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MEMO

MEMO CONCERNS

SIMO 4.0.7 Release Notes

FOR YOUR ATTENTION	COMMENTS ARE INVITED	FOR YOUR INFORMATION	AS AGREED

DISTRIBUTION

SIMO Users

FILE CODE	CLASSIFICATION
P	Unrestricted

REFERENCE NO.

PROJECT NO.	DATE	PERSON RESPONSIBLE / AUTHOR	NUMBER OF PAGES
516412	2013-09-19	Harald Ormberg & Knut Mo	12

Contents

1 SIMO releases

1.1 SIMO 4.0.7 (2013-09-19)

1.1.1 Mooring system optimization (STAMOD)

This functionality has been temporarily deactivated, and will not be available until it has been thoroughly reviewed and tested.

1.1.2 Avoid printed error message indicating error termination

The message "ERROR in TERMINATE_WIND: value for LPU not set!" was given during the run of STAMOD and DYNMOD. This was a faulty indication of error. The error message is now avoided. No consequence to results.

1.1.3 Error handling and layout

Minor improvements in error handling and layout.

1.2 SIMO 4.0.6 (2013-08-30)

1.2.1 Decoding of input files

Trailing zeros after the decimal point are now removed before decoding floating point numbers on ASCII input files. 0.5 and 0.500000 will now result in the same value. This may improve stability in simulations for cases where the time domain integration parameters are given with many trailing zeros. Slight changes in results may occur.

1.2.2 Error correction: Reading wind turbine data.

The cone angle and twist angles were a factor of 4 too small. Error in converting angles from degrees to radians.

1.2.3 Improvement: Static results to psc-file for coupled analysis

Static body results are printed to a psc type of file also when running coupled analysis. This file is used by SIMA.

1.2.4 Error correction: Time series of global accelerations

The double derivatives of Euler angles have been replaced by rotational body accelerations for time series presentations. No consequence to results except for the presented acceleration signals.

1.2.5 Error correction: Thruster forces for visualization (SIMVIS/SIMA)

Erroneous forces stored to file to be used for visualization in SIMVIS and SIMA. The error has been corrected. Note: No error correction with regard to thrust time series, i.e. no consequence to results.

1.3 SIMO 4.0.5 (2013-05-16)

1.3.1 Error correction: Thruster force time series

The thrust force time series were incorrectly stored when than one body had thrusters and both total thrust force and individual thruster forces were stored. The error did not affect other simulation results.

1.3.2 Error correction: DP yaw moment assignment

DP system assigned large yaw moments to thrusters when the heading error was 0°, which was miscalculated to 360°. The error has been corrected

1.3.3 Improvement: Diffracted wave transfer functions for wave elevation only

Diffracted transfer functions may now be given for wave elevation only. Previously, this was not allowed when waves were generated by FFT.

1.4 SIMO 4.0.4 (2013-03-22)

1.4.1 Improvement: Added mass in the kinetic equation used in time domain

Modelling of non-linear kinetic effects related to added mass was found not to be strictly correct. This showed itself as a tendency to give e.g. too large roll motions compared with model test results. The reason was found i) to be unfavourable treatment of the frequency independent part of added mass, which was assumed to be constant in body fixed frame of reference and ii) that the relative fluid flow past the body used in the kinetic equation included the wave frequency part of body motions.

These shortcomings have been corrected by modelling the added mass as constant in the body related frame of reference and by low pass filtering the vessel velocities before using them in the kinetic equation.

It is not straight forward to specify an appropriate filter period, therefor the user is offered the following options in application of the filter:

1. No filtering
2. Low pass filtering with specified cut off period
3. Complete blocking of velocities (all velocity components set to zero)

Results will change for body type 1 for which 1st order wave forces are described in time domain, i.e. by 1st order wave force transfer functions, retardation functions and added mass at infinite frequency.

Note! This new option requires extra input commands for dynamic analysis if waves are present. Existing macro files used for dynamic analysis (dynmod) have to be modified, e.g.

Example: No filter

```
Set simulation parameters      ' DYNMOD main menu
/                      ' Default main analysis parameters ? (N)
FFT only                       ' Select method for calculation of waves
12                                   ' Integer power of 2 - NFFT
0.25                                 ' Time step - DT
1                                    ' Number of subdivision each step
No filter                      ' Select method for filtering
/                      ' Default method parameters ? (N)
```

Example: Filter

```
/                      ' Use default file names ? (Y)
Read initial condition file    ' DYNMOD main menu
Set simulation parameters      ' DYNMOD main menu
n                      ' Default main analysis parameters ? (N)
FFT only                       ' Select method for calculation of waves
12                                   ' Integer power of 2 - NFFT
0.25                                 ' Time step - DT
1                                    ' Number of subdivision each step
Filter                         ' Select method for filtering
50.                                  ' Filter period
n                      ' Default method parameters ? (N)
```

Example: Blocked filter

```
/                      ' Use default file names ? (Y)
Read initial condition file    ' DYNMOD main menu
Set simulation parameters      ' DYNMOD main menu
/                      ' Default main analysis parameters ? (N)
FFT only                       ' Select method for calculation of waves
12                                   ' Integer power of 2 - NFFT
0.25                                 ' Time step - DT
1                                    ' Number of subdivision each step
Blocked filter                 ' Select method for filtering
/                      ' Default method parameters ? (N)
```

1.5 SIMO 4.0.3 (2013-03-22)

1.5.1 Improvement: Dynamic positioning and thrust allocation

Thrust allocation means distributing the demand for total force and moment from the DP controller to the thrusters in the system. Usually this can be done in many ways. In Simo it is done according to an optimality criterion by which it is attempted to fulfil the demand for force and moment with as little use of thrust as possible.

When large total force or moment is demanded it can happen that a thruster is instructed to deliver a thrust that would exceed its capacity. In this case a saturation handler routine is called which tries to distribute the excess thrust on other thrusters in the system. In the previous Simo versions (4.0) there was a coding error in the saturation handler, which made the allocation erratic.

In the new version (4.0.3) capacity exceedance in the allocation, is handled by simply enforcing the limit to the thrust instead of trying to amend the situation by redistributing thrust. This has proven to be a robust way to deal with the problem in most cases.

1.5.2 Error correction: Dynamic positioning

An error in the DP control module when dynamic positioning and mooring was used simultaneously has been identified. In this case a false constant bias force was added to the force from the thrusters. This defect has been corrected.

1.5.3 Error correction: Diffracted waves

A potential error with regard to systems with a large number of diffracted wave specifications and applications has been identified. This has been corrected.

1.5.4 Improvement: Diffracted waves

Application of diffracted wave elevation alone and not only in context with diffracted wave velocity has made possible.

1.6 SIMO 4.0.2 (2013-01-11)

1.6.1 Error correction: Dynamic positioning

The required rate of change of thrust direction did not work. That is, the limitation in change of thrust direction did not work. This resulted in a momentary change in the direction of azimuth thrust direction set to required direction. This gave non-conservative results. Fixed.

1.6.2 Error correction: Dynamic positioning, thrust allocation.

When the thrust command of a thruster is greater or equal to the maximum allowed thrust of the thruster, the allocation algorithm try to find a new solution by reassigning the thrust to the other thrusters. If the thruster system is not redundant, this can lead to absurd answers, since the solution is unique anyway. Fixed: The "compensation algorithm" is jumped over if the system is not redundant.

1.6.3 Error correction: Wind specification

Use of wind type 11 (Fluctuating uniform 2-component wind) resulted uncontrolled program termination (NaN). This has been corrected.

1.6.4 Improvement: Dynamic positioning

Maximum numbers of thrusters per body has been increased from 10 to 20.

1.7 SIMO 4.0.1 (2012-11-19)

1.7.1 Error correction: Distributed element force and dept dependent coefficients

Several "slender elements" can be given under data group "Distributed Element Force" (DEF). Originally, data group (DEF) could only be given one time for each body. In visualization, this was inconvenient, because all slender elements were one graphic object. The input to SIMO was therefore modified so that the data group (DEF) could be given several times for each body. In SIMA each "Slender Element" has its own (DEF) group.

A "Slender Element" may have "Depth-dependent" coefficients. Internal in the program, these coefficients are stored in increasing order. At the system input file (sys-file), the coefficients may be given in increasing or decreasing order.

An error did occur if more than 3 levels of depth-dependent coefficients were given and the coefficients were given in decreasing order.

An error did also occur if more than 1 slender element with depth-dependent coefficients were specified in the same (DEF) group.

1.7.2 Correct reading of long real input

Correctly handle reading of real input with long parts before the decimal point, e.g. 11529732831.1. Previously, such numbers were incorrectly read and gave erroneous results. Longstanding limitation in SIMO

1.8 SIMO 4.0.0 (2012-10-17)

Initial release of SIMO 4.0.0.

All corrections of errors to the SIMO 3.6 versions have been implemented in the SIMO 4.0.0 version.

2 Modifications in SYSTEM FILE and MACRO files in SIMO 4.0

In version there is some new modelling possibilities. Description of new functionality is not described. There has been one change in the DYNMOD macro file.
In version 3.6 there was a misleading question:

Store SUM SPECIFIED FORCES ? (N)

In version 4.0, this question has been changed to:

Store SPECIFIED FORCE for any body ? (N)

In version 3.6, the SPECIFIED FORCE input at the "sys-file" had to be a force. In version 4.0, the specified force can also be a moment.
Version 3.6 - (IMETH = 2 or 3) => Parameter IDOF/IMOM is dummy
Version 4.0 - (IMETH = 2 or 3) => Parameter IDOF/IMOM is a force/moment switch (=IMOM)

IMOM = 0 => Force is specified IMOM = 1 => Moment is specified

3 New / improved modelling functionality in SIMO 4.0

3.1 Improvements in DP-modelling

These improvements include:

- The possibility to specify a 3x3 stiffness matrix to account for restoring forces.
- The possibility to specify a force table to account for nonlinear forces from a single hawser or a single mooring line.
- No reduction of other thrust forces in case one thruster experience saturation.
- For azimuth thrusters, the allocation algorithm is improved so that the new algorithm allocates the thrust with the instantaneous thruster direction.

3.2 Manoeuvring

Vessel manoeuvring is made possible by specification of a path for the DP reference point. This option involves modelling of thrusters and a DP-system.

3.3 Thrust force

A model for the effect (lifting surface) of a rudder on the thrust force has been implemented.

3.4 Second order wave forces due to swell

Computation of second order wave forces (qtf- and drift forces) due to swell has been implemented. These forces adds to the second order wave forces due to wind waves.
The wave drift force from swell (long periodis waves) will normally be small. However, in some cases the specified swell (2nd wave spectrum) is used to add an additional wind sea from another direction.

3.5 Direction dependent force coefficients

The new input description allows for directions not starting from 0°. For example is the direction sequence: 5°, 35°, 65°, ….. , 335° is accepted.

3.6 User-specified moment

It is possible to define user-specified moment (in addition to specified force)

3.7 Ratchet coupling

Ratchet type coupling, characterised by its asymmetric slip – lock response, (used in offshore installation or de-commissioning of heavy structures)

3.8 Body components

3.8.1 Controllable tensioner

Hydraulic/pneumatic tensioner. May be applied in coupled, dynamic simulation of pipe-laying, where the mean force can be controlled to ensure symmetric motion about mid-stroke position). The mean force may also be controlled over HLA in the MARINTEK simulator set-up

3.8.2 Active heave compensator

The intention is to facilitate the modelling of an active HC, where the vertical motion of the suspended load is minimized, preferably so that the HC piston moves around its mean-stroke position.

3.9 Crane modelling and crane operations

This feature has been accomplished by defining a SIMO articulated structure. The articulated structure is a collection of bodies constituting a crane. The joints have to be of type slide/telescoping or hinged. It is possible to predefine a motion sequence, or it may be controlled over HLA in the MARINTEK simulator set-up.

3.10 Wind Turbine

The wind turbine modelling feature is implemented as an alternative wind load model. The wind load computation is based on a Blade Element Momentum (BEM) method for dynamic analysis of horizontal axis wind turbines. This feature includes a control system for collective blade pitch and power take-off. This model involves the possibility to import turbulent full-field wind inflow.

3.11 Modelling and accuracy improvements

- The calculation method for bodies with large rotations has been improved. Thereby the mathematical singularity in the Euler angle expressions has been eliminated. Relevant

examples are free-fall installation method, skid-launched lifeboats and up-ending of SPAR buoys and wind turbine towers.
- The numerical accuracy has been increased. This has been done by applying double precision instead of single precision representation float values when solving the equations of motion. This is an important improvement typically in simulation of marine operations where the focus is on forces in stiff coupling or contact elements. Independent of the selected time step in the simulation, numerical inaccuracies lead to non-repeatable, chaotic behaviour affecting the calculated forces and resulting body motion.
- The reference system for added mass at infinite frequency has been changed to be in accordance with the reference system for the retardation function forces, resulting in more consistent behaviour.

3.12 General Line Data

The numerical formulation and stability of the catenary formulation of the general line modelling option have been improved.

4 Useful tools

4.1 SIMO modelling tutorial

Simo modelling tutorial may be a useful tool a new tool. The intention of the tutorial is to give some advice on how SIMO can be used to model the marine units and the various mechanical systems often encountered in different marine operations. Thus the focus has been, based on experience, to comment on how the numerous models available in SIMO can be used, alone or in combination, to represent practical cases as well as possible. Also comments are given on where special attention should be paid to avoid numerical problems. It has not been the intention to write a general textbook on marine hydrodynamics. Neither has it been an intention to replace the Theory Manual or the Users Manual, where a more complete description of the theory and input data is found. It is our hope that the tutorial can give some additional advice to the user regarding practical use of SIMO.

The zip-file "SIMO_Tutorial.zip" contains the necessary files. The file may be downloaded from the SIMO web pages. Extract the files and double click on the file "SIMO_modellingTutorial.html" to run the tutorial.

4.2 System Description File generator – SysGen (deprecated)

Together with the release of SIMO 3.4.0, the utility SysGen was made available. The purpose of SysGen is to read hydrodynamic coefficients from WAMIT result files (wamit.out, wamit.1, wamit.4 etc.), calculate retardation functions and write all relevant data to a SIMO system description file.

The following data groups are written (if present on the Wamit result files):

- Mass data including added mass matrix (infinite/zero)
- Hydrostatic stiffness
- First order wave force transfer functions
- First order motion transfer functions
- Retardation functions
- Second order wave drift coefficients
- Hydrodynamic interaction between bodies
  - Coupled added mass data

- Coupled retardation functions

Note that the present version of SysGen does not write QTF data.

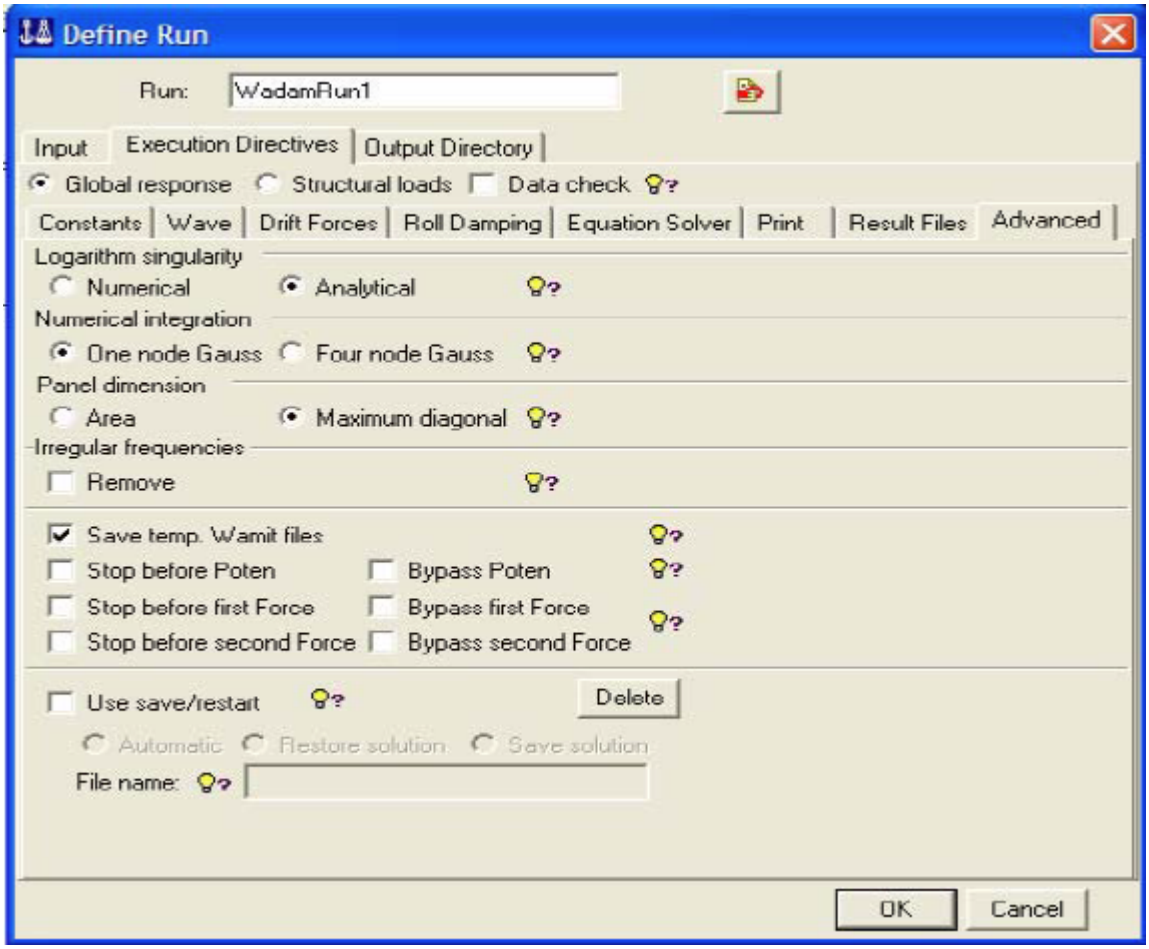
SysGen is run from a console window:

```
java -jar path\to\SysGen.jar wamit.out
```

Options:

```
-time_delay <dt> 'retardation function time delay' (Default 0.5)
-pressure        'drift force by pressure'
-info            'info messages'
```

SysGen requires a java virtual machine to be installed on your system. Virtual machines can be downloaded from http://www.java.com/. Please note that SysGen is beta software. The sys-file produced by this utility should be thoroughly checked. SIMO-INPMOD is the recommended tool for sys-file generation for cases where hydrodynamic interaction between vessels is not present. SysGen does not read sif-files from WADAM directly. As a work around for WADAM users that want to use SysGen, one may specify WADAM to export results to WAMIT. For more information, confer WADAM User Manual, DNV Software.



5 Run-time DLL

You might have to upgrade the FORTRAN dlls on your computer. If you get a system error message mentioning the file "DFORMD.DLL" run the dll install program "VFRUN66AI.exe" found on your distribution medium.

6 Work array size in DYNMOD and OUTMOD

The size of the DYNMOD and OUTMOD work arrays may be specified using the environment variable SIMO_MEM. The variables give the size in MB, i.e. 4 times the number of million words. The minimum size is 4 MB and the maximum size is 800 MB.

The default size of the DYNMOD and OUTMOD work arrays is 4 million words. This corresponds to specifying 16MB.

7 SIMO version number

SIMO 4.0 is the new official version of SIMO replacing SIMO 3.6 that was initially released in December 2007. The sub-version number is added to track corrections made to the version. Subsequent (bug fix) releases will be labelled 4.0.1, 4.0.2, etc.

The odd numbered versions, e.g. 3.7, 4.1, are reserved for internal development versions. The next official release will therefore be SIMO 4.2.

The version umbers 3.8 and 3.9 have not been used.

8 SIMO licensing

SIMO is license-managed using the FLEXlm / FLEXlnet software license management system. If you want SIMO to be usable from any networked computer on your site you must run a license manager on a server in your network. Alternatively, SIMO may be run on a single computer using a standalone license file.

In order to issue license keys for this license manager, MARINTEK needs the following info on your server:

- License type (server or standalone)
- Operating system and version (Windows 7, Windows XP, HP-UX and Linux currently supported)
- MAC address / FLEXlm hosted of the computer. Please see the section “Getting the FLEXlm HOSTID of a PC” in the SIMO FAQ.

Your IT-staff is probably already familiar with this procedure as FLEXlm is used by a large number of other applications (e.g. Matlab).