OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY
FACT SHEET

ESTD
Engineering Science & Technology Division

ROBOTICS AND ENERGETIC SYSTEMS RESG GROUP

Controls Modeling and Simulation (Virtual Prototyping)

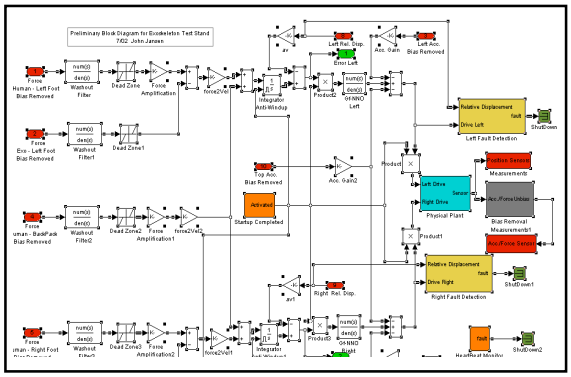
Integrated Approach to Sensing, Controls, Actuation, and Structures to Achieve Advanced Capabilities in Robotics and Energetic Systems

Technology Need

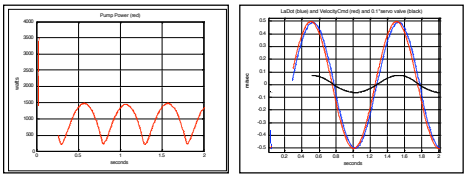
Ability to model and simulate (virtual prototyping) complex systems to allow for trade-off analysis and performance evaluations prior to building hardware.

Virtual Prototyping

- Integrated systems approach
  - As opposed to an "over the wall" approach
- Unique analysis and modeling tools
  - Geometric
  - Stress
  - Dynamic Behavior
  - Sensing and controls element modeling
  - Controls simulation
  - Non-linear elements and phenomena (e.g., hydraulics, temperature, compliance, backlash, etc.)
- Tools – virtual prototyping of novel systems with advanced performance specifications
- Leads to systems with cutting edge performance



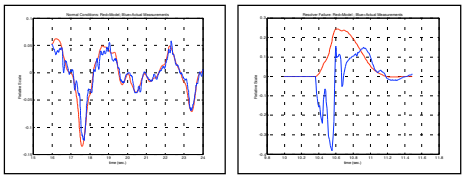
Exoskeleton test stand block diagram.



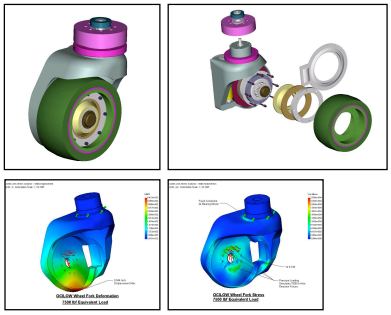
Simulation of hydraulic system
(power requirements and system response).

Unique M&S Tools to Predict System Performance

- Frequency domain-based methodology
  - Significant role of bandwidth and natural frequency on mechanical design a frequency domain
  - Allows modeling of non-linear phenomena
  - Provides way to predict system performance
  - Developed relationships between hardware and system performance
    - Hardware: fluid-based actuators, structural links, joints, servo valves and other controls elements, fluid transmission systems, etc.
    - Non-linear phenomena: deflection, fluidic elasticity, stiction, backlash, orifice effect, etc.
- Trade-off analysis through design and systems integration phase
- Predict system performance prior to committing to hardware



Fault detection - simulation and actual data
(normal operation and sensor failure).



System and component analysis
(deflection and stress analysis).

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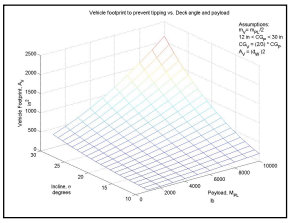

Parametric analysis.

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