# Developer’s Guide to FAST v8.00.00a-bjj

Bonnie Jonkman  
National Renewable Energy Laboratory  
April 2, 2013

This document is designed to help guide you through some of the changes that FAST is undergoing. FAST v8.00.00a-bjj is the first release of FAST under the new modularization framework developed at NREL. Many features of FAST v7.02.00 have not yet been added to this version. FAST v8.00.00a-bjj is a work-in-progress, and is intended for software developers only. If are not developing software for the new FAST framework, we *strongly* suggest you download and use [FAST v7.02.00d-bjj](http://wind.nrel.gov/designcodes/simulators/fast) instead.

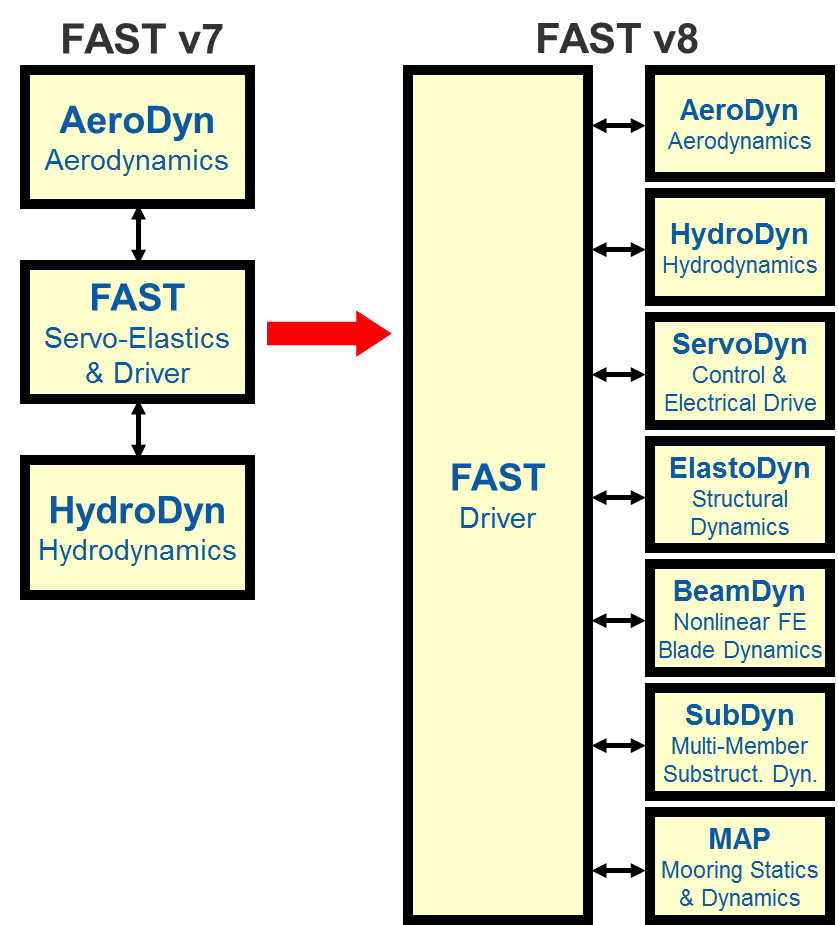


Figure 1: Architectural Comparison of FAST 7 and FAST 8 (figure courtesy of Jason Jonkman, NREL)

## Major changes in FAST v8.00.00a-bjj

The former software called “FAST” has been split into three pieces of software, following the [FAST modularization framework](http://wind.nrel.gov/designcodes/simulators/developers/):

1. ElastoDyn models the structural dynamics portion of the code.
2. ServoDyn models the controls and electrical drive portion of the code: pitch control, yaw control, and torque (electrical generator torque, instantaneous high-speed-shaft brake torque, and electrical power).
3. FAST—the driver (glue code)—couples all of the modules together. It controls the overall simulation progress, mapping inputs to outputs.

FAST v8.00.00a-bjj compiles with the following modules:

|  |  |  |  |
| --- | --- | --- | --- |
| Module | | Version | In FAST Framework? |
| ElastoDyn | v1.00.00a-bjj | | Yes |
| ServoDyn | v1.00.00a-bjj | | Yes |
| AeroDyn | v13.00.02a-bjj | | Not this version |
| InflowWind | v1.01.01a-bjj | | Not this version |
| HydroDyn | v1.01.02a-bjj | | Not this version |
| NWTC Subroutine Library | v2.00.00c-bjj | | Yes |

ElastoDyn, ServoDyn, and FAST have their own input files; see Figure 2 and the section “Converting from FAST v7.x to FAST v8.00.x” of this document. Please do not attempt to modify your input files for HydroDyn v1.01.02a-bjj. Work on a new version of HydroDyn has been completed, and we will modify the FAST glue-code to use that version (with very different input files) in the near future.

## Limitations

We are working to add the features of FAST v7.02.00d-bjj into the new FAST framework. This list contains the features that are not yet implemented, or are implemented in FAST v8.00.00a-bjj but not in the framework:

* No hydrodynamics
* No earthquake excitation
* No furling
* No gearbox friction
* No tip or HSS brakes
* No noise
* No linearization
* No FAST-to-ADAMS preprocessor
* No Simulink or LabVIEW interface
* User-defined routines not yet in framework
* MulTabLoc is no longer available for AeroDyn
* AeroDyn and InflowWind modules need further work …

## Future Work

* AeroDyn has been converted to the new framework, but needs to be linked into FAST v8.
* InflowWind has partially been converted to the new framework, but needs to be linked into FAST v8.
* The new SubDyn module needs to be incorporated into FAST v8.
* The glue code will be updated with a better coupling scheme, without lock-step integration.
* ElastoDyn will have a separate discretization scheme (currently uses AeroDyn’s).
* Items from the “Limitations” section will be addressed.
* And much, much, more…

## Converting from FAST v7.x to FAST v8.00.x

We have created template input files for FAST v8.00.00a-bjj, ElastoDyn v1.00.00a-bjj, and ServoDyn v1.00.00a-bjj. These template files can be found in the Matlab Simulation Toolbox that is now included in the FAST archive: Utilities\SimulationToolbox\ConvertFASTVersions\TemplateFiles\V8.00.x\

### Summary of Changes to Inputs

* The primary FAST input file has been converted to primary input files for FAST, ElastoDyn, and ServoDyn and some of the inputs have been reordered
* The FAST Platform file has been eliminated, with some of the inputs now part of the ElastoDyn primary input file and some of the inputs now part of HydroDyn’s input file
* All of the inputs formerly labeled “[CURRENTLY IGNORED]” have been removed
* Switches for ADAMS preprocessing and linearization have been removed
* Noise has been removed
* PtfmLdMod has been converted to CompUsrPtfmLd
* TwrLdMod has been converted to CompUserTwrLd
* The tip brake inputs have been removed
* PtfmCM is now PtfmCMzt, with PtfmCMzt = -PtfmCM
* Corresponding inputs PtfmCMxt and PtfmCMyt have been added
* The output decimation factor (DecFact) has been converted to DT\_out (DT\_out = DT\*DecFact)
* The yaw and pitch maneuvers no longer specify end times for the maneuvers. Instead they specify a rate for the maneuver
* The GBRevers variable has been removed; input GBRatio must now be specified as a negative number if GBRevers was previously set to TRUE
* ElastoDyn’s blade input properties table no longer specifies AeroCent. Instead, it specifies the location of the pitch axis, PitchAxis, which is calculated as PitchAxis = 0.5 – AeroCent; the aerodynamic center will become part of AeroDyn in a future release
* The OutList variables have been divided among the various FAST modules, and several outputs are no longer valid.

### Matlab Conversion Script

Because the changes to the input files are significant, we have created Matlab scripts to automatically convert FAST v7.x input files to FAST 8.00.00a-bjj input files. The files you will need are included in the Simulation Toolbox, located in this directory of the FAST archive: Utilities\SimulationToolbox\ConvertFASTVersions

We recommend that you add the Simulation Toolbox to your Matlab path so that you can access all of the routines defined in it:

FASTSimulationToolbox = 'C:\Users\bjonkman\FAST\UtilityCodes\SimulationToolbox';

addpath( genpath( FASTSimulationToolbox ) );

An example showing how we converted the NREL CertTest input files for use with FAST v8.00.00a-bjj is included in the FAST archive: CertTest\ConvertFiles.m. You can use this script as a basis for helping to convert your own input files; however, we *strongly* recommend that you make copies of all your input files before running any scripts to convert them.

You will need to provide the conversion routine (ConvertFAST7to8) with the name of the old FAST (v7.x) primary input file and the directory where the new input files should be placed. *The new directory should not be the directory where the old files are located!*

If your input file has pitch or yaw maneuvers, you may also provide the routine with the new rates (instead of the end times previously used). We have also provided a Matlab routine (CalculateYawAndPitchRates) that will calculate these rates, but you must provide the routine the name of the FAST output file that contains the previous results of the Pitch and/or Yaw channels.

### Model Time Steps

Please note that due to some of the changes in the coupling scheme of FAST v8, you may need to change the time steps in your existing models. (Currently, we use lock-step coupling, so ElastoDyn, ServoDyn, and FAST must have the same time step.) For example, we have noticed that the NREL 5-MW Baseline model must use a much smaller time step.

## Compiling

If you want to compile the code, please see the compiling folder in the FAST archive for a *makefile* or Windows® batch script containing the list of files that are needed. Please also pay attention to the compilation switches used there (you will need to add an option for pre-processing the source files so that the NWTC Library will compile).

The \*Registry.txt files are input files for the FAST Registry. These files are used to generate the \*\_Types.f90 files for the component modules (i.e., ElastoDyn and ServoDyn).

Note: the current version of the Registry (Rev276) contains a bug, forcing the developer to manually remove unbalanced parenthesis in the ElastoDyn\_Types.f90 file’s ED\_Input\_ExtrapInterp routine for all the input variables that have 3 array dimensions. This routine also requires the /assume:realloc\_lhs compile switch available in IVF 12 (or another manual change to the ED\_Input\_ExtrapInterp routine).

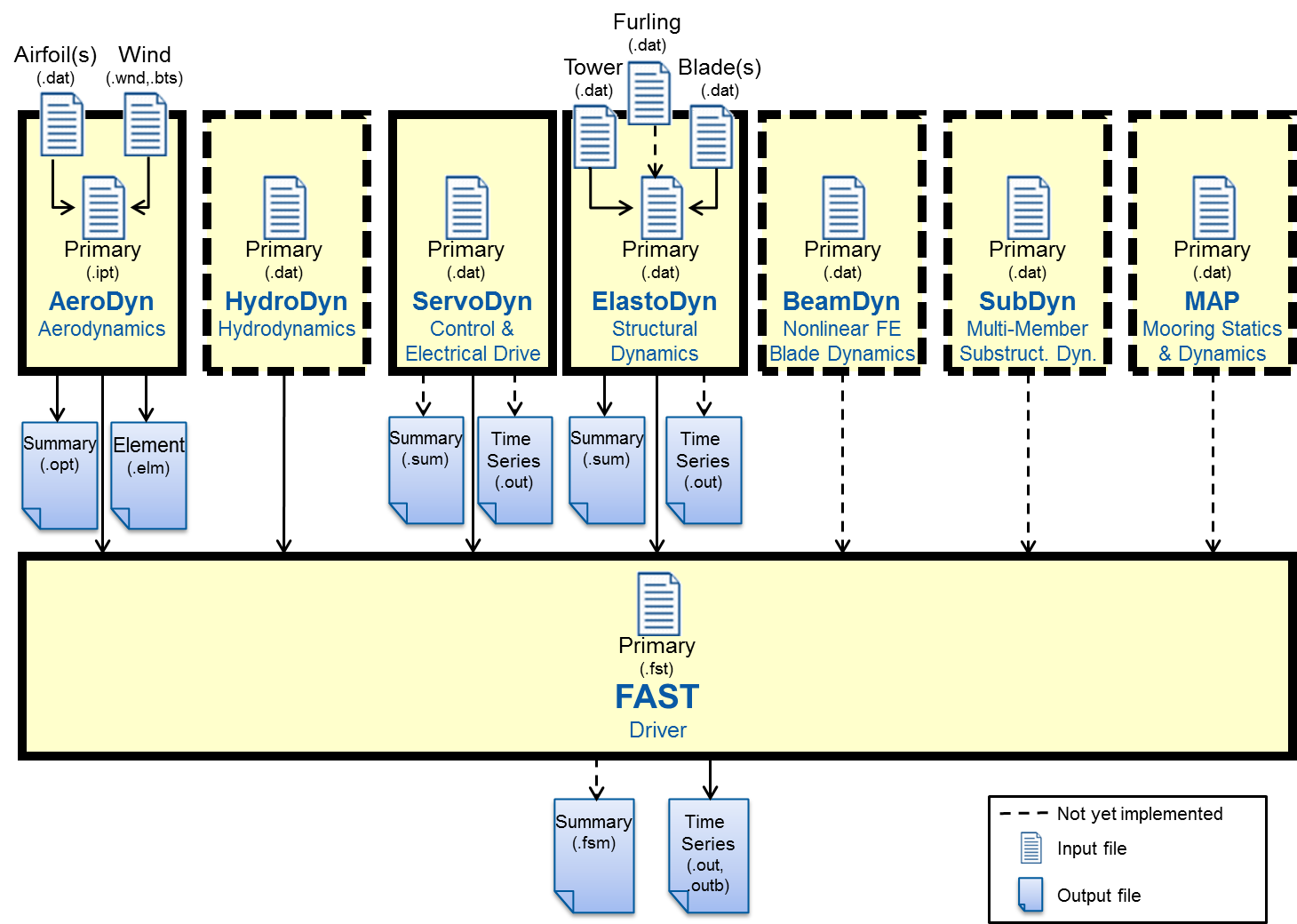


Figure 2: Summary of Input and Output Files for FAST v8.00.00a-bjj