Integrating FAST with Digital Prototyping Tools for Offshore Wind System Design

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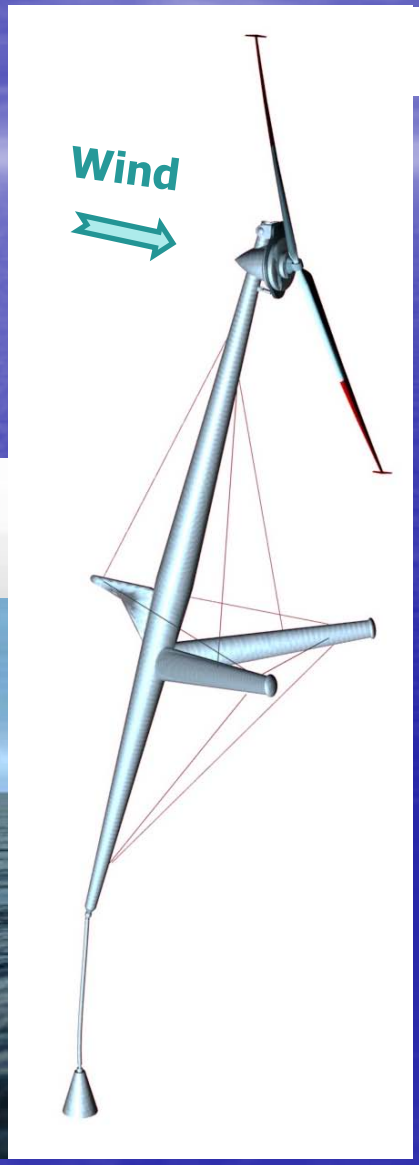
Future Turbines May Be Different

Advanced Floating Turbine (AFT)

Nautica WINDPOWER



Design / Benefits

Two Flexible Blades
- Increase Reliability
- Larger Diameters & Energy Capture
- Reduce Loads/Weight/Costs

Downwind Rotor, Angled Tower
- Reduces Blade/Tower Impact Failures
- Aligns Without Yaw System
- Optimizes Strength & Reduces Noise

Single Mooring Point
- Simplifies Installation & Removal
- Reduces Anchor Costs
- Minimizes Seafloor Impact

Buoyant Tower w/o Ballast
- Assembles at Port & Floats to Site
- Self Raises without Cranes at Sea
- Lowers for Maintenance or Repair

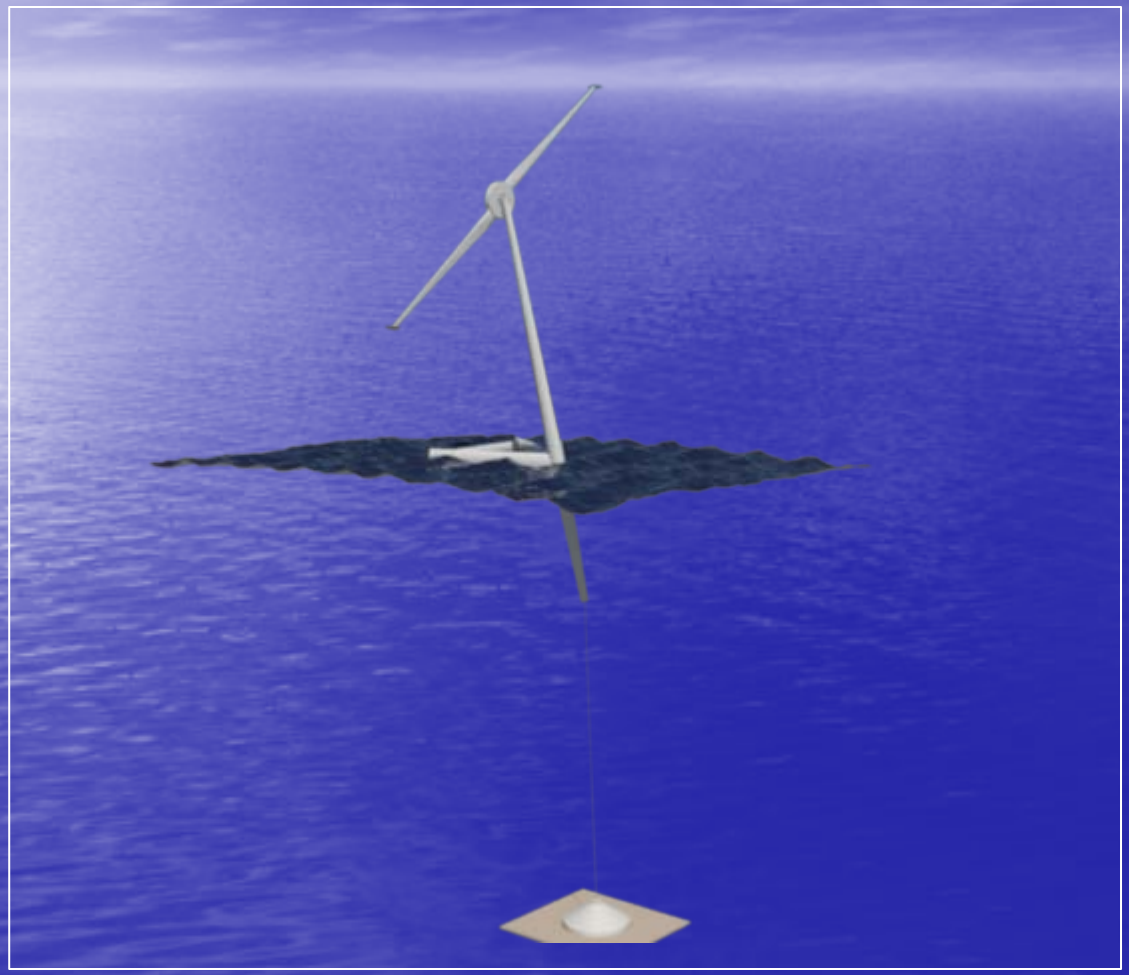
CAE & Digital Prototyping

Key to reducing technical risks & development time for future offshore turbines

- Correctly modeling dynamics of normal operation & extreme conditions such as hurricanes and tsunamis
- Insuring controls & mechanical systems work correctly under loads
- Reducing the design cycle by integrating finite element based stress analysis
- Enabling more complex & asymmetric designs
- Validating offshore deployment methods

Preliminary Digital Prototype of AFT

Nautica's Virtual Offshore Turbine Environment (VOTE)



Time Domain Based

Structural Dynamics

- **Multi Rigid Body**
- **Arbitrary 3D Geometry**
- **Elastic Mooring**

Fluid Dynamics

- **Free Surface**
- **Various Wave Models**
- **Smoothed Particle Hydrodynamics option**

Aerodynamics

- **Prescribed Forces**
- **Planned FAST-based**

Servo/Controls

- **Flexible Algorithms**

Use and Verification

- **Concept Design**
- **To be compared with FAST / WAMIT**

Concluding Comments

- Time domain based CAE tools are needed to correctly integrate the nonlinear character of structural / fluid / control dynamics for offshore wind turbines.
- These tools should accommodate complex geometric models from commercial CAE/CAD tools
- Thanks to NREL and all of you working on this important engineering model development
- Thanks to DOE for providing the vision, direction and funding of this effort