

# Z09 Vessel time history



## Introduction

A vessel's primary or superimposed motion, or both, can be prescribed in OrcaFlex by providing a tab-delimited text file containing the time history motion data you want to specify.

The example file *Z09 Vessel Time History.sim* contains a shiver of six sharks circling the model's global origin. In addition, the sharks are also oscillating, menacingly, in the pitch degree of freedom.

## Building the models

Each shark is modelled using a dedicated *vessel* object named *Shark1*, *Shark2*, .. *SharkN*. All the vessel objects share a single *vessel type* named *SharkType*. Because we are going to be prescribing the vessel motion, the only *vessel type* data that is used in this example is that contained on the *shaded drawing* tab. This data is used to specify the shaded drawing file and manipulate the size and attitude of the drawing. Shaded 3D images can be imported into OrcaFlex if they are in the Direct X format (.x file extension) or .obj format. For more information, see the *shaded graphics* section of the Orcina website:

<http://www.orcina.com/Support/ShadedGraphics/index.php>.

In the model, open the data form for the *Shark1* vessel. On the calculation page, notice that the vessel has both *primary motion* and *secondary motion* specified by *time history*. The *primary motion* models the circular motion of each shark, while the *secondary motion* models the pitching behaviour. We have applied these motions via two separate time history files because we want to specify the circling behaviour relative to the global origin, and the pitching motion relative to the vessel's origin.

On the [primary motion](#) page of the data form, the time history data file that defines the circular motion is specified on the [source](#) tab. If an [external data source](#) is used, then this is done by giving the full or relative path of the file that contains the data. In this example, the primary motion time history data is contained in [circle.txt](#).

The time history data contained within the text file must be tab-delimited, and, when being used to specify vessel motion, it can contain up to seven columns, one for the time and six for the vessel's degrees of freedom (*X, Y, Z, Rotation 1, Rotation 2 and Rotation 3*). These columns can appear in any order in the text file, but you must match the column to the time/degree of freedom in the [data](#) tab. You can also assign no data to a degree of freedom, e.g. if *Z* doesn't change with time then you can select [none](#), to indicate that there is no data from the txt file to describe this degree of freedom. In this example, we want to set *X, Y* and *Rotation 3* to vary with time, so the columns that hold the data for each of these is identified on the [data](#) page.

When being used to specify a [primary motion](#) the data in the text file must specify the position and attitude of the [datum point](#) with respect to the global axis system. In this example the [datum point](#) is at the vessel's local origin, i.e. ( $x=0.0m, y=0.0m, z=0.0m$ ), so the time history data effectively defines the position of the vessel's origin through time, with respect to the global axis system.

If you look at the [primary motion](#) data across the different vessel data forms, you will notice that they all use the same text file for the time history data [input file](#) and yet the sharks all appear to occupy unique positions in space (the global axis system). This is achieved by specifying a unique [vessel time origin](#), in the [primary motion, source](#) sub-tab, for each shark. The [vessel time origin](#) is used to specify the vessel's time history origin relative to the [global time origin](#), i.e. it allows you to define by how much the vessel's time history leads or lags global time. In the example, there are six sharks and they complete one full circle in sixty seconds, traveling at a constant angular velocity. So for each shark to be evenly spaced about the circle they need a temporal spacing of ten seconds; the [vessel time origin](#) for each shark is set to be ten seconds behind the preceding shark, with the first shark's [vessel time origin](#) equal to zero seconds (i.e. its time history is in step with the global time). Notice that to do this for a simulation defined from -8s to 60s the time history has to be defined from -8s to 110s, because the 6<sup>th</sup> shark lags behind the 1<sup>st</sup> by 50s.

In addition to the circular motion of the sharks, the oscillatory pitching motion of each shark is prescribed as the vessel's [superimposed motion](#). This is done by choosing [time history](#) as the [superimposed motion](#) on the [calculation](#) tab on the [vessel data](#) form. The time history data is again specified by opening the associated tab, [superimposed motion](#), and giving its path in the [input file](#) data field on the [source](#) sub-tab. In this example, the shark's pitching motion time history data is contained in [pitchingMotion.txt](#).

When being used for [superimposed motion](#), the time history data text file must be formatted in the same way as it was for the [primary motion](#), however now the columns containing the motion data should represent the position and attitude of the [datum point](#) with respect to the [primary motion](#) frame of the vessel (*Surge, Sway, Heave, Roll, Pitch and Yaw*). The [datum point](#) that is specified on the [superimposed motion](#) tab is specific to the time history data being used to prescribe the [superimposed motion](#) for this vessel and does not have to be the same as the [datum point](#) that was specified for the [primary motion](#).

The time history data contained in [pitchingMotion.txt](#) represents the motion of a point on the vessel at ( $x=1m, y=0m, z=0.5m$ ), and so this is what is entered for the shark's [superimposed motion datum point](#). The motion it describes is pure pitching about the vessel's local origin. If you examine the time history text data file notice that at time=-8s (1<sup>st</sup> column) there is no *Pitch* (4<sup>th</sup>

column) but the *Surge* (2<sup>nd</sup> column) and *Heave* (3<sup>rd</sup> column) are both non-zero. This is because the superimposed motion time history data specifies the *position* and not the *displacement* of the datum point, in the vessel's primary heading frame, so the surge and heave data must be inclusive of the position of the datum point measured from the vessel's local axis origin. The reason the surge and heave motion data is time varying, even though the motion is pure pitch about the vessel origin, is because the data describes the motion of a point away from the vessel origin and so there are pitch-heave and pitch-surge components. If the data described the motion at the vessel's local origin then the surge or pitch would be zero for all time.

Again, the *vessel time origin* is used to phase the shark's superimposed pitching motion to ensure they all pitch up and down at the same point on their circular journey around the global origin.

### **Caution!**

It is possible that the superimposed time history data you have been provided with describes the *displacement* of a datum point away from its original position, rather than its *position*, with respect to the primary heading frame. If your *datum point* is at the vessel's local origin then the *position* and *displacement* are equivalent and you do not need to worry about this. But if the *datum point* is not at the vessel's local origin and your data defines its *displacement* then you will need to make a small correction to your time history data text file. To make the correction to the time history data text file you simply need to add the *datum point's* x component to the *Surge* data, the y component to the *Sway* data, and the z component to the *Heave* data.