USING SYSTEMMODELER AND MATHEMATICA TO RAPIDLY BUILD HARDWARE CONTROL SYSTEMS

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AC Kinetics
WHO IS AC KINETICS?

- INDEPENDENT ENGINEERING AND MOTION CONTROL DESIGN AND DEVELOPMENT COMPANY – ARMONK, NY
- MIT-TRAINED PHD SCIENTISTS, ENGINEERS AND DEVELOPERS
- TWENTY-FIVE YEARS OF EXPERIENCE DEVELOPING MACHINE AND VIBRATION CONTROL SOFTWARE
AC KINETICS EXPERIENCE

HISTORY OF SOFTWARE COMMERCIALIZATION, DEVELOPMENT, AND LICENSING (SINCE 1990)

- Residual vibration reduction – motorized equipment
- ‘No-sway’ crane control
- Hard drive read/write seek times and acoustics
- Developed proprietary non-linear optimization technique
- Developed AC induction motor control that saves energy
- Entered into a joint development agreement with Koch Industries
LICENSEEES OF PREVIOUS SOFTWARE

USED IN HUNDREDS OF MILLIONS OF MACHINES AND APPLICATIONS WORLDWIDE

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OVERVIEW

- USAGE CASE: DEVELOPING, TESTING, AND VERIFYING REAL-TIME SOFTWARE IN SYSTEMMODELER
  - AC KINETICS MOTOR DRIVE HARDWARE
  - MODELING THE AC INDUCTION MOTOR SYSTEM
  - USE OF SYSTEMMODELER/MODELICA
  - VERIFICATION OF FIELD DATA AND SIMULATION DATA
OVERVIEW (PART 2)

- NEW MATHEMATICA/WSM FUNCTIONALITY ENABLES
  - ADVANCED ANALYSIS
  - PROGRAMMATIC MODEL CONSTRUCTION

- SYSTEMMODELER (WSM) AND MODELICA ARE GREAT AT MODELING SYSTEMS

- WSM IS MOSTLY A SIMULATION PACKAGE

- MATHEMATICA ENABLES SYMBOLIC ANALYSIS AND PROGRAMMATIC CONTROL
CASE STUDY - HOW AC KINETICS USES WSM/MODELICA IN ITS WORKFLOW
USAGE CASE 1: DEVELOPING, TESTING, AND VERIFYING REAL-TIME SOFTWARE IN SYSTEMMODELER
VERIFYING C CODE

Verify

SystemModeler

AC Kinetics C API

Run in Simulation

Test

Hardware Drive

Run in Hardware
SYSTEMMODELER MODEL
DISPENSED TOWEL WINDER TESTING

PAPER MILL (SAVANNAH RIVER) - HAND TOWEL (MAIN DRIVE)

- Configured a motor and load to replicate the winder in a NIST-certified laboratory including the large inertia of winder’s main spindle (60HP motor, 92.4% eff)
- Completed lab tests utilizing field-measured torque and speed profiles
- ACK compared to existing production drive on normal hand towel winding operation (including...
HAND TOWEL WINDER CONFIGURATION

MAIN PAPER ROLL SPINDLE (60HP) FINISHED PRODUCT ROLLS

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60HP TOWEL WINDER - VELOCITY PROFILE

DYNAMIC LOAD (CHANGING PAPER ROLL DIAMETER)

SOURCE: ACK / GEORGIA PACIFIC FIELD TESTS - PRODUCTION WINDER DATA
60HP TOWEL WINDER EFFICIENCY
NEW DRIVE ECONOMICS (INCREMENTAL)

ANNUAL MOTOR POWER COST
(350 DAYS,$0.06/KWH):
$4,900

COMBINED EFFICIENCY GAIN:
49%

ANNUAL SAVINGS:
$2,400

SOURCE: ADVANCED ENERGY CERTIFIED TESTS - RALEIGH, NC
WINDER MOTOR (60HP)

30-MINUTE MACHINE PROCESS CYCLE

ADDITIONAL BENEFITS OF ACK SOFTWARE:

- REDUCED HEAT DISSIPATION
- LOWER MOTOR OPERATING TEMP

SOURCE: ADVANCED ENERGY CERTIFIED TESTS - RALEIGH, NC
CASE STUDY 2- USING WSM/MODELICA TO MODEL A SYSTEM AND USE MATHEMATICA TO DESIGN A CONTROLLER
USING NEW WSM-MATHEMATICA FUNCTIONALITY FOR A BETTER WORKFLOW

- QUICKLY CREATE A MODEL IN WSM/MODELICA
- EXTRACT THE EQUATIONS OF MOTION FROM A MODELICA MODEL
- USE THE EQUATIONS OF MOTION
  - CONTROLLER DESIGN
  - ANALYSIS/INSIGHT
  - LOAD CONTROLLER INTO SYSTEMMODELER
MMA/ WSM DEMONSTRATION
QUESTIONS?

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