## Observation Theory

### Script V13A – Elements of the estimation problem

We would like to arrive at a standardized, generic procedure, which would help us to describe any kind of estimation problem, using a mathematical model.

If we would succeed in such an approach, like following a recipe, we can apply a large amount of standard mathematical methods to produce optimal results.

One of the first steps in this procedure is to analyze the problem, and distinguish three different elements in the estimation problem.

We refer to them as the knowns, the unknowns, and the observations.

The ‘knowns’ contain the information that we consider to be undisputed.

They do not follow from measurements.

They are per definition deterministic.

The ‘Observations’ are the measurements, such as the readings from an instrument.

They are per definition stochastic.

The ‘unknowns’ are the values of the parameters we are actually interested in.

As discussed before, in our approach they are considered to be deterministic.

Now, in order to get familiar with this approach, let's look at some examples and practice.

I propose that you take a pen and some scratch paper and make some notes…

You can make a problem analysis table, and draw three columns, for the observations, the knowns, the unknowns.

Do you have it?

Then I'll explain the following problem

A race track is used by 10 cars for an experiment.

The cars have to drive at a constant speed of 70 km/h, for 5 laps.

We're timing their laps.

What's the length of the track?

So, did you recognize the knowns, unknowns and observations?

Shall I repeat it?

You can wind back the video to give it a try by yourself.

Let's see how you did:

In the description, we highlight the relevant information: the amount of cars, the velocity, the amount of laps, the fact that we are recording time, and the purpose of the whole exercise: the length of the track.

In the problem analysis table, we can list them in the corresponding columns.

We can then conclude that we have one 'Observable' (which is time), but 50 observations, compared to only one unknown parameter; the track length.

Easy, right?

Indeed this is easy at first sight, but often, the devil is in the details.

Probably the amount of cars can indeed be considered as undisputed, just like the number of laps.

But the fact that we can have constant velocity with all these cars, at all these times, seems rather unrealistic.

And isn't the reading of the drivers of the car of their speedometer actually also an observation?

In that case, it would be stochastic.

Hmm, perhaps not too easy?

Now back to our canal width experiment, can you fill in the problem analysis table there?

Please give it a try.

What are the observations, what are the knowns and what are the unknowns?

We will come back to this in a later video.

In this video we discussed the basic elements of an estimation problem: the observations, the knowns, and the unknowns.

Although it may seem trivial or even childish at first sight, it is good practice to have a systematic approach when you try to solve a problem.

If you familiarize yourself with this way of thinking, you are ready to tackle any kind of problem.