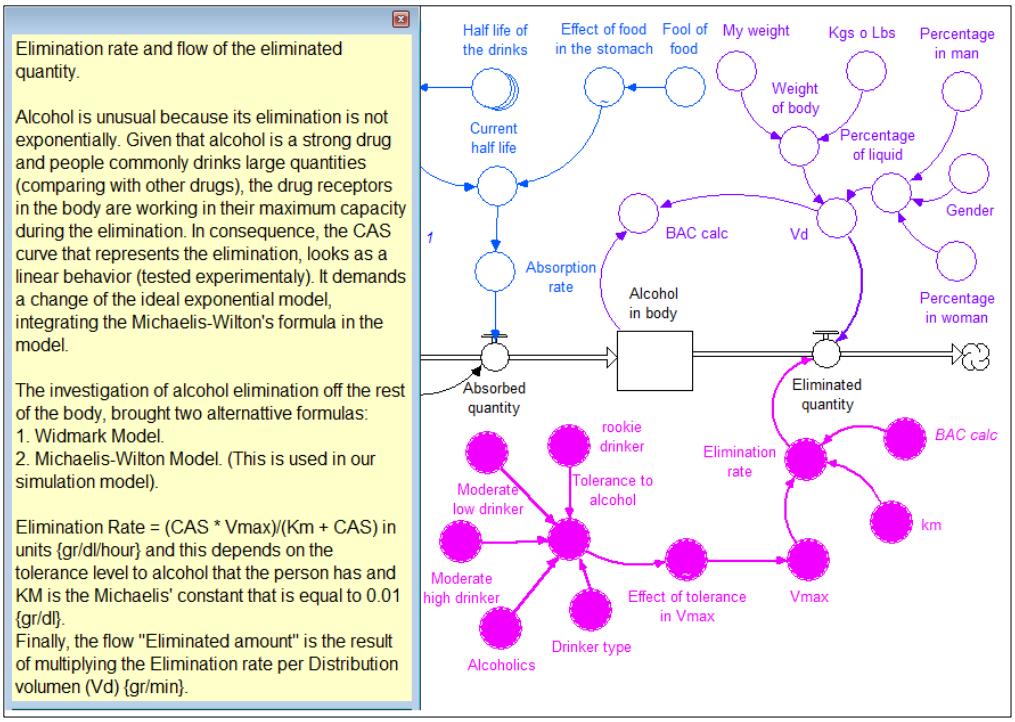


Illustration 14: New logic for the Elimination Rate.

Reference Values for BAC in the world.

In many cities and countries of the world, values have been defined for CAS to comply with the driving limits and, doing it to avoid accidents or problems about the way individuals drink. Below we show a figure with some of these values to cities in the USA and Mexico.

1. The maximum CAS level for driving is (0.08 gr/dl) in Oregon City and many other cities in the world.
2. An individual normally lose consciousness with a CAS of (0.30 gr/dl)
3. The risk of death exists at (0.45 gr/dl).

In many places of USA, the acceptable limit to drive is (0.10 gr/dl).

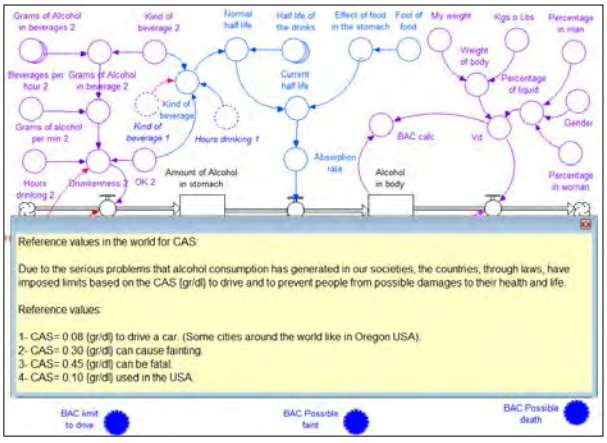


Illustration 15: Reference values in the world for BAC.

BAC Model Complete.

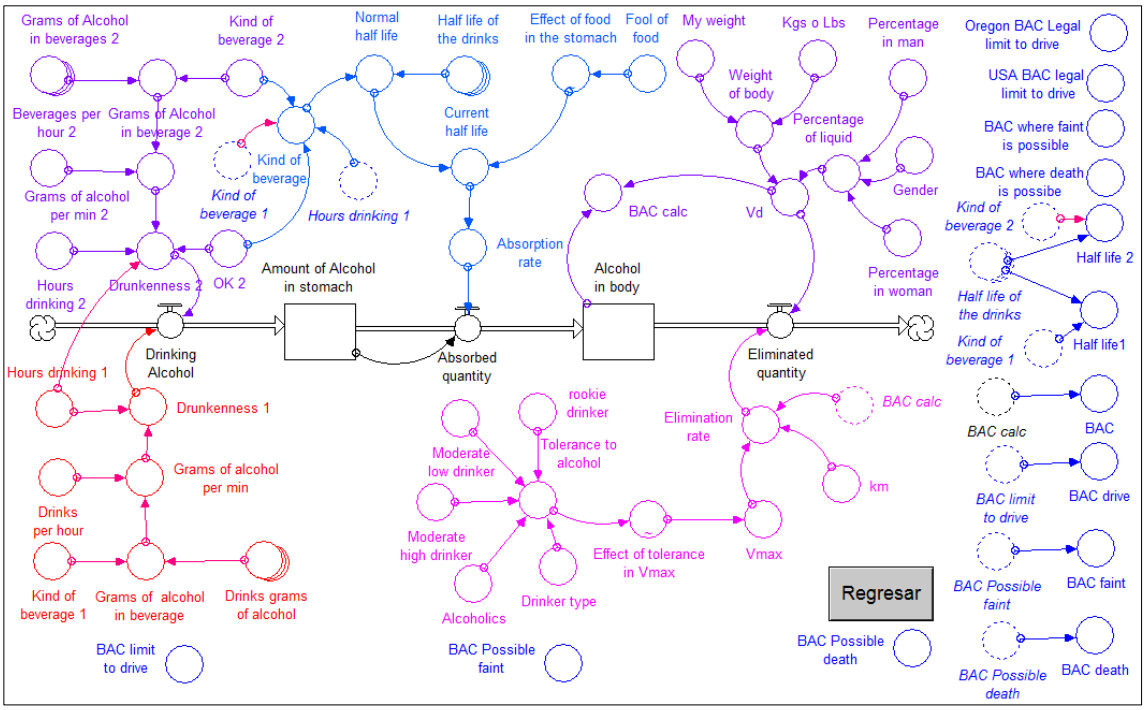


Illustration 16: BAC Model Complete including its auxiliary variables.

Note: The model equations are reported in the appendix "A".

Control Center of simulation with the three bands of reference for BAC.

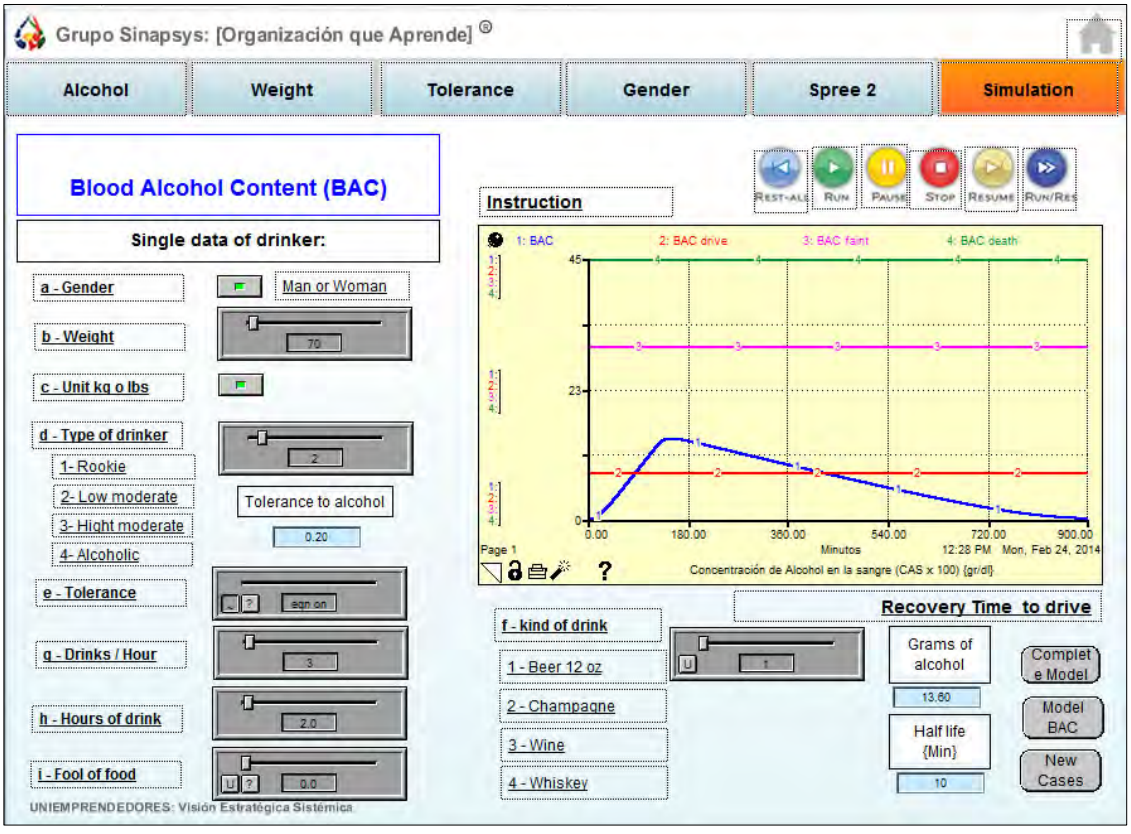


Illustration 17: Control Center with the reference values for BAC.

The impact of plotting the BAC reference values.

How important is to plot the BAC reference values, so we can quickly realice the impact a few drinks have about the recovery time needed to drive again or to know if an specific drink will makes us sleep or perhaps put us on the verge of death.

In this way, we can clearly vizualice how much we can drink, at what time the risk starts, what we must do to comply the laws of the city or country, when is the time to stop drinking and not jeopardize our physical integrity and the others'. What an amazing learning lab has been created!

Alcohol Learning Lab

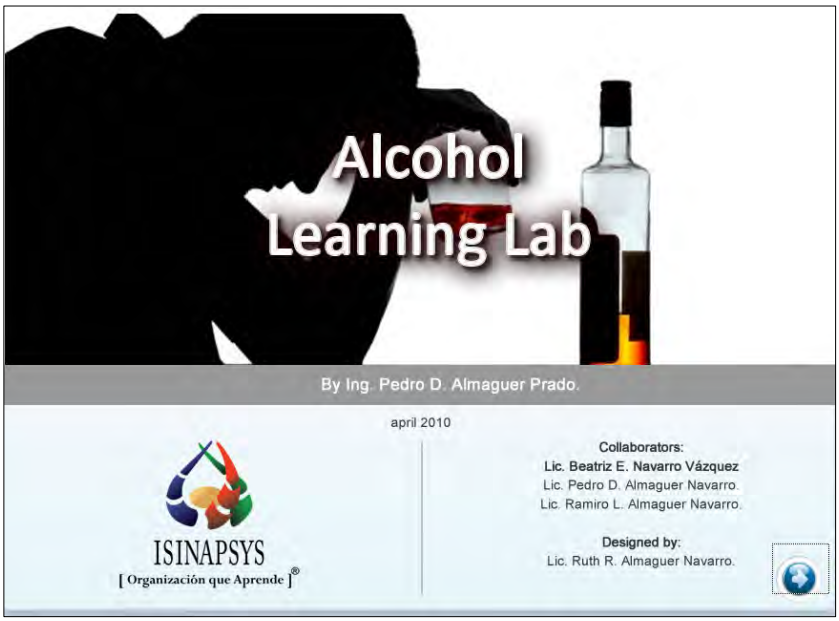


Illustration 18: Learning Lab for BAC.

Alcohol: Sensitivity Analysis.

There are occasions when it's important to make comparisons of CAS (Blood concentration of alcohol) to obtain a variable with different values and see their numerical and graphical results and the impact of these changes and their behavior over the time. So we can dicover the differences in drunkenness between a man and a woman and specially, the time needed to drive again since the binge finished to comply the CAS limits of 0.08 {gr/dl} impossed as a law in many parts fo the world.

Study cases presented below:

1. Compare differences between genders.
2. The impact on people of the same sex, but different weight.
3. The role of the tolerance level to alcohol.
4. How it impacts the results if the stomach is full or empty of food.
5. What happens if the person participates in a second party and drinks the same or different beverages.
6. Compare the impact of two different drinks, taken during a single party.

7. The possibility of developing new study cases, different to those shown.

Note: To develop the sensitivity analysis, use the menu option RUN “Sensi Specs”.

History of Alcohol

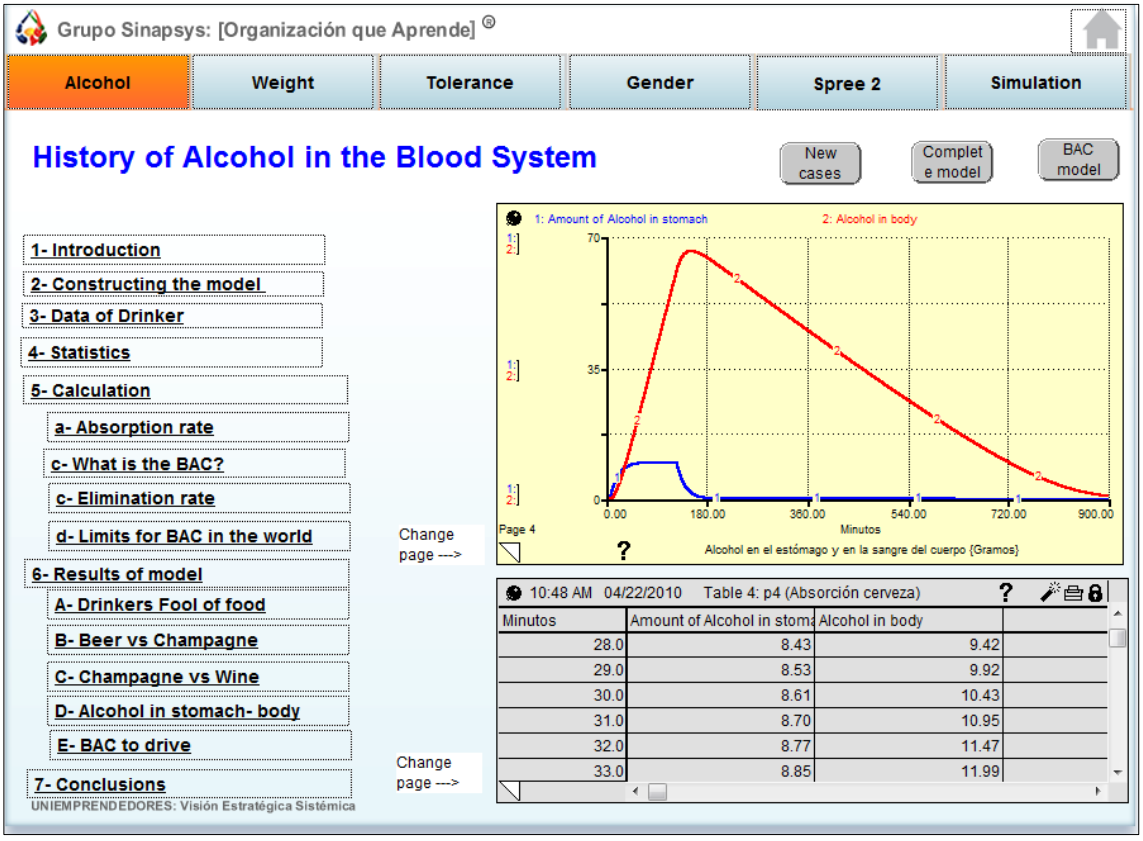


Illustration 19: History of alchol and graphical results.

Compare results when the stomach is empty and when its full of food.

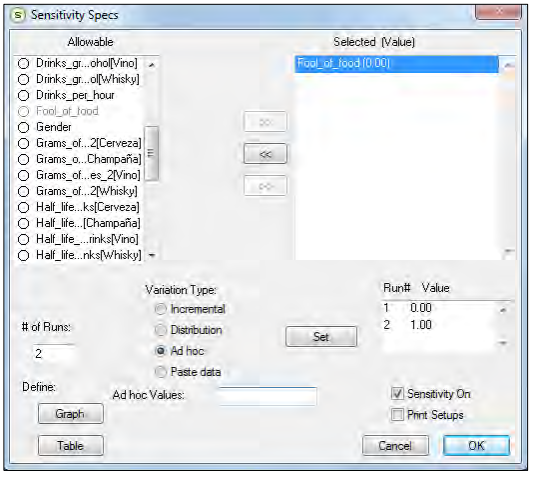


Illustration 20: Sensitivity analysis for individuals with the stomach empty or full of food.

Full of food

Giving values to this variable between 0 and 1, we indicate to the simulator the amount of food the stomach contains before drinking alcohol.

In this case, we want to compare what happens if the person drinks a specific type of beverage and the stomach is empty or full of food.

1. Empty stomach = 0 means empty stomach.
2. Full of food = 1 when the stomach is full.

Graphical Results for a person who drinks beer or wine having or haven't eaten.

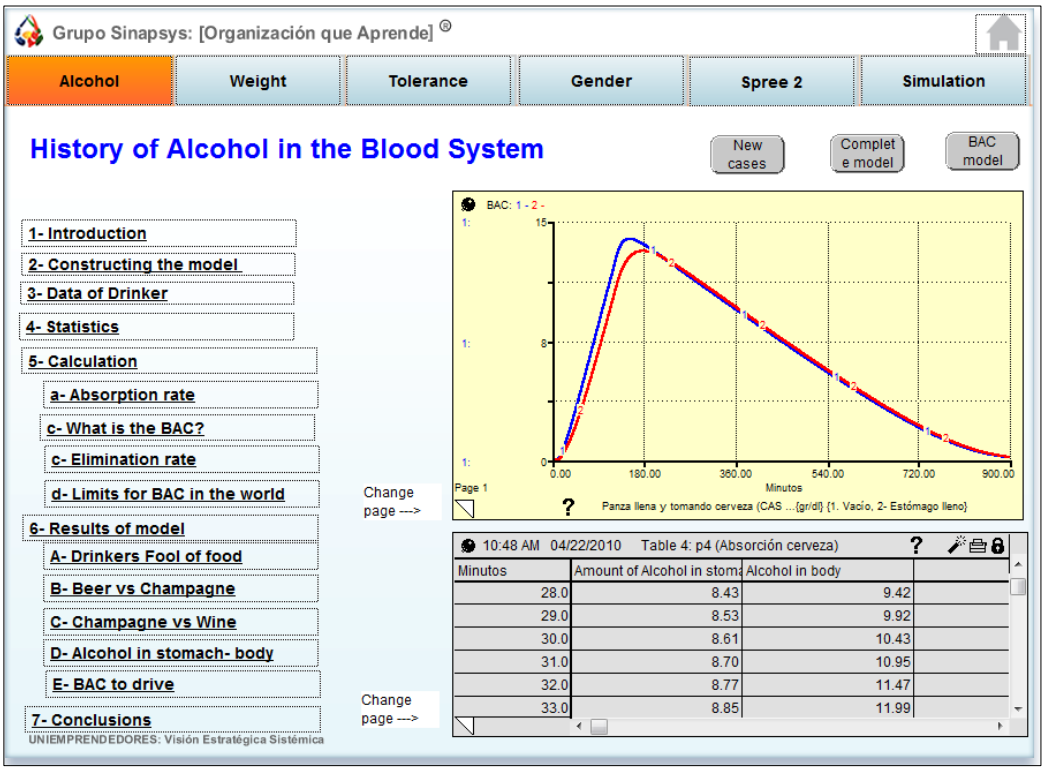


Illustration 6: Comparing (1) Empty Stomach, (2) full of food, drinking *beer* in both cases.

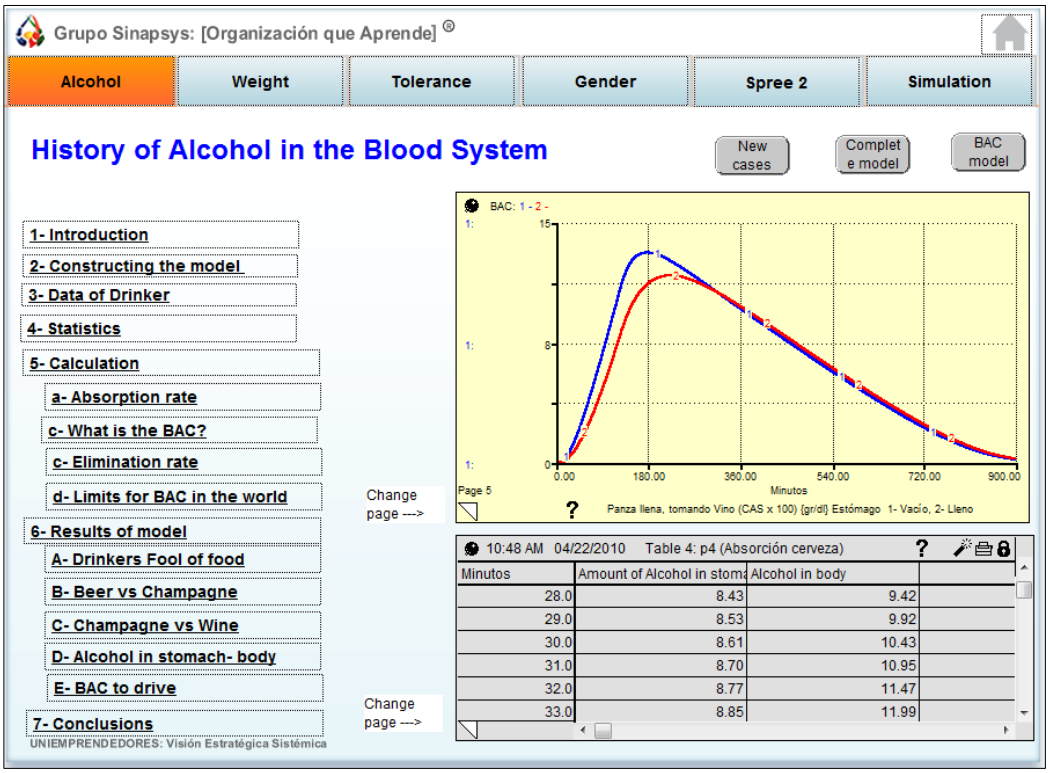


Illustration 7: Comparing (1) Empty stomach, (2) full of food, drinking *Wine* in both cases.

Comparing what happens with different kind of drinks.

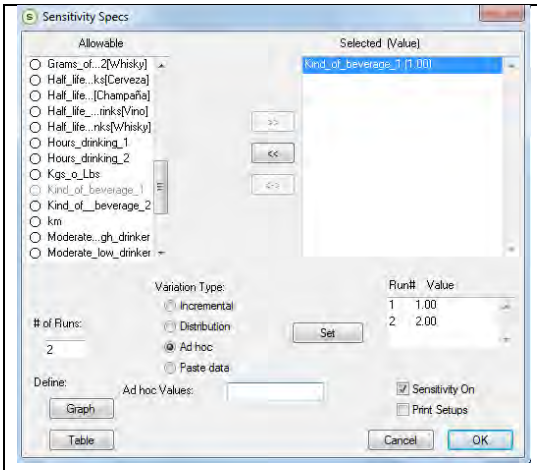


Illustration 21: Compare Beer vs. Champagne

Beverage type 1

In this case, we can make comparissons of the impact on the recovery time to drive a vehicle a person will have if drinks different type of drinks.

The possible values for the drink type 1 are:

1. Beer
2. Champagne
3. Wine
4. Whiskey

¿What happens if instead of beer someone drinks champagne?

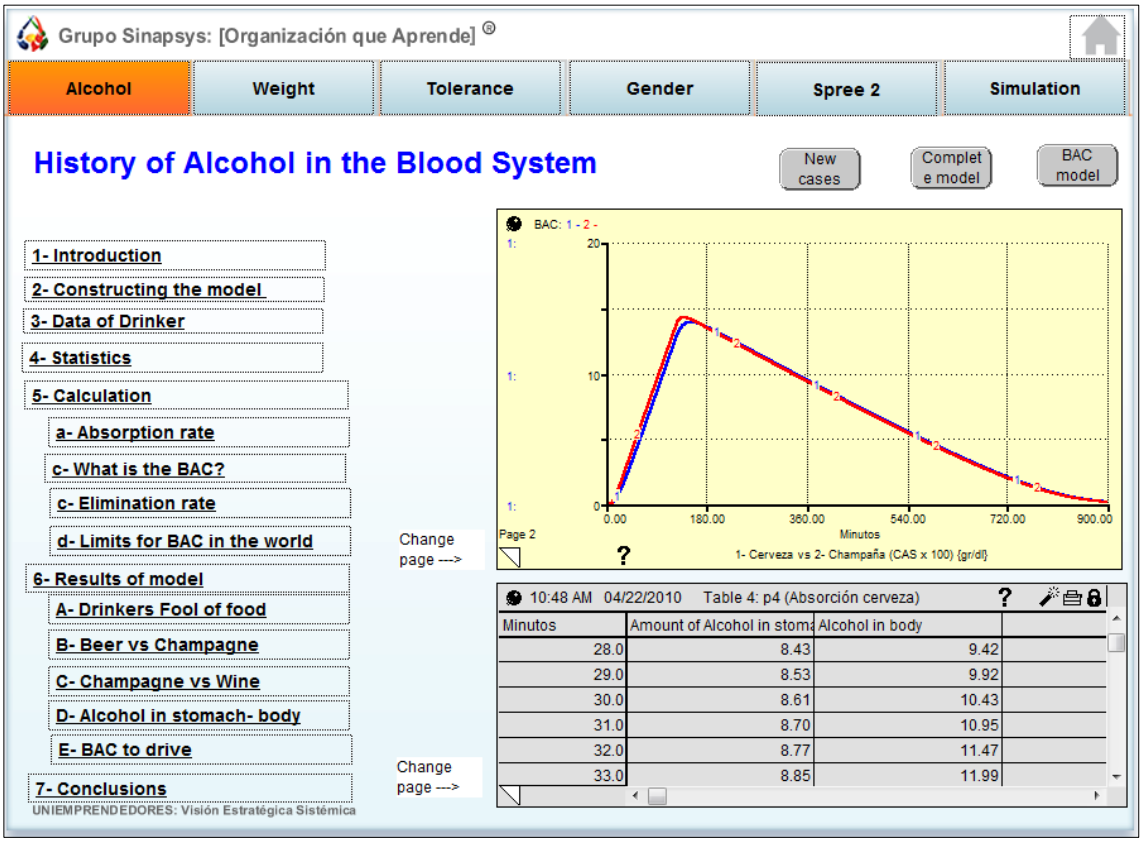


Illustration 22: Different type of drink, Beer (1) vs. Champagne (2)

¿What if someone drinks champagne vs. wine?

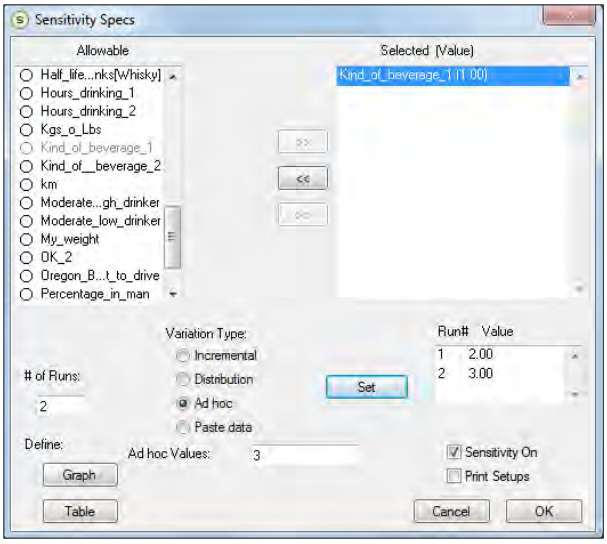


Illustration 23: Comparing champagne vs. wine

Type of drink 1

In this case, we compare the impact champagne vs. wine. In the following chart, we can see that champagne is faster than wine.

Values for the drink type 1:

- Champagne = 2
- Wine = 3

Clearly, champagne drunks faster than wine.

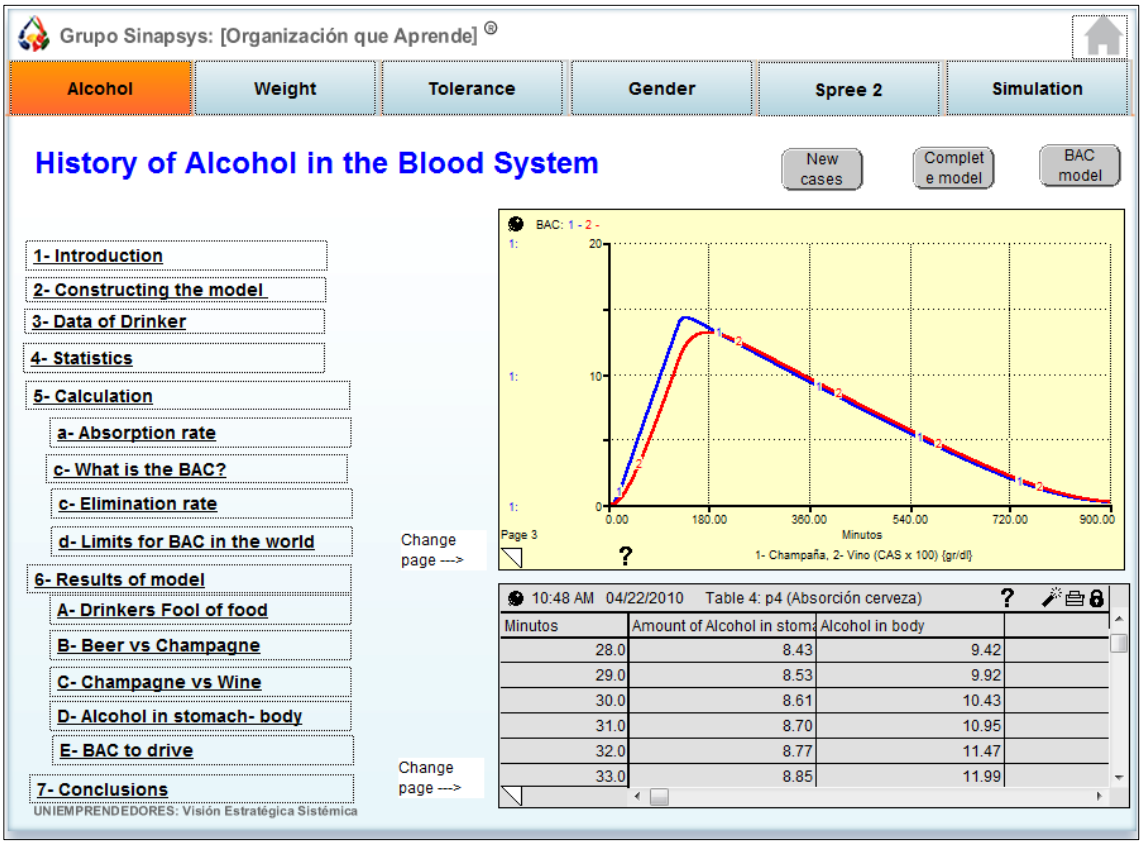


Illustration 24: Comparing Champagne (1) vs. Wine (2)

Now, let's compare men of different weights.

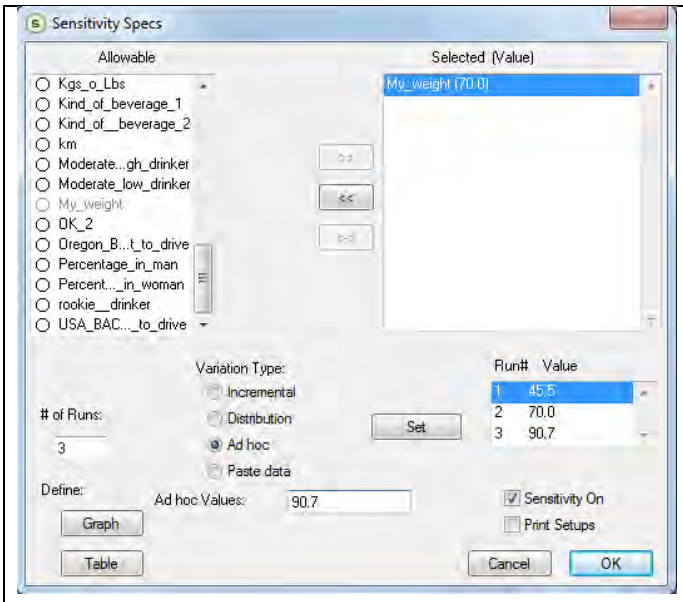


Illustration 25: Compare men of different weights.

My weight

Here we'll compare the impact on the recovery time for three men of different weight in kilos.

1. 45.5 kg
2. 70.0 kg
3. 90.7 kg

In the chart below, we can see that the lower the weight, the more the impact alcohol has on the recovery time to drive.

How alcohol impacts to individuals of different weights in kilos.

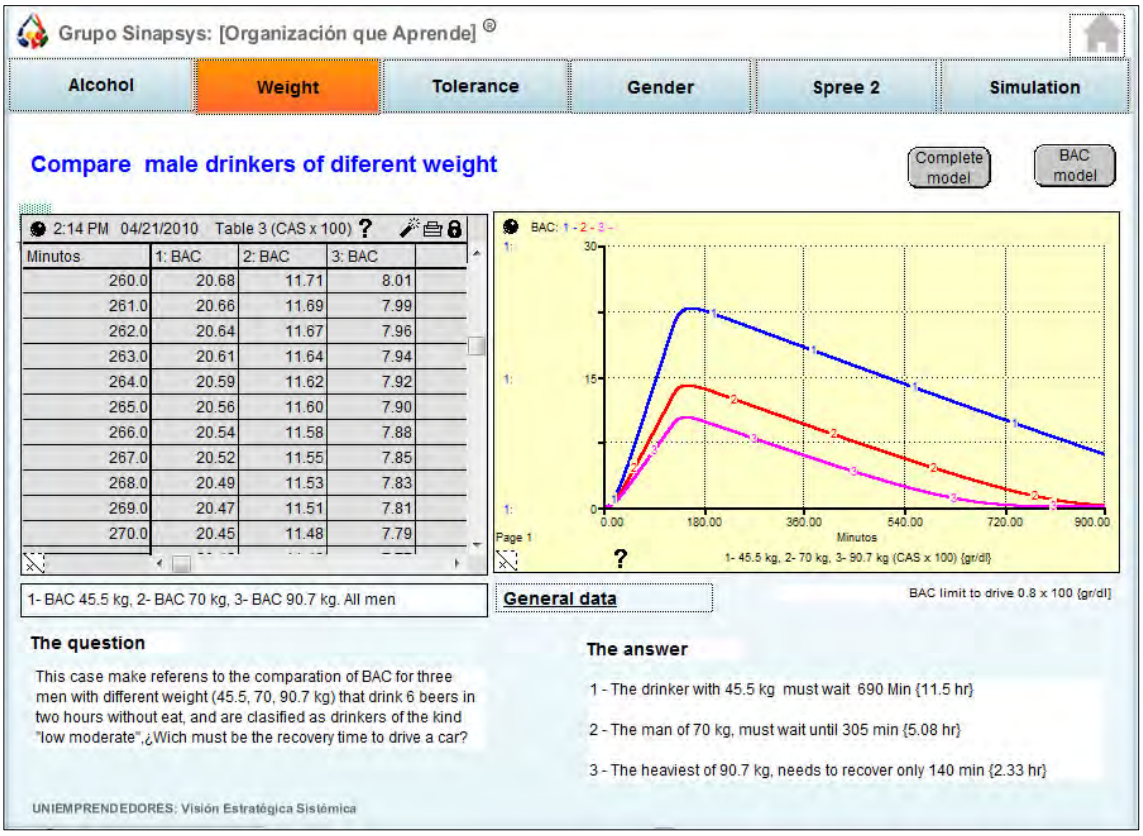


Illustration 26: Compare different weights of men (1) 45.5 Kg, (2) 70 y (3) 90.7 Kg

Now let's see what happens with a man and a woman.

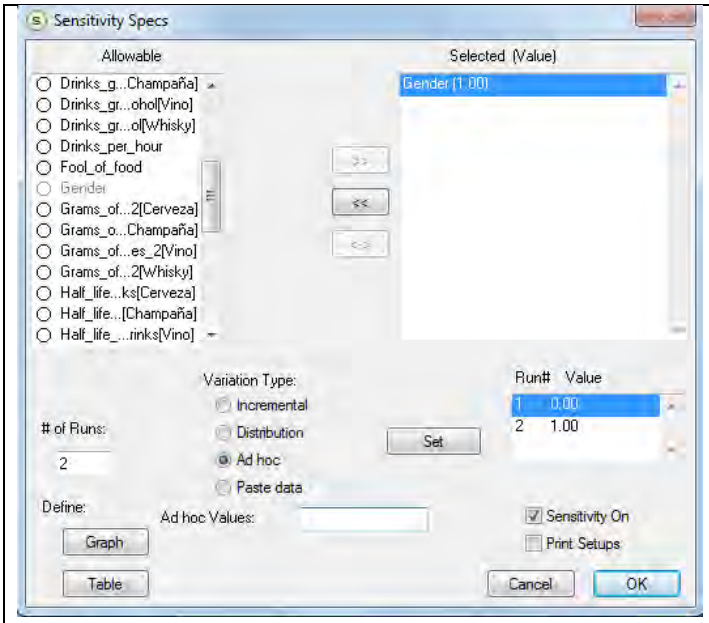


Illustration 27: Compare a man and a woman.

Gender.

To make comparissons between a man and a woman about the impact of the recovery time when drinking alcohol. Give the following values to the variable Gender:

1. Gender = 0 for women.
2. Gender = 1 for men.

In the following chart, is clear that women are more affected than men for the alcohol.

Comparing the alcohol effect between a man and a woman.

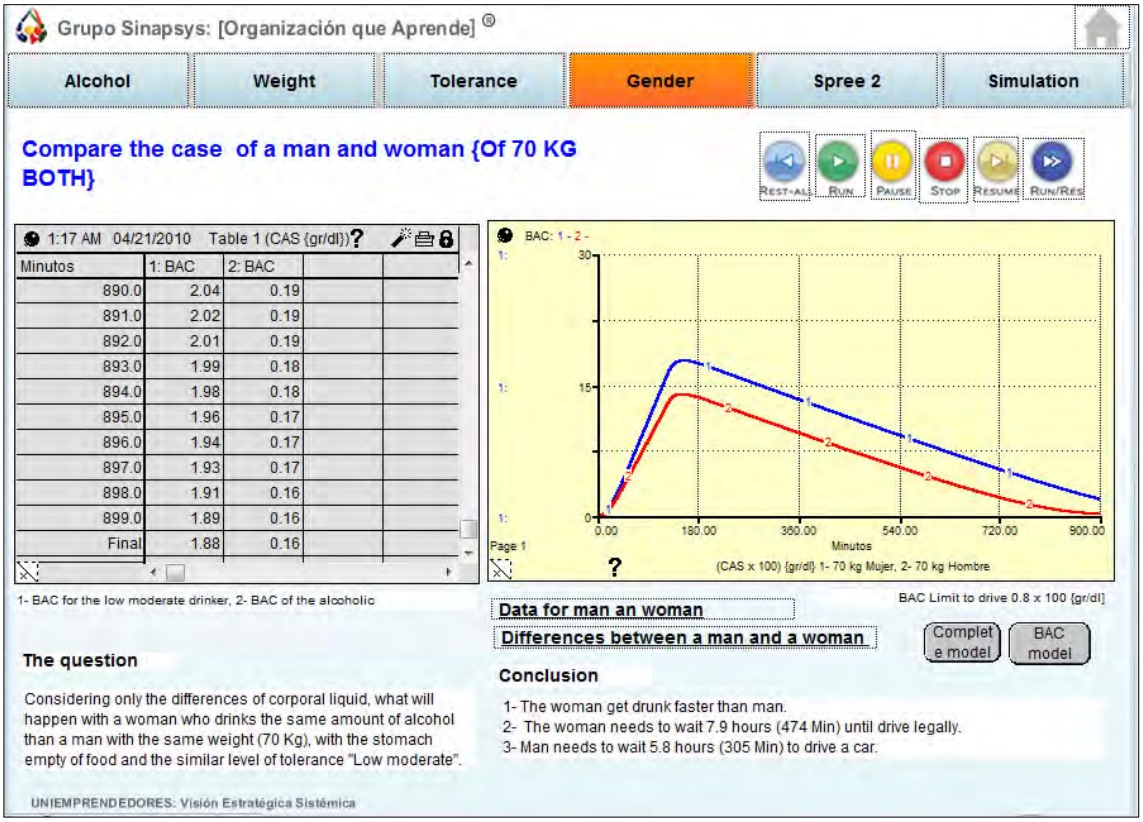


Illustration 28: Compare both of them 70 KG (1) Woman, (2) Man

What happens to individuals with different tolerance level to alcohol.

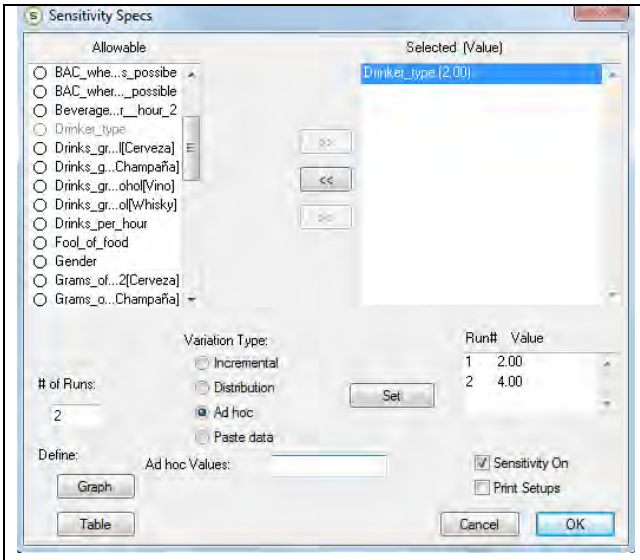


Illustration 29: Comparing the tolerance Level.

Type of drinker.

The tolerance level of an individual is defined in the variable **Drinker Type** wich can take the following values:

1. Rookie drinker.
2. Moderate low drinker.
3. Moderate high drinker.
4. Alcoholics.

This ranges from a low level to the highest tolerance level.

What happens with alcoholics, how does the tolerance level affects ***them?***

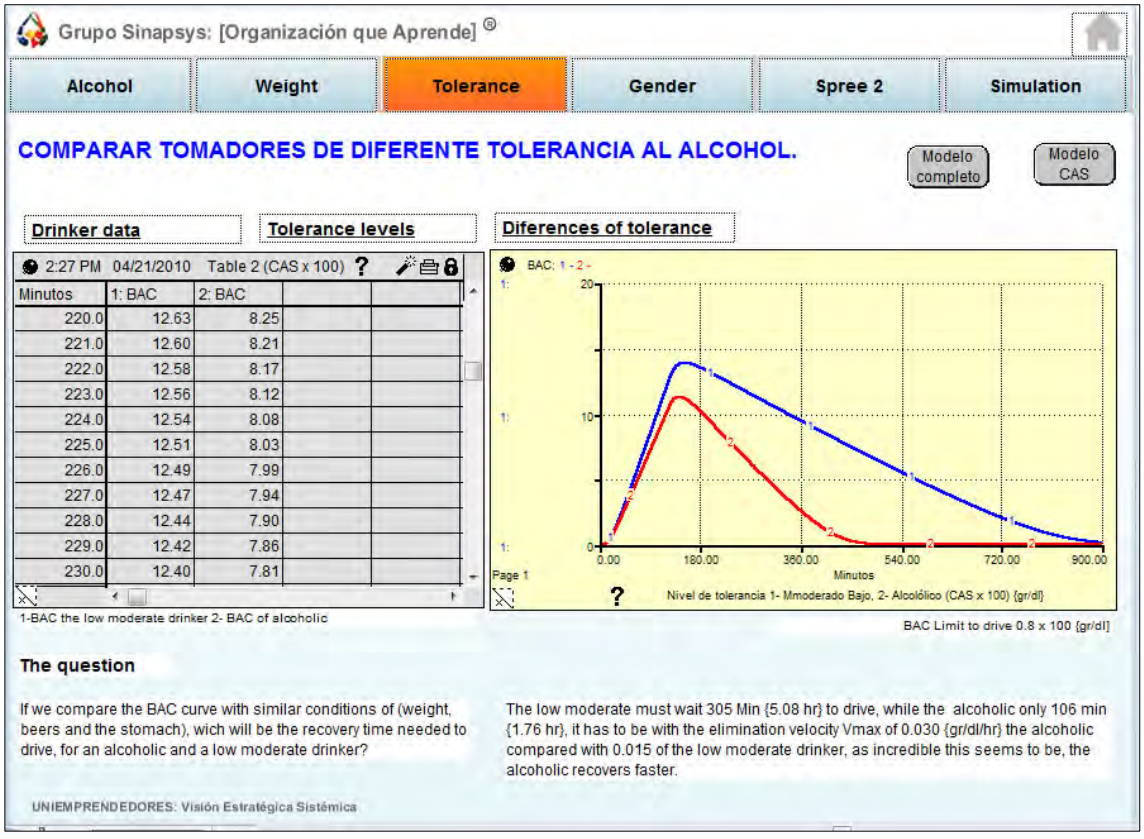


Illustration 30: Tolerance level (1) Moderate low, (2) Alcoholic

What happens when we continue with the spree at a second party?

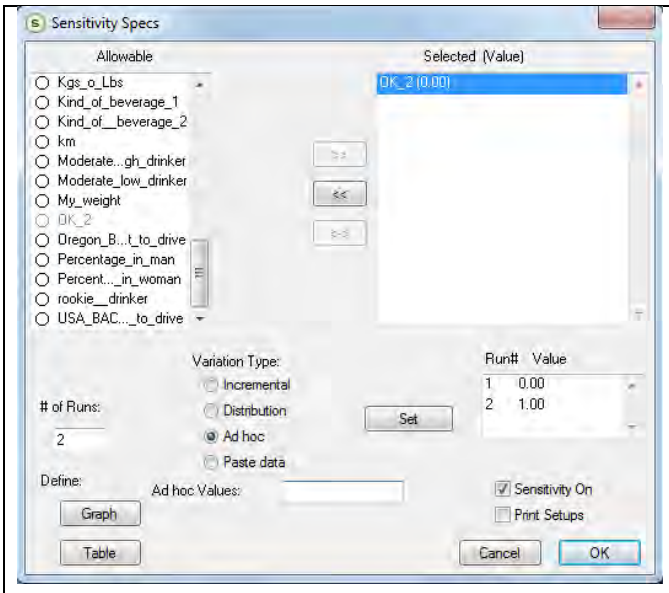


Illustration 31: What's the impact of a second spree.

OK 2

Through this variable, we indicate to the simulator if we attended a second party as shown below:

1. OK = 0 means that we only attended the first party.
2. OK = 1 in this case, we have attended both parties. The individual could choose to have different drinks in each party.

What's the impact of a second spree?

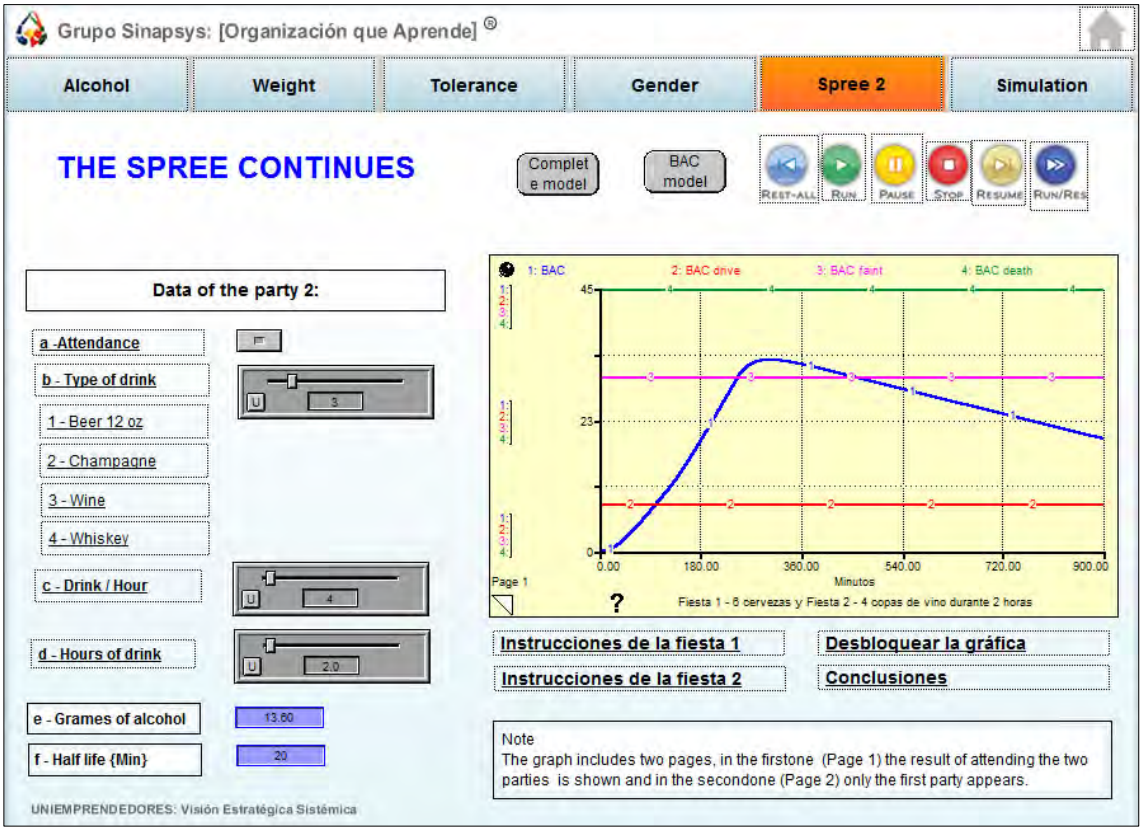


Illustration 32: Party 1 + Party 2 both together.

Comparing results of one and two sprees.

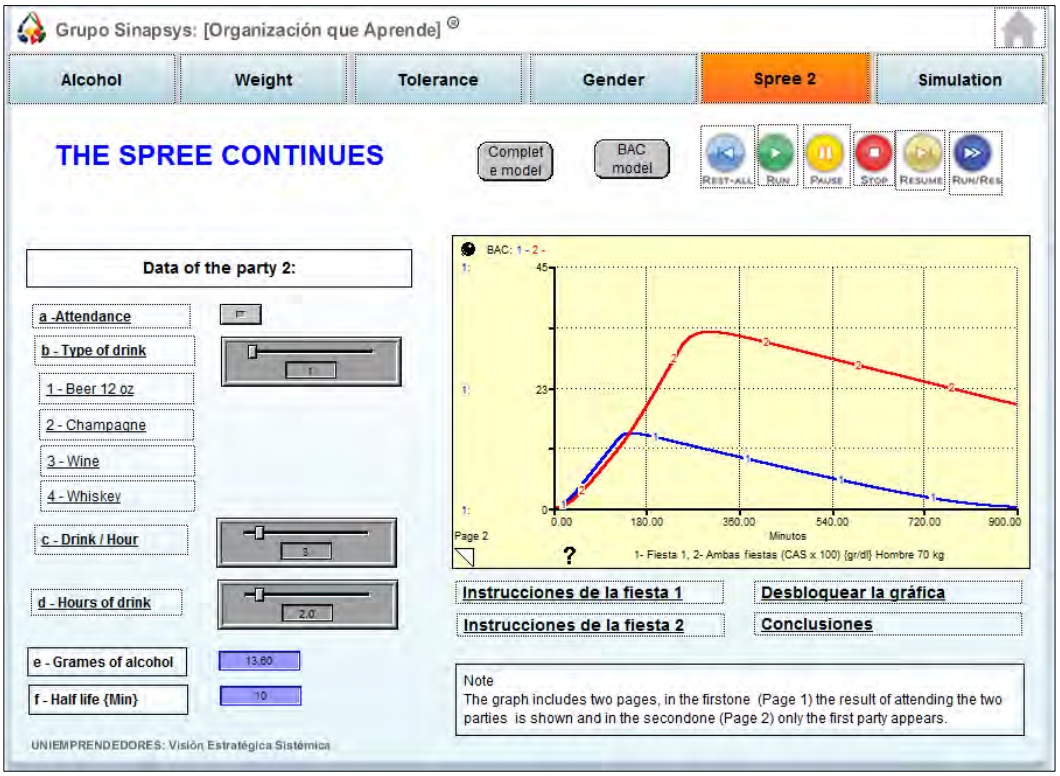


Illustration 33: (1) only party 1, (2) both parties together.

Develop of new cases of study.

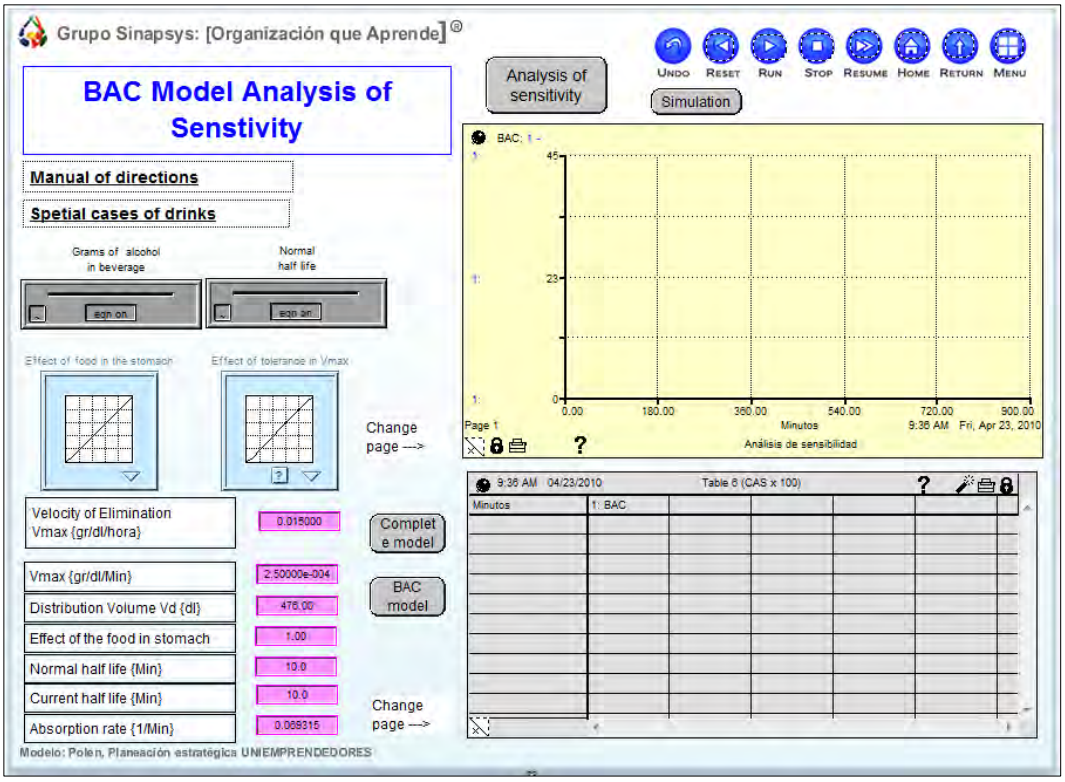


Ilustración 34: To develop other sensitivity analysis not covered until now.

Conclusions

What an interesting model! Now more tan ever it becomes necessary to bring this type of learning labs to middle schools, secondary schools and high schools, due to those stages our youth are starting drinking alcohol.

It's very important to aware them since an early age, to know what happens inside their bodies if they consume alcohol, and the possible consequences of current and future traffic accidents if they become alcoholics.

This learning lab is not only useful for youth, but to create awareness among adults, parents, women (who are genetically in disadvantage to drink, or at least the impact is higer than in a man, because they take more time to recover from a binge).

When a person is already sick of alcoholism, and magically recovers from a binge, this is just an appearance, becasue the damage is terrible to the liver and kidneys which are the organs that release the alcohol out the body. Also the impact in the organs for an individual with diabetes must be horrible when they dare to drink alcohol of any kind. The desire to drink is removed only knowing the terrible consequences at studying cases like those presented in this lab.

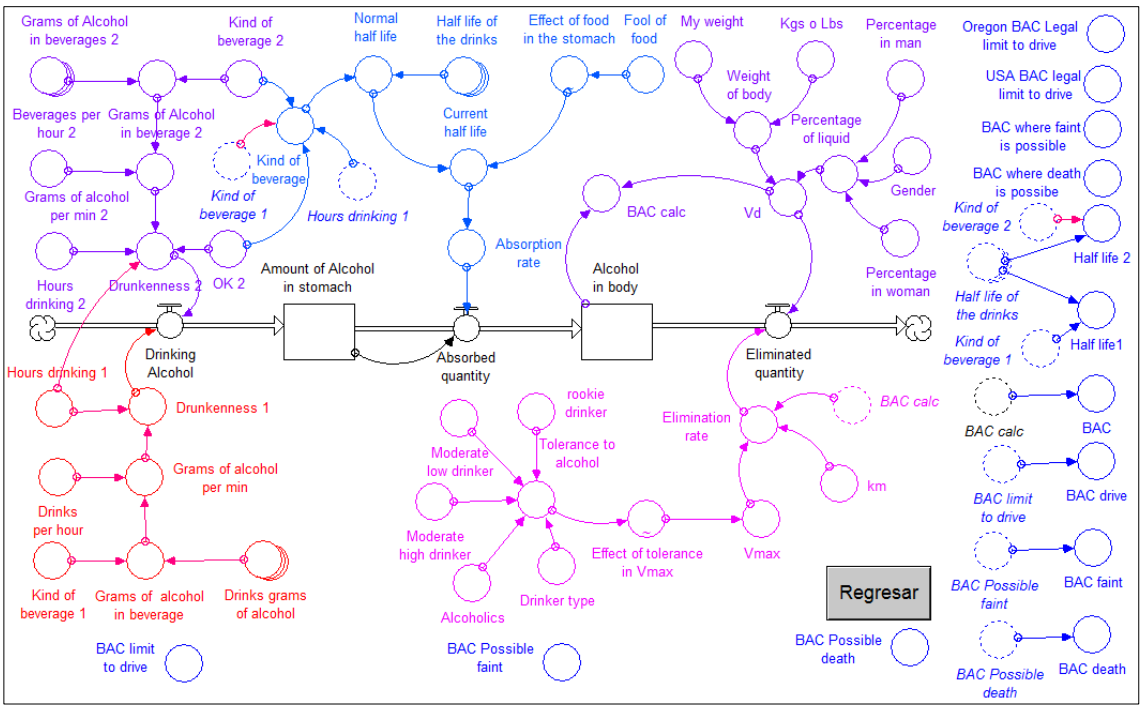
If we start thinking in the high social and public health costs that we're paying, given the secondary consequences of the accidents casued by drunk individuals, we realice how important it is to make available this kind of lab to all the people, making them accesible by the internet. This is an important key.

Of course, this problem is also part of schools of higher education. In recent years, it's scary what we see in the bars, women participate in high consumption of alcohol, they mix all kind of drinks so easily without thinking the consequences, and possibly without being concious about the personal and colateral damage it could cause.

Summarizing, we can say that drinking alcohol excesively, provoques a health public problem. The education, using pratical methods that involve all, could give the tools for a better defense. The systemic thinking, applied to the understanding of economic, social and ecological problems, brings an open door of hope to develop our analysis, synthesis and evaluation skills, and also improves our emocional and social abilities of self-awareness, self-management, social awareness and relationship management.

Apendix "A" BAC Model documentation.

BAC Full model.



BAC Model equations.

Alcohol_in_body(t) = Alcohol_in_body(t - dt) + (Absorbed_quantity - Eliminated_quantity) * dt
INIT Alcohol_in_body = 0 {gr}
INFLOWS:
Absorbed_quantity = Amount_of_Alcohol_in_stomach*Absorption_rate {gr/min}
OUTFLOWS:
Eliminated_quantity = Vd*Elimination_rate {gr/min}
Amount_of_Alcohol_in_stomach(t) = Amount_of_Alcohol_in_stomach(t - dt) + (Drinking__Alcohol - Absorbed_quantity) * dt
INIT Amount_of_Alcohol_in_stomach = 0 {gr}
INFLOWS:
Drinking__Alcohol = Drunkenness_1+Drunkenness_2 {gr/min}
OUTFLOWS:
Absorbed_quantity = Amount_of_Alcohol_in_stomach*Absorption_rate {gr/min}
Absorption_rate = LOGN(2)/Current_half_life {1/min}
Alcoholics = 0.8
BAC = BAC_calc*100
BAC_calc = Alcohol_in_body/Vd {gr/decilitros}
BAC_death = BAC_Possible_death*100
BAC_drive = BAC_limit_to_drive*100
BAC_faint = BAC_Possible_faint*100
BAC_limit_to_drive = 0.08 {g/dl}
BAC_Possible_death = 0.45 {g/dl}
BAC_Possible_faint = 0.3 {g/dl}
BAC_where_death_is_possibe = 0.45 {g/dl}
BAC_where_faint__is_possible = 0.3 {g/dl}
Beverages_per__hour_2 = 3 {Bebidas/Hora}
Current_half_life = Normal_half_life*Effect_of_food_in_the_stomach
Drinker_type = 2
Drinks_grams_of_alcohol[Cerveza] = 13.6

```
Drinks_grams_of_alcohol[Champaña] = 13.6
Drinks_grams_of_alcohol[Vino] = 13.6
Drinks_grams_of_alcohol[Whisky] = 13.6 {Gramos/Bebida}
Drinks_per_hour = 3 {Bebidas/Hora}
Drunkenness_1 = step(Grams_of_alcohol_per_min,0) + step(-
Grams_of_alcohol_per_min,Hours_drinking_1*60)   {gr/min}
Drunkenness_2 = if OK_2=1 then Step(Grams_of_alcohol__per_min_2,Hours_drinking_1*60)+ step(-
Grams_of_alcohol__per_min_2,(Hours_drinking_1+Hours_drinking_2)*60)
else 0    {gr/min}
Elimination_rate = (BAC_calc*Vmax)/(km+BAC_calc)    {(g^2/dl^2/min)/(g/dl)  =  g/dl/min}
Fool_of_food = 0 {No unidaes}
Gender = 1 {1=hombres, 0=mujeres No unidad}
Grams_of_alcohol_per_min = (Drinks_per_hour*Grams_of__alcohol_in_beverage)/60 {Gramos/Minuto}
Grams_of_Alcohol__in_beverages_2[Cerveza] = 13.6
Grams_of_Alcohol__in_beverages_2[Champaña] = 13.6
Grams_of_Alcohol__in_beverages_2[Vino] = 13.6
Grams_of_Alcohol__in_beverages_2[Whisky] = 13.6 {Gramos/Bebida}
Grams_of_Alcohol__in_beverage_2 = if Kind_of__beverage_2=1 then
Grams_of_Alcohol__in_beverages_2[Cerveza]    {Gramos/Bebida}
else if Kind_of__beverage_2=2 then Grams_of_Alcohol__in_beverages_2[Champaña]
     else if Kind_of__beverage_2= 3 then Grams_of_Alcohol__in_beverages_2[Vino]
          else if Kind_of__beverage_2=4 then Grams_of_Alcohol__in_beverages_2[Whisky]
               else Grams_of_Alcohol__in_beverages_2[Cerveza]
Grams_of_alcohol__per_min_2 = (Beverages_per__hour_2*Grams_of_Alcohol__in_beverage_2)/60
{Gramos/Minuto}
Grams_of__alcohol_in_beverage = if Kind_of_beverage_1=1 then Drinks_grams_of_alcohol[Cerveza]
{Gramos/Bebida}
else if Kind_of_beverage_1=2 then Drinks_grams_of_alcohol[Champaña]
     else if Kind_of_beverage_1= 3 then Drinks_grams_of_alcohol[Vino]
          else if Kind_of_beverage_1=4 then Drinks_grams_of_alcohol[Whisky]
               else Drinks_grams_of_alcohol[Cerveza]
Half_life1 = if Kind_of_beverage_1=1 then  Half_life_of_the_drinks[Cerveza]                {Min}
else if Kind_of_beverage_1=2 then Half_life_of_the_drinks[Champaña]
     else if Kind_of_beverage_1=3 then Half_life_of_the_drinks[Vino]
          else if Kind_of_beverage_1=4 then Half_life_of_the_drinks[Whisky]
               else Half_life_of_the_drinks[Cerveza]
Half_life_2 = if Kind_of__beverage_2=1 then  Half_life_of_the_drinks[Cerveza]                {Min}
else if Kind_of__beverage_2=2 then Half_life_of_the_drinks[Champaña]
     else if Kind_of__beverage_2=3 then Half_life_of_the_drinks[Vino]
          else if Kind_of__beverage_2=4 then Half_life_of_the_drinks[Whisky]
               else Half_life_of_the_drinks[Cerveza]
Half_life_of_the_drinks[Cerveza] = 10 {Min}
Half_life_of_the_drinks[Champaña] = 5 {Min}
Half_life_of_the_drinks[Vino] = 20 {Min}
Half_life_of_the_drinks[Whisky] = 10 {Mjn}
Hours_drinking_1 = 2 {Horas}
Hours_drinking_2 = 2 {Horas}
Kgs_o_Lbs = 1 {kg=1, lbs=0}
Kind_of_beverage = if OK_2=1 then
    if time<=Hours_drinking_1 then Kind_of_beverage_1
    else Kind_of__beverage_2
else Kind_of_beverage_1
Kind_of_beverage_1 = 1 {No unidades}
Kind_of__beverage_2 = 1 {No unidades}
km = 0.01  {g/dl}
Moderate_high_drinker = 0.5
```

```
Moderate_low_drinker = 0.20
My_weight = 70 {Kg}
Normal_half_life = if Kind_of_beverage=1 then  Half_life_of_the_drinks[Cerveza]                {Min}
else if Kind_of_beverage=2 then Half_life_of_the_drinks[Champaña]
     else if Kind_of_beverage=3 then Half_life_of_the_drinks[Vino]
          else if Kind_of_beverage=4 then Half_life_of_the_drinks[Whisky]
               else Half_life_of_the_drinks[Cerveza]
OK_2 = 0 {No unidades}
Oregon_BAC_Legal_limit_to_drive = 0.08  {g/dl}
Percentage_in_man = 0.68  {No unidad}
Percentage_in_woman = 0.55  {No unidad}
Percentage_of_liquid = if Gender=1 then Percentage_in_man
else Percentage_in_woman {No unidad}
rookie__drinker = 0
Tolerance_to_alcohol = if Drinker_type=1 then rookie__drinker
else if Drinker_type=2 then Moderate_low_drinker
     else if Drinker_type=3 then Moderate_high_drinker
          else Alcoholics
USA_BAC_legal__limit_to_drive = 0.1  {g/dl}
Vd = Weight_of_body*Percentage_of_liquid*10   {Decilitros}
Vmax = Effect_of_tolerance_in_Vmax/60  {gr/dl/min}
Weight_of_body = if Kgs_o_Lbs=1 then My_weight else My_weight/2.204 {kg}
Effect_of_food_in_the_stomach = GRAPH(Fool_of_food {No unidades})
(0.00, 1.00), (0.1, 1.10), (0.2, 1.20), (0.3, 1.30), (0.4, 1.40), (0.5, 1.50), (0.6, 1.60), (0.7, 1.70), (0.8, 1.80),
(0.9, 1.90), (1, 2.00)
Effect_of_tolerance_in_Vmax = GRAPH(Tolerance_to_alcohol {No unidades})(0.00, 0.01), (0.1, 0.012),
(0.2, 0.015), (0.3, 0.017), (0.4, 0.02), (0.5, 0.023), (0.6, 0.025), (0.7, 0.028), (0.8, 0.03), (0.9, 0.033), (1,
0.035)
```

Data specification for the run of the simulator.

Fron 0 to 900, DT=0.1, integration method Runge-Kutta 4, unit of time = Other (minutes), Run mode = normal, Interaction mode = normal, Sim Speed = 0, Pause interval = INF.

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