SeaSoft Version 6 Release Notes

The Version 5.x epoch of the SeaSoft Library has drawn to a close; a comprehensive "catch-up" to the release notes spanning that epoch is long overdue. The most profound single change since the previous formal release (Version 5.2) is the transition to a vastly more robust analytic treatment of the normal modes of low-frequency motion for Moorsim, SPMsim, Sparsim and TLPsim, along with exhaustive overhaul of all low-frequency forcing and damping models. The infrastructure required for the new normal mode analysis was complex and considerable, and resulted in several strategic "methodology do-overs" before the dust finally settled; the debugging of, and the quality assurance [QA] for that infrastructure impacted all areas of development, requiring a transition to a more suitable version control system, and development of an exhaustive set of QA test suites.

As always, details and discussions of recent changes (as yet unavailable in the user manuals) can be found in [1] each individual program's online help, and [2] the comprehensive "FAQ Library" at http://seasoftsys.com (also available at a lower-bandwidth backup site, http://seasoft.org).

A cumulative list of previous release notes (all available from the SeaSoft website "Documentation" area) follows:

Release_Notes [v 5.2x]
Release_Notes [v 5.05]
Release_Notes [v 4.32]
Release_Notes [v 4.20]
Release_Notes [v 4.14]
Release_Notes [v 4.07]
Release_Notes [v 3.95]
Release_Notes [v 3.90]
Release_Notes [v 3.60-3.89]

Recent Infrastructure Highlights

- Incorporation of a robust modern version control system ("VCS"; specifically, Linus Torvald's open-source "GIT"). Any SeaSoft version subsequent to version 5.0 can now be reproduced, with digital fidelity, at will.
- Development of multiple comprehensive databases of input files for use in automated testing, debugging and QA efforts.
- Exhaustive cross-platform compatibility efforts to ensure that Classic Mac (PPC), Mac OS X (PPC), Mac OS X (Intel), and Windows versions all play nicely together and permit cross-platform datafile import/export.
- Radical overhaul of SeaSoft's website, which now runs on a dedicated server under Apache and supports sophisticated batch operations with batch error reporting of individual simulation failures within a batch submission.
- We have been experimenting recently with post-processing enhancements to support third-party (e.g., Mathematica/MatLab) dynamical visualizations, for animation of normal modes and other dynamical processes; stay tuned.

Expanded Capabilities

- Assignment of numerical line/riser identifiers to supplement the legacy ASCII identifiers - [A = 1, B = 2, etc.].
- "B"atch option on the startup screen to permit unambiguous handling of toggle-type editor entries to permit batch execution operations.
- Mooring line/riser exclusion database for application of "inertial correction" to loads.
- Enhancement to user current profile specification (CURPROF.txt) to include current whose direction varies (e.g., spirals) with depth.
- Generalized user-specified mooring line/riser stress-strain specification database (LINE_STRAIN_DB.txt).
- Wave spectrum additions: Ochi-Hubble and TMA shallow water.
- Wind spectra enhancement: N.P.D. Spectral Evaluation Height option.
- Addition of a second, independent swell; now three completely independent wave systems can be modeled simultaneously.
- Comprehensive low-frequency vessel motions spectral output (LF_SpecDat.stxt); see relevant FAQ items beginning here:[http://seasoftsys.com/FaqFrame2.html#265].
- Mooring/riser nodal motions capability; useful in several contexts, including comprehensive analysis of mooring line "trenching" around suction piles (Node_Motn.stxt); FAQs here: [http://seasoftsys.com/FaqFrame2.html#266].
- Slowsim: Many extensions and improvements to spectral data options, including spectra at both [fixed vessel angle, variable frequency] & [variable vessel angle, fixed frequency].
- SPMsim option to lock the turret to include development of mooring moments as the vessel swivels.
- Improved handling of single-line moorings for SPMsim.
- Double precision handling of equilibrium search for TLPsim.
- Towsim: Improvements to generalize towing track in any global direction against a fixed environment.
- XCLDAT RMS and peak variable updates: Green Water variables (e.g., "air gap" vessel-relative crests and troughs); mooring centroid acceleration variables; mooring/riser nodal endpoint load and motion data.

Modeling Improvements

- Normal mode low-frequency overhaul for all simulations eliminates historic analytical simplifications and leads to vastly improved LF dynamical modeling in highly crossed environments; many FAQs relate to these changes, see for example: [http://seasoftsys.com/FaqFrame1.html#9019].
- Preservation of and enhancements to "Legacy" normal mode processing, which capability remains as a back-up option. Also, useful for exploring the effects of the new normal mode processing on legacy simulation runs.
- Elimination of a class of equilibrium finding failures in Moorsim arising from numerical lock-in loops during equilibrium search.
- Improvement in hull added mass estimates for all vessel types (ship/buoy/semisubmersible).
- Improvement in round ship/buoy handling of keel/skirt added mass and damping.
- Improvement in "broken line" database handling.

General Improvements

- Complete symmetrization of "Wind waves" and "Swell" spectral options; "Swell" can now be assigned any spectral form available to "Waves", and vice-versa.
- Introduction of more granular version tracking has been implemented; all builds, even unreleased builds, now get a unique version/build number (historically, SeaSoft version number changes have been subjective and at times inconsistent).
- Requests for "Spectral estimates for standard deviations" and "Node Loads & Motions" are mutually incompatible and should be avoided; a runtime alert is issued to warn of this combination.
- Internal script documentation capability for DOS shell (Windows) and BASH shell (Mac OS X) "batch" execution scripts has been implemented.
- Scratch files (LINEANG, FAIRMOT, etc.) are now deleted at simulation termination.

Web Site Developments

If you have not checked out the web site (http://seasoftsys.com), you should make a point to do so. Free access to website-hosted simulations is available to anyone with a support license requesting an on-line account. The FAQs have recently been massively re-worked; the volume of FAQs has nearly doubled and they now form an integral part of the documentation. They are downloadable and easily searched locally on your desktop system for keywords using search tools of your choice. (The full Technical FAQ document can be found at http://seasoftsys.com/FAQframe2.html).

There are also new sections and FAQs covering "Batch" submission of simulation datasets for processing, access these from the "FAQ Library" link on the home page. Batchfile Submission Guidelines are here: http://seasoftsys.com/batch_intro.html. Some useful website-interface FAQs are here: http://seasoftsys.com/Web_FAQ.html

QA Test Database Developments

Considerable effort has gone into the development of multiple comprehensive databases of input files for use in automated testing, debugging and quality assurance (QA) efforts. The development of large standardized databases, which are now used in automated QA testing, should reduce reports such as: "the new release fails to run some of my old data files" and similar problems. These new databases are also very effective in eliminating the *introduction* of bugs during the development process as new features are added. The databases presently comprise well over a hundred distinct simulation cases which can be executed in batch with automated comparison of output streams across different versions.

One of these new test databases employs a kind of "Monte Carlo" strategy to deal with the stupendous number of unique paths through the code (over a googol = 10^100; by comparison, there are by some estimates ~ 10^88 electrons and protons in the observable universe). The idea here is to use a collection of real-life data files from various users, all of whom employ the simulations in different ways and have their own peculiar set of input preferences. This is a sort of "randomly produced file" strategy, only it comprises individual simulation scenarios using random (but rational) engineering objectives dictated by humans. The usefulness of this process relies on the expectation that the input parameters in any human-prepared simulation has undergone extensive troubleshooting by the user, so that the simulation parameters (moorings, environments, etc.) can be expected to reflect a physically realizable and environmentally sensible configuration. This self-selection of "interesting" cases eliminates a mind-boggling subset of the parameter space that would be included by a true "Monte Carlo" exploration but that represents excruciatingly improbable or physically impossible systems and parameter values.

Other databases comprise symmetry-verification suites of datafiles which employ azimuthally symmetric systems to facilitate testing for symmetry-breaking bugs introduced during code developments or enhancements.

Yet other "quick-check" databases comprise smaller collections, such as the "Demo" data files that are part of SeaSoft's WebSite demonstration packages; these databases are used primarily for quick, automated testing across all simulations during development to identify "fixes" that produce unexpected and undesired failures.

The database development is an ongoing effort; data files are added over time, usually because they involve new (i.e., previously untested) problematic paths through the code.

R&D Efforts Discussion

Low-Frequency Wave Drag & Wave Drift (a.k.a. "Wave Absorption", "Wave Dissipation", "Wave Reflection") Efforts

This release culminates several years of basic research and development focussed primarily on low-frequency dynamical analysis, comprising a fundamental theoretical treatment of "wave drag" forces (a.k.a. "wave absorption forces"; see Release_Notes of Mar_04) on surface-piercing cylinders and a comprehensive rework of low-frequency normal mode damping and excitation arising from these effects. This analysis includes a robust analysis of the interplay between these forces and any underlying mean current.

The "wave drag" developments impact principally Moorsim/Sparsim/TLPsim (this trio of simulations is referred to as "MST" below). In particular, these new drag-related developments relate only to semisubmersible-type vessels (semis, spars and TLPs). The underlying "wave drag" model for shipshapes has not been fundamentally overhauled in this release (although there have been bug fixes). Unlike the semi-type treatment, the shipshape treatment remains limited to zero current speed, which means it will generally underestimate wave drag effects (mean forces and LF excitation), especially in aligned wave-current conditions. Correcting that deficiency for shipshapes remains a relatively high priority.

Also revised: The built-in wave drift forcing model (a.k.a. "wave reflection" forcing) of the same class of vessels (i.e., semi-type).

Low-Frequency Model Efforts; expanded discussion

In addition to the pure wave-related low-frequency research and modeling efforts, the underlying physical and analytical models of low-frequency normal mode damping and excitation have been extensively reviewed, overhauled, and improved; these changes benefit, in addition to MST: SPMsim, SALMsim and Towsim. As most of these changes relate to low-frequency dynamics modeling, there have been relatively few changes, aside from bug fixes, to the statics and wave-frequency modules (Catsim, Statmoor, Shipsim, Semisim, Discsim).

Damping and Excitation arising from square-law processes: A comprehensive rework of low-frequency damping and excitation from wind and current.

In addition to the overhauled normal mode dynamical analysis, there has been a complete overhaul of low-frequency normal mode excitation and statistical measures (e.g., RMS and most probable peak) fairlead low-frequency motion amplitudes in strongly crossed environmental conditions. The legacy treatment incorporated a number of approximations and simplifications that have been removed, producing a more robust estimate of LF fairlead motions and their associate LF line load variations.

Partial Bug Extermination List

Note: Most bugs survive testing because they lie on rarely-accessed paths through the code, which is why they can sometimes hide, undetected, through multiple version updates. Accordingly, only a few of these bugs, and perhaps none at all, will impact any particular configuration of vessel, moorings and environment.

- General
  - Bug in "LINE_STRAIN_DB" processing.
  - Bugs in Node-Load & Excluded line capability.
  - Bug in yaw contribution to LF line load variability.
  - Bug in excluded/broken line implementation of LF damping from WF line motions.
  - Bug in API wind spectrum implementation.
  - Multiple bug fixes for peak factor estimates.
  - Bug in inertial correction to mooring line & riser loads at fairlead.
  - Bug: Production of interpolation tables when tables declined by user selection.
  - Bug in assignment of anchor-fairlead heights in the presence of vessel heel/trim.
- XCLDAT
  - Bugs in moonpool and bow-relative water level fluctuations.
  - Bug in API peak load algorithm.
  - Bug in net LF vessel loads.
  - Bug in minimum line loads at intermediate nodes when node-loads requested.
  - Bug in reported mean and variable vessel forces (LOWOUT & XCLDAT): incorrect coordinate system used.
  - Bugs in minimum line load estimates.
- RANOUT
  - Bugs in node load evaluations, in particular when inertial correction became excessive.
  - Bug in low-frequency line load variations.
  - Bug in bottom friction correction.
  - Bug triggered by azimuthally spread seas when the "spectral estimates for standard deviations" option was selected.

- LOWOUT
  - Multiple bugs in low-frequency wave & swell drag damping estimates, including an erroneous factor of 2.
  - Bugs in swell processing when secondary to unaligned waves.
  - Asymmetry bugs in swell & wave handling related to wave drag.
  - Bug in stillwater damping estimates (SPMsim only).
  - Bug in transformations required for user-supplied vessel forces and moments.
  - Bugs in current-mediated mooring line & riser drag forces and damping.
  - Bug in rotational transformation for RMS and peak load values from vessel to normal-mode coordinate system.
  - Bug in ensemble extreme motion and load estimates.
  - Bug in LF damping from WF line motions.
  - Bug fixes in low-frequency system damping from moorings & risers due to [1] square-law quasi-static line motions and [2] wave-frequency line motions.
  - Improper handling of broken line contribution to low-frequency damping produced by wave-frequency fairlead motion.
- Catsim, Sparsim & TLPsim
  - Bug in minimum anchor tensions.
  - Bug in peak factors for tendon/riser tensions.
  - Bug in crossed environment damping, wave drag.
  - Bug relating to large user-supplied yaw moments.
  - Bug in INPUTOFF.txt processing (Catsim only).
  - Bug in hydrostatic moment corrections due to improper rotations into Global system.
- Wave-frequency vessel motions (Shipsim, Discsim, Semisim)
  - Serious pitch/roll moment bug affecting primarily the roll response of low-stability (long roll period) shipshapes.
  - Minor pitch/roll bug for semisubmersibles & spars.
  - Phase-related bug in relative vessel-water particle RAOs used in wave drag damping estimates.
  - Bug in natural period estimates loop & equivalent draft estimate (Discsim).
  - Bug in skirt added mass estimate (Discsim).

- Bug in semisubmersible editor member rotation option (Semisim).

• SPMsim

  - Error in moment arm applied to fairlead motions; bug in rotations required for RMS motion/load transformations.

  - Bug in low-frequency wave damping of yaw.