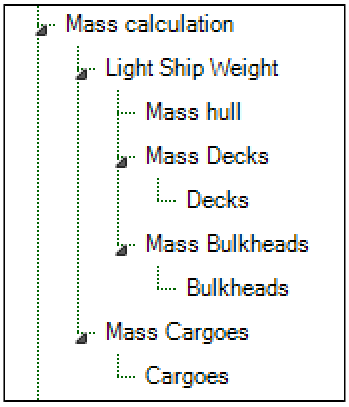
Perform design analyses

1 Mass calculation

Now that the ship lay out is finalized, the first analysis, **Mass calculation**, can be performed. Incidentally, it is always possible to change the values you entered in the previous section. The child entities of `Mass calculation` are:

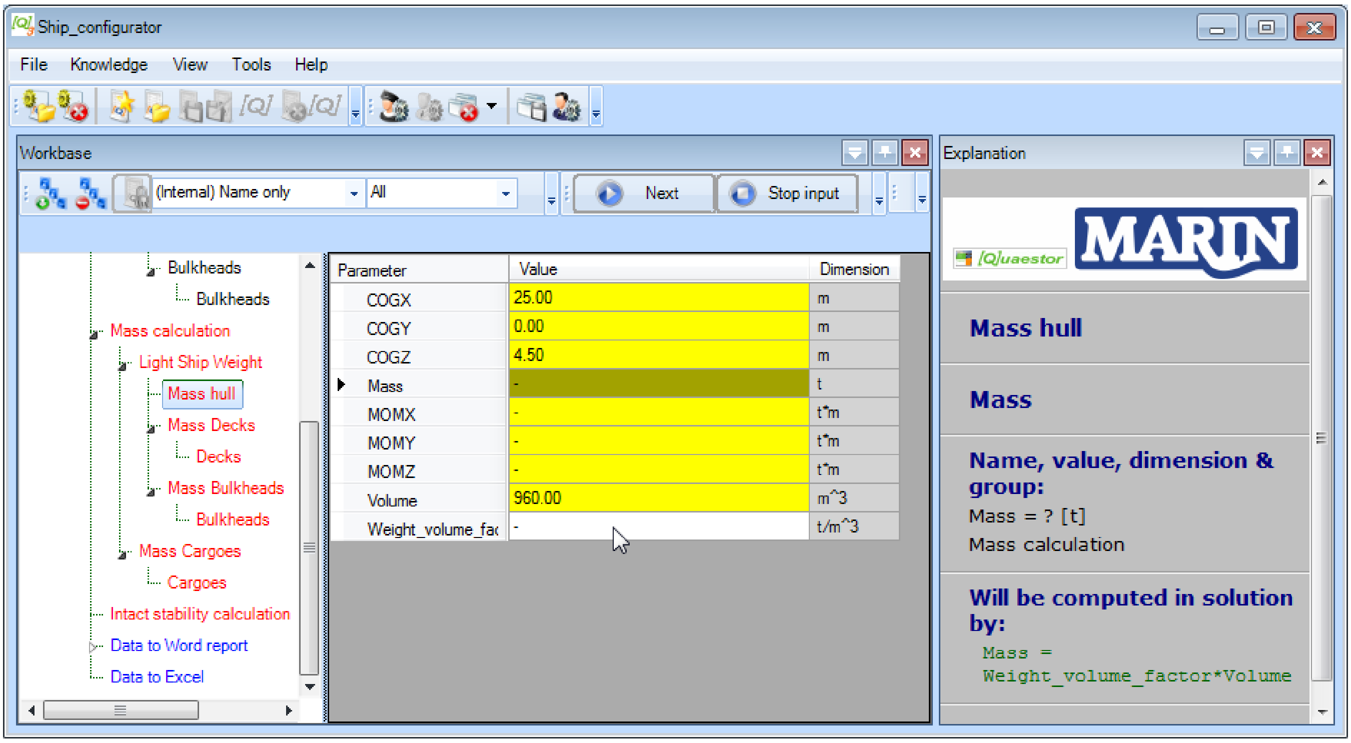


- Mass calculation
  - Light Ship Weight
    - Mass hull
    - Mass Decks
      - Decks
    - Mass Bulkheads
      - Bulkheads
  - Mass Cargoes
    - Cargoes

In the `Mass Calculation` entity, which is a subgoal of the total solution, the **mass** and **the centre of gravity** of the whole system will be calculated. These quantities depend on the mass and centre of gravity of both the ship itself (`Light Ship Weight`) and the cargo it carries (`Mass Cargoes`). The total mass is calculated by the summation of all mass components. The centre of gravity of a system of components is defined as the average of their positions, weighted by their masses. This method is used at every level (entity/subgoal) of `Mass calculation`.

In the entities `Mass Calculation` and `Light Ship Weight` (and `Mass Cargoes)` no input is requested from the user.The first 'stop' in the calculation process is in `Mass hull`.

- If you have not done so already in the previous part of this tutorial, click *Next*. In any case, the screen should now look like this:



Parameter	Value	Dimension
COGX	25.00	m
COGY	0.00	m
COGZ	4.50	m
Mass	-	t
MOMX	-	t*m
MOMY	-	t*m
MOMZ	-	t*m
Volume	960.00	m^3
Weight_volume_fac	-	t/m^3

Mass hull

Mass

Name, value, dimension & group:
Mass = ? [t]
Mass calculation

Will be computed in solution by:
`Mass = Weight_volume_factor*Volume`

Quaestor will calculate all information in these entities when all required information from lower entities is available. You can see this because these entities are still colored red. A yellow cell will be calculated by a relation.

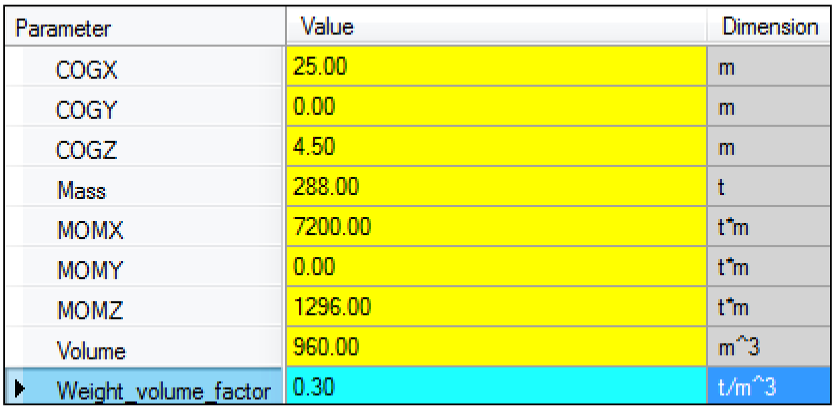
Based on the results of the entities `Main Dimensions` and `Hydrostatics` (in `Ship design | Lay out | Hull`), the **centre of gravity** and **volume** of the hull is determined. Scroll through the parameter list to see the used relations in the **Explanation window**. For this simplified ship configurator it is assumed that the mass of the hull can be computed by:

```
Mass = Weight_volume_factor * Volume
```

As a user, you only have to provide a **weight volume factor**. The moments around the X, Y and Z axis are determined by Mass multiplied by respectively COGX, COGY and COGZ.

- Enter 0.3 [t/m^3] as the value of `Weight_volume_factor` and press *Enter*.

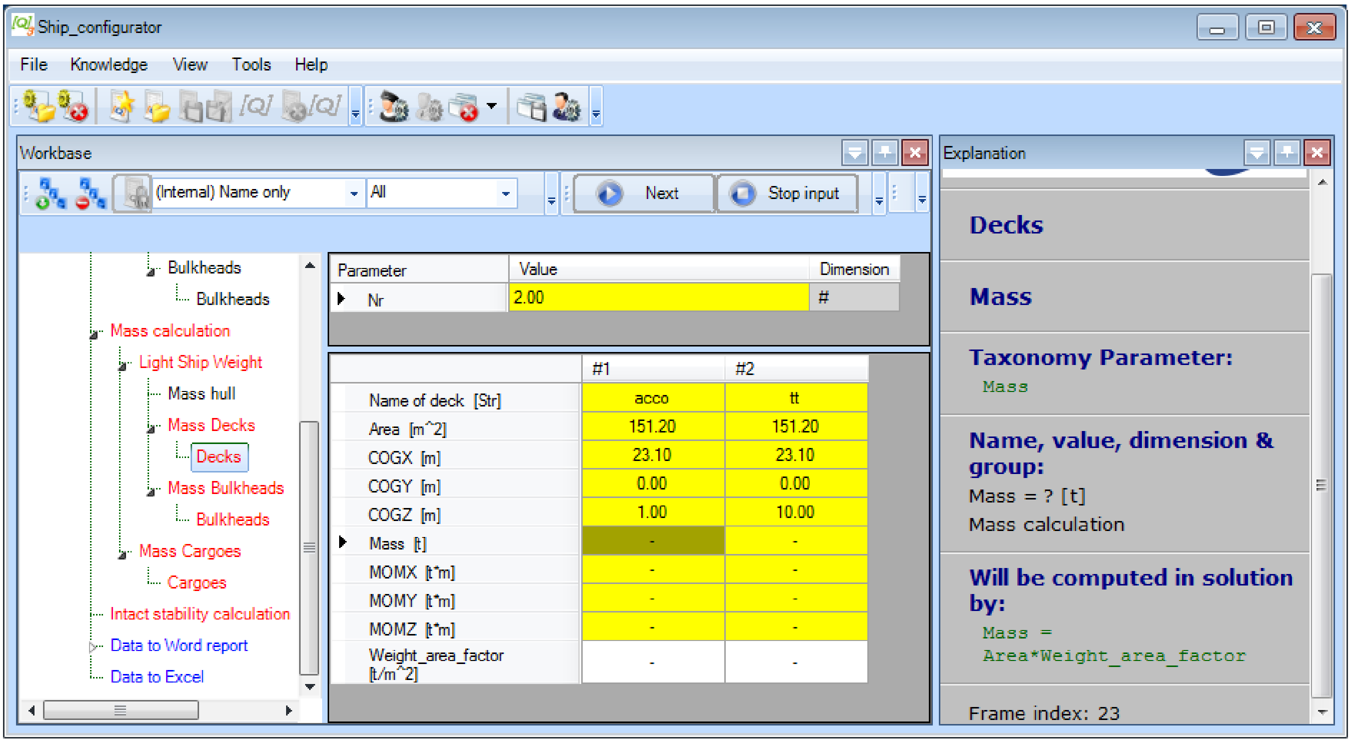
Quaestor calculates everything it can upto now and fills in all values in the list:



Parameter	Value	Dimension
COGX	25.00	m
COGY	0.00	m
COGZ	4.50	m
Mass	288.00	t
MOMX	7200.00	t*m
MOMY	0.00	t*m
MOMZ	1296.00	t*m
Volume	960.00	m^3
▶ Weight_volume_factor	0.30	t/m^3

- Click *Next* to continue the calculation of the next subgoal (entity).

In the previous section, you defined the names and positions for two decks. The entity `Decks` presents a table which contains a number of parameters for each defined `Deck`.



Parameter	Value	Dimension
▶ Nr	2.00	#

	#1	#2
Name of deck [Str]	acco	tt
Area [m^2]	151.20	151.20
COGX [m]	23.10	23.10
COGY [m]	0.00	0.00
COGZ [m]	1.00	10.00
▶ Mass [t]	-	-
MOMX [t*m]	-	-
MOMY [t*m]	-	-
MOMZ [t*m]	-	-
Weight_area_factor [t/m^2]	-	-

Decks

Mass

Taxonomy Parameter:
`Mass`

Name, value, dimension & group:
Mass = ? [t]
Mass calculation

Will be computed in solution by:
`Mass = Area*Weight_area_factor`

Frame index: 23

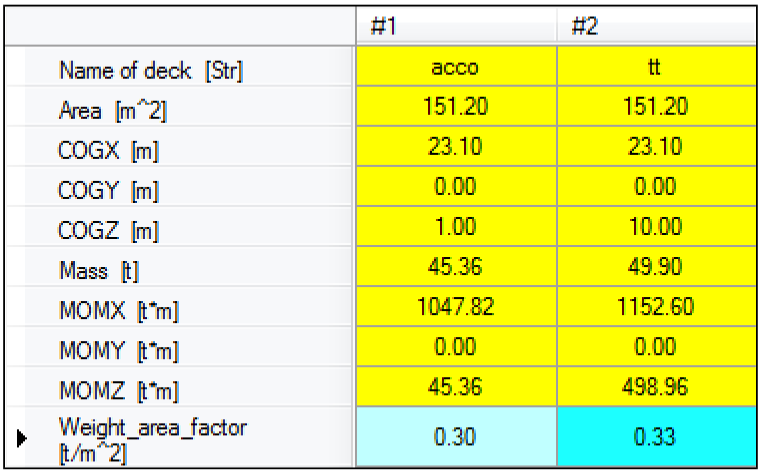
Again, a yellow cell means that a value is be determined by a relation. The parameters `Nr`, `Name of deck`, and `Area` are automatically copied from the defined `Deck` entities below `Lay out`. When you add or remove a deck, or change properties of an existing defined deck, these adaptations will be automatically propagated to the `Mass Decks` entity.

The centre of gravity of a deck is based on the given location in your ship design. For this simplified ship configurator, it is assumed that the mass of the decks can be computed by:

```
Mass = Weight_area_factor * Area
```

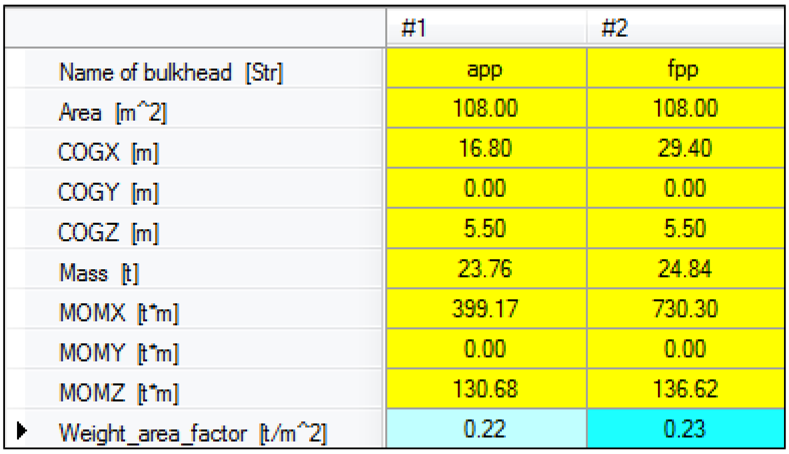
As a user, you only have to provide a **weight area factor** for each deck. The mass calculation as applied for decks is also used for the mass calculation of bulkheads.

- Enter the values 0.30 [t/m^2] and 0.33 [t/m^2] for the `Weight_area_factors` of the decks and press *Enter*.



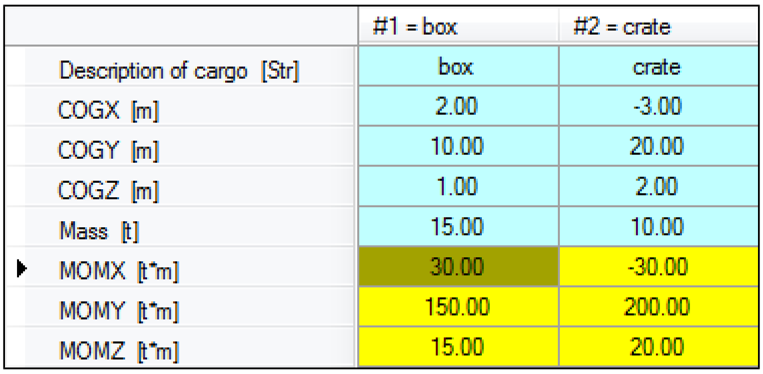
	#1	#2
Name of deck [Str]	acco	tt
Area [m^2]	151.20	151.20
COGX [m]	23.10	23.10
COGY [m]	0.00	0.00
COGZ [m]	1.00	10.00
Mass [t]	45.36	49.90
MOMX [t*m]	1047.82	1152.60
MOMY [t*m]	0.00	0.00
MOMZ [t*m]	45.36	498.96
Weight_area_factor [t/m^2]	0.30	0.33

- Click Next and enter the values 0.22 [t/m^2] and 0.23 [t/m^2] for the `Weight_area_factors` of the bulkheads and press *Enter*.



	#1	#2
Name of bulkhead [Str]	app	fpp
Area [m^2]	108.00	108.00
COGX [m]	16.80	29.40
COGY [m]	0.00	0.00
COGZ [m]	5.50	5.50
Mass [t]	23.76	24.84
MOMX [t*m]	399.17	730.30
MOMY [t*m]	0.00	0.00
MOMZ [t*m]	130.68	136.62
Weight_area_factor [t/m^2]	0.22	0.23

The last thing to do for the mass calculation is entering data for the cargo objects. You'll know how to do this. For this tutorial, limit yourself to a few objects, because otherwise you will have a lot to enter! Note that there is a picture of the coordinate system to help you in the Explanation window. For two pieces of cargo, the input will look something like this:

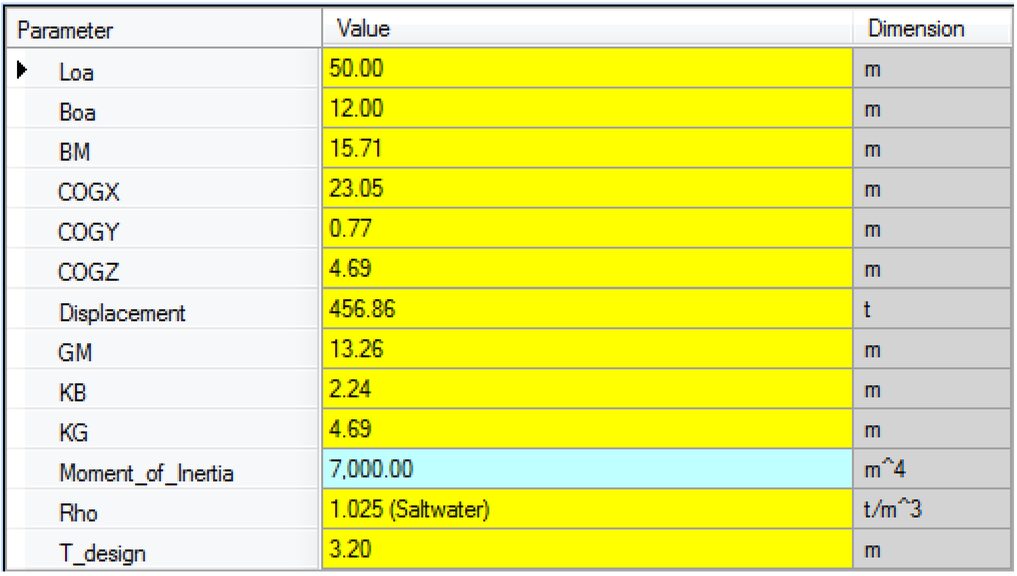


	#1 = box	#2 = crate
Description of cargo [Str]	box	crate
COGX [m]	2.00	-3.00
COGY [m]	10.00	20.00
COGZ [m]	1.00	2.00
Mass [t]	15.00	10.00
MOMX [t*m]	30.00	-30.00
MOMY [t*m]	150.00	200.00
MOMZ [t*m]	15.00	20.00

2 Intact stability calculation

The mass and centre of gravity of the whole system are input for the intact stability calculation. For this tutorial a very unrealistic simplified stability calculation is developed. The moment of inertia of the water plane area is the only required input value.

The entity `Intact stability` is only included to give an idea how a configurator can be built with a taxonomy approach. Example input values for the entity `Intact stability` are presented below:



Parameter	Value	Dimension
Loa	50.00	m
Boa	12.00	m
BM	15.71	m
COGX	23.05	m
COGY	0.77	m
COGZ	4.69	m
Displacement	456.86	t
GM	13.26	m
KB	2.24	m
KG	4.69	m
Moment_of_Inertia	7,000.00	m^4
Rho	1.025 (Saltwater)	t/m^3
T_design	3.20	m

3 Data to Word report

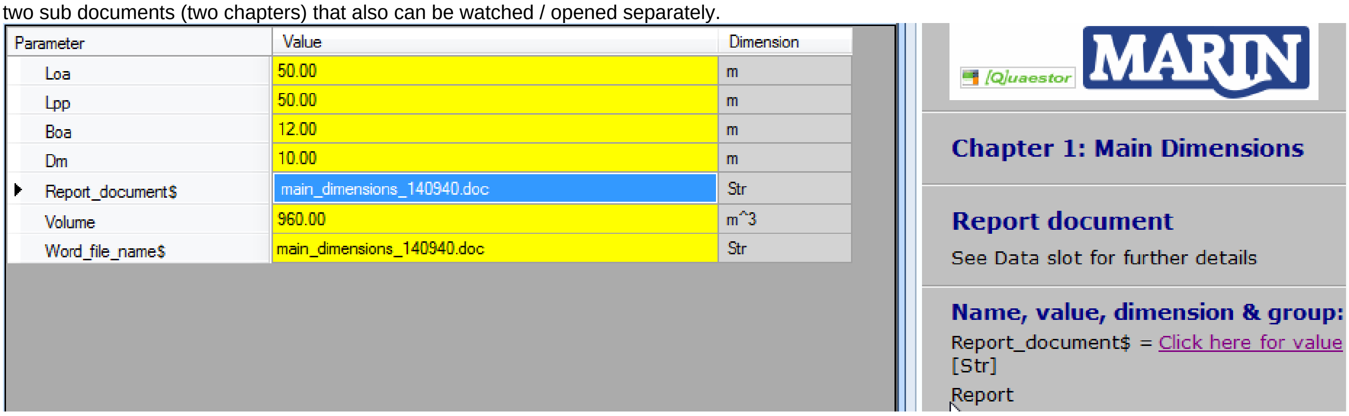
At the moment you leave the entity `Intact stability` with the *Next* button, Quaestor jumps automatically to the entity `Data to Word report`. Here you do not have to provide any input values. Quaestor will directly generate (if all information from the previous entities is available) a little MS Word report. When you have this document open at that moment, you will see the generation of the reports taking place on your screen.

> ⚠ Be aware that fatal errors may occur when you are actively working in Word while the reports are generated. Therefore, please wait until the documents are closed.

There are two ways to open the created Word documented from inside Quaestor.

- Select the parameter `Report_document$` in the entity `Example report` and click on "Click here for value" in the Explanation window below "Name, value dimension & group".
- *Double click* on the value of parameter `Report_document$`.

Of course, it is always possible to find and open the document in your project folder on your computer. The example report document is built up from two sub documents (two chapters) that also can be watched / opened separately.



Parameter	Value	Dimension
Loa	50.00	m
Lpp	50.00	m
Boa	12.00	m
Dm	10.00	m
Report_document$	main_dimensions_140940.doc	Str
Volume	960.00	m^3
Word_file_name$	main_dimensions_140940.doc	Str

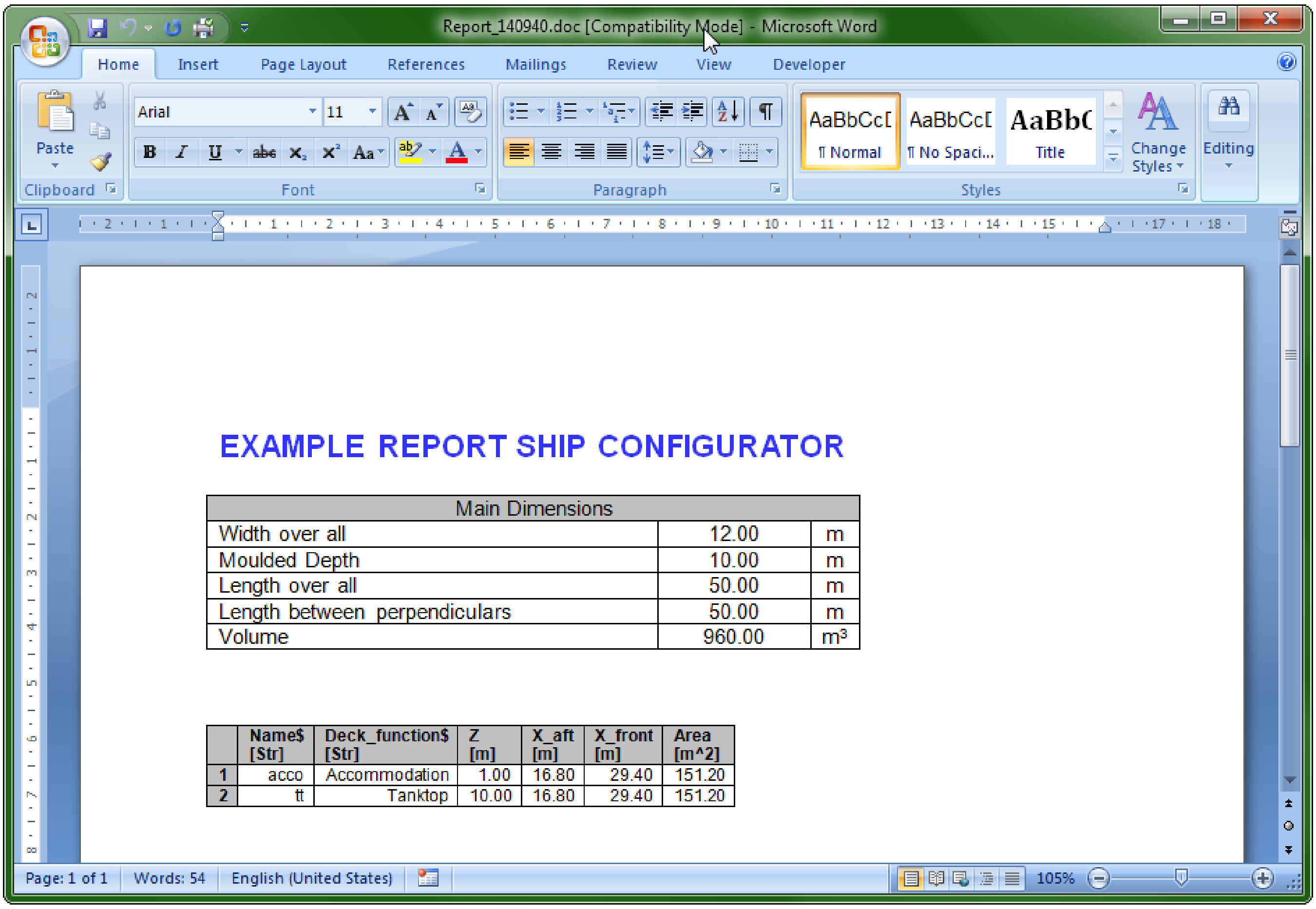
Chapter 1: Main Dimensions

Report document

See Data slot for further details

Name, value, dimension & group:

Report_document$ = Click here for value
[Str]
Report



EXAMPLE REPORT SHIP CONFIGURATOR

Main Dimensions		
Width over all	12.00	m
Moulded Depth	10.00	m
Length over all	50.00	m
Length between perpendiculars	50.00	m
Volume	960.00	m³

	Name$ [Str]	Deck_function$ [Str]	Z [m]	X_aft [m]	X_front [m]	Area [m^2]
1	acco	Accommodation	1.00	16.80	29.40	151.20
2	tt	Tanktop	10.00	16.80	29.40	151.20

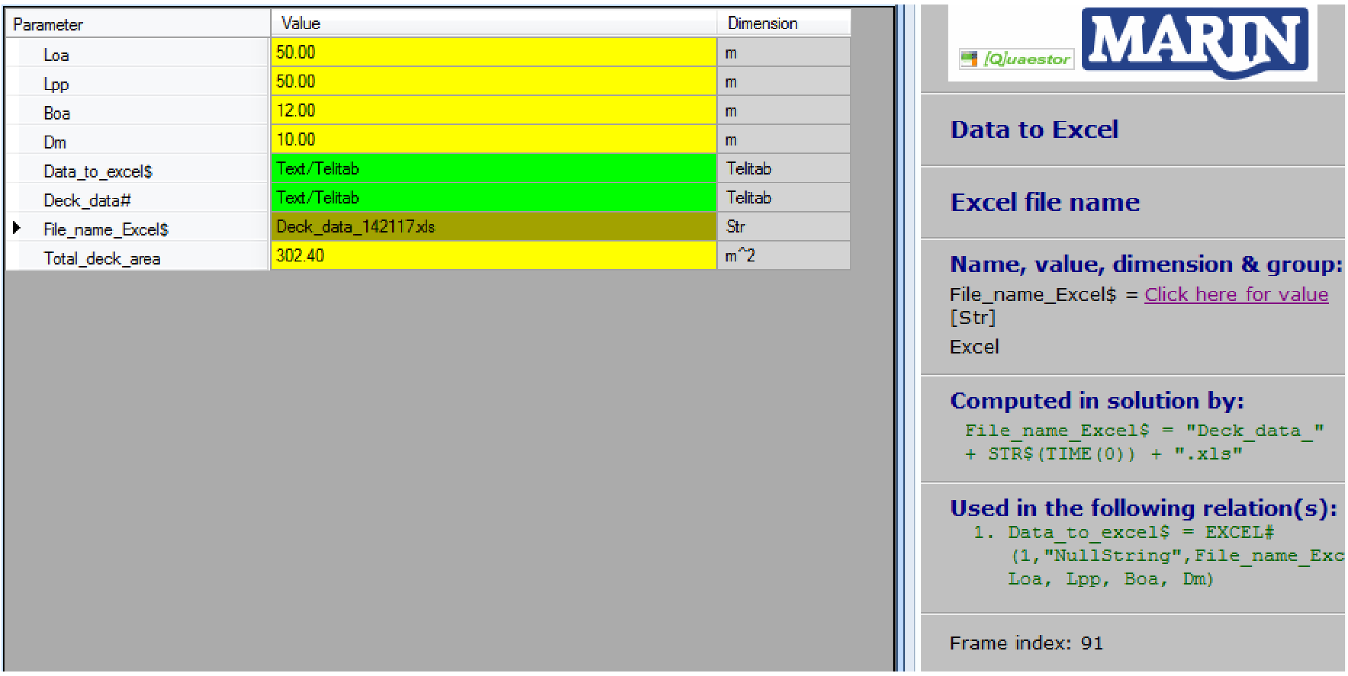
4 Data to Excel

The main dimensions and a table of deck data will be written to an Excel file too. Here, the total deck area will be calculated and the result will be send back to Quaestor in parameter `Total_deck_area`. If Quaestor knows all the required data, the Excel file will be made at the moment you visit the entity `Data to Excel`.

> ⓘ The knowledge engineer (the developer) can decide whether to leave an Excel sheet (or Word document) open, or close it automatically. In the case of the Excel sheet, it was decided to leave the Excel sheet open.

There are two ways to open an Excel file from Quaestor.

- Select the parameter `File_name_Excel$` in the entity `Data to Excel` and click on “Click here for value” in the Explanation window below “Name, value dimension & group”.
- *Double click* on the value of parameter `File_name_Excel$`.



Parameter	Value	Dimension
Loa	50.00	m
Lpp	50.00	m
Boa	12.00	m
Dm	10.00	m
Data_to_excel$	Text/Telitab	Telitab
Deck_data#	Text/Telitab	Telitab
File_name_Excel$	Deck_data_142117.xls	Str
Total_deck_area	302.40	m^2

Data to Excel

Excel file name

Name, value, dimension & group:

File_name_Excel$ = Click here for value
[Str]
Excel

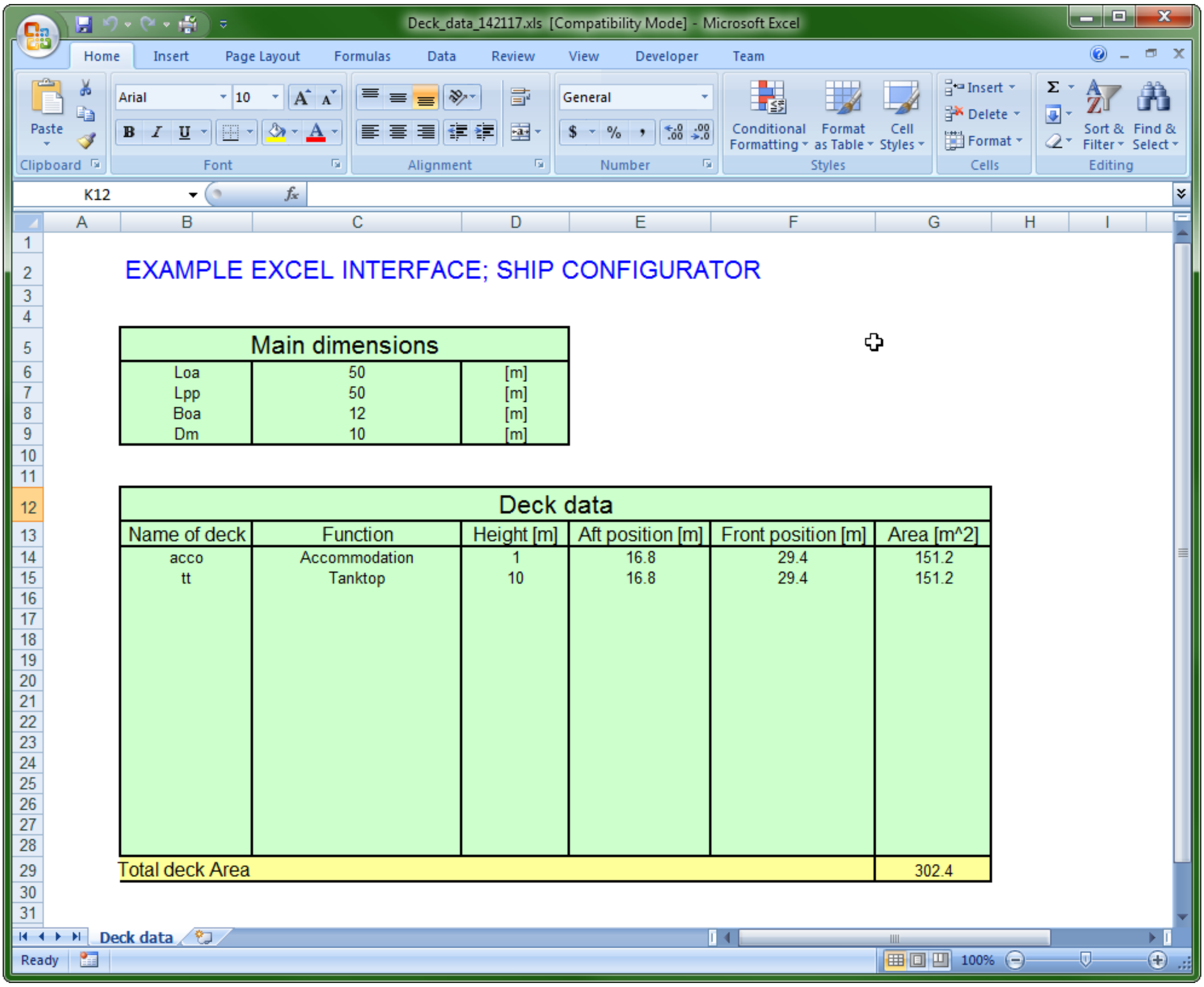
Computed in solution by:

```
File_name_Excel$ = "Deck_data_"
+ STR$(TIME(0)) + ".xls"
```

Used in the following relation(s):

```
1. Data_to_excel$ = EXCEL#
   (1,"NullString",File_name_Exc
   Loa, Lpp, Boa, Dm)
```

Frame index: 91



EXAMPLE EXCEL INTERFACE; SHIP CONFIGURATOR

Main dimensions		
Loa	50	[m]
Lpp	50	[m]
Boa	12	[m]
Dm	10	[m]

Deck data

Name of deck	Function	Height [m]	Aft position [m]	Front position [m]	Area [m^2]
acco	Accommodation	1	16.8	29.4	151.2
tt	Tanktop	10	16.8	29.4	151.2
Total deck Area					302.4

Of course it is always possible to find and open the document in your project folder on your computer (The default path for the Ship_configurator is `C:/Users/Public/Documents/My_Knowledge/Projects/_Ship_configurator/Solutions`).

ⓘ If you are a Knowledge Engineer, you might want to continue with the tutorial explaining how the database that was used here can be developed.

Back to content | << Previous