



## Wind Turbine Trainer

The Wind Turbine Trainer by Lotus Creative Innovations, LLC. is the premier product to teach most aspects of automation and controls with the focus on wind energy. The engineer behind the design is Ashish Gavali, a graduate of Iowa Lakes Community College. Ashish has wind experience from the factory to the field as both an engineer & technician. The motivation for designing this trainer was realizing the lack of skills of many current wind technicians in the industry. Today's wind turbines require a much higher level of knowledge than the previous generation. Techs must understand the fundamentals of analog and digital signals, industry standard ladder logic programming, instrumentation, finally signals and their analysis for troubleshooting. This trainer mimics real world applications that go beyond just wind energy. The Wind Turbine Trainer is truly “designed by technicians for technicians”.

The Wind Turbine Trainer comes as a kit form. Its unique design is **better** than an actual scaled down version of a wind turbine. All of the important working components and sub-systems are present. The handheld remote control offers finite control of the trainer, yet the limits of the design are almost infinite. The power requirement is a standard household outlet available just about anywhere, yet produces industrial signals that are completely safe. The “stubby” blades, battery backup & rolling chassis offer unrivaled portability, you don't even need a classroom. The hub is designed so students can fit their hands inside the hub and all of the working parts without any challenges. We estimate that each trainer can have 3 to 4 students working on the trainer in each group. Two students can work on the nacelle portion while another two on the hub section. Objectives include physical assembly, following schematics, wiring, termination, tests like short circuit and continuity, PLC communicating, programming and troubleshooting. Ultimately the goal for the students is to fully commission the wind turbine trainer (not as simple as it looks!).

### **General Specs & Dimensions:**

- Height (to top of blade) 6'8" (80")
- Minimum clearance for operation is 6' diameter circle
- Weight approx. 175 lbs.
- Blade length from hub center: 2'
- Maximum rpm is approx. 20rpm
- Safety Features: swivel/brake locking casters, maximum system voltage 28 v.d.c., generator output <1 volt p-p phase to phase (ideal for safely porting into a PC).
- Power input/consumption: 1 single phase 120 vac outlet, approx. 150 watts @full power



## **Components & Features:**

- Variable speed drive motor w/PWM: simulate all wind conditions
- Clear, dry-run gearbox/generator for easy visibility (supplied by Andymark Robotics)
- Gearbox can be set up for step up, step down, and pass through with gear change
- 3 phase P.M. Generator- low voltage delta (for safety)
- Fully functional 360 degree pitch and yaw system
- Fiberglass Blades- “cut off” for easy workability
- Locking casters: easy portability and stability, rolls out of the way
- Clear nose cone & nacelle cover: easy visibility and safety ( safety glasses should always be worn)
- Dual mode power: can run on batteries (at reduced run time)
- Unique exploded view yaw bearing system (non-slewing)
- Double slipring system: non-binding rotary contacts, endless yaw capabilities
- Sliprings have extra wires for expandability into nacelle and hub (power, comms & signals)
- Simple, streamlined control system: 12 ch. RF transmitter, PLC with I/O card to relay board, and communications cables
- Digital encoders: single channel on gearbox/gen, dual on pitch & yaw motors
- Digital sensors: inductive proximity sensor for hub speed, photosensors for pitch “home” calibration
- Allows diagnostics & troubleshooting via signals and analysis
- Spring applied pitch brakes: simulates real world equipment, allows instruction in on/off delay circuits (may be replaced with LED module)
- Expandable Directlogic PLC includes LCD display, ladder logic programming software and communication cables to run trainer in real-time
- System includes data logger and oscilloscope software to view analog/digital signals in real-time
- Multiple camera system with DVR software for maximum impact training
- Variable angle locking flip panel for ease of wiring and troubleshooting
- Made in the U.S.A.: durable PVC plastic, Lexan and 6061 aluminum

### **Possible classes of instruction with Turbine Trainer**

General, technical and college physics

Vectors and phasors, moment, torque, HP, EMI & RFI, electrostatics and lightning, electromagnetism, mass, inertia and momentum, gyroscopic forces, levers, torque, moments of inertia, mutual induction

Units of measurement ,conversion and word problem calculations (rad/s to MPH)

## Ac/dc electricity

Circuit analysis, micro-controllers, solid state electronics, 3 phase power, power rectification, diodes, LED's, ripple frequency, wiring, fusing, digital signals, position feedback, open voltage vs. loaded

## Industrial electricity

Motors and controls, practical wiring, PLC programming, test measurement tools, power electronics, signals and analysis, instrumentation, practical schematics reading, 3 phase delta to Y transforms, transformer action, step up , step down and isolation, relay logic, capacitance, inductance and phase shifting

Grid frequency, generators, power inversion/conversion , ADC and DAC , analog and digital signal conversion, synchronous speed, sub-synchronous and super synchronous, logic flowcharting, electrical troubleshooting, OSHA topics, HV and arc blast training, pulse width modulation

## Industrial maintenance

Powertrain systems, gears and ratios, gearboxes, gear torsion, gear backlash and mesh frequency, planetary and parallel shaft gearbox, chain and sprocket power transfer, power coupling, torque and tension, metallurgy, lubrication, rotary unions, generator loading, yaw systems, pitch systems

## Airfoils and fluid dynamics

Wind measurement systems, Bernoulli effect, vortex shedding, airfoil lift, drag, and eddy currents.

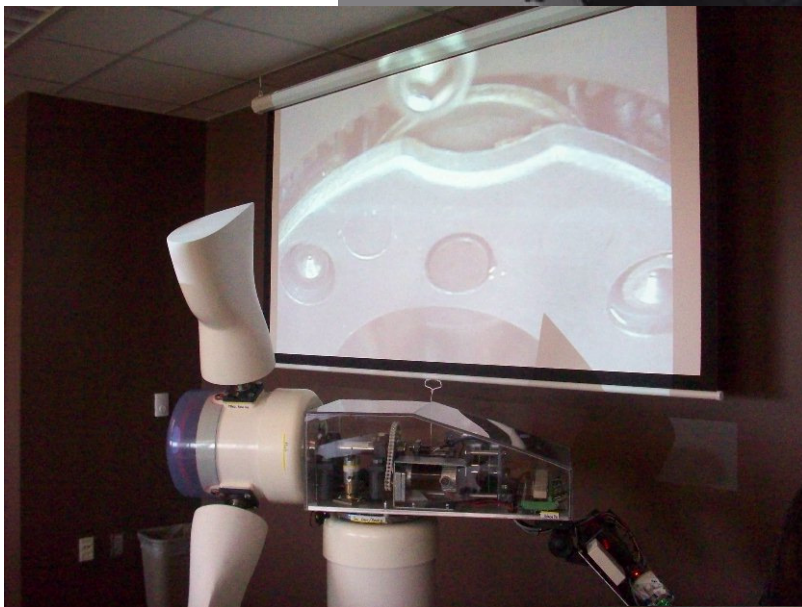
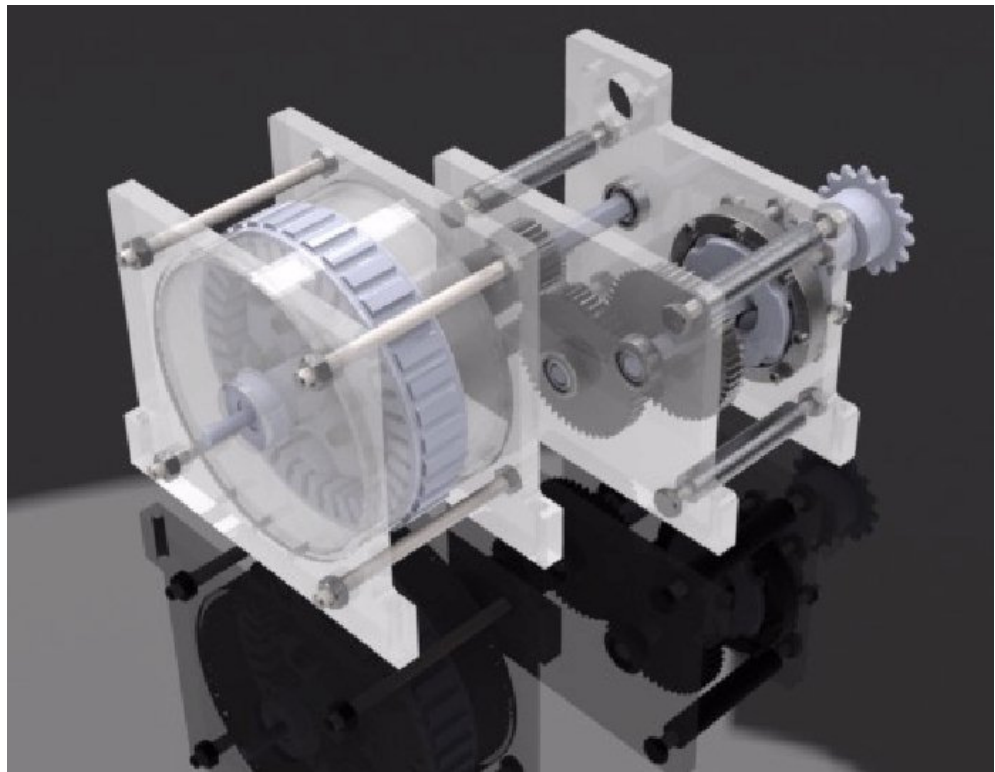
## SCADA systems

Vibration measurement, data logging and analysis, remote monitoring, radio frequency broadcasting, CCTV monitoring

## Turbine commissioning

Wind siting, blade change out, terminal interfacing of sub systems, short circuit testing, routing, crimping, soldering, terminating, cont. & cross short check, schematics, RS-232 (and other) connections, networking.

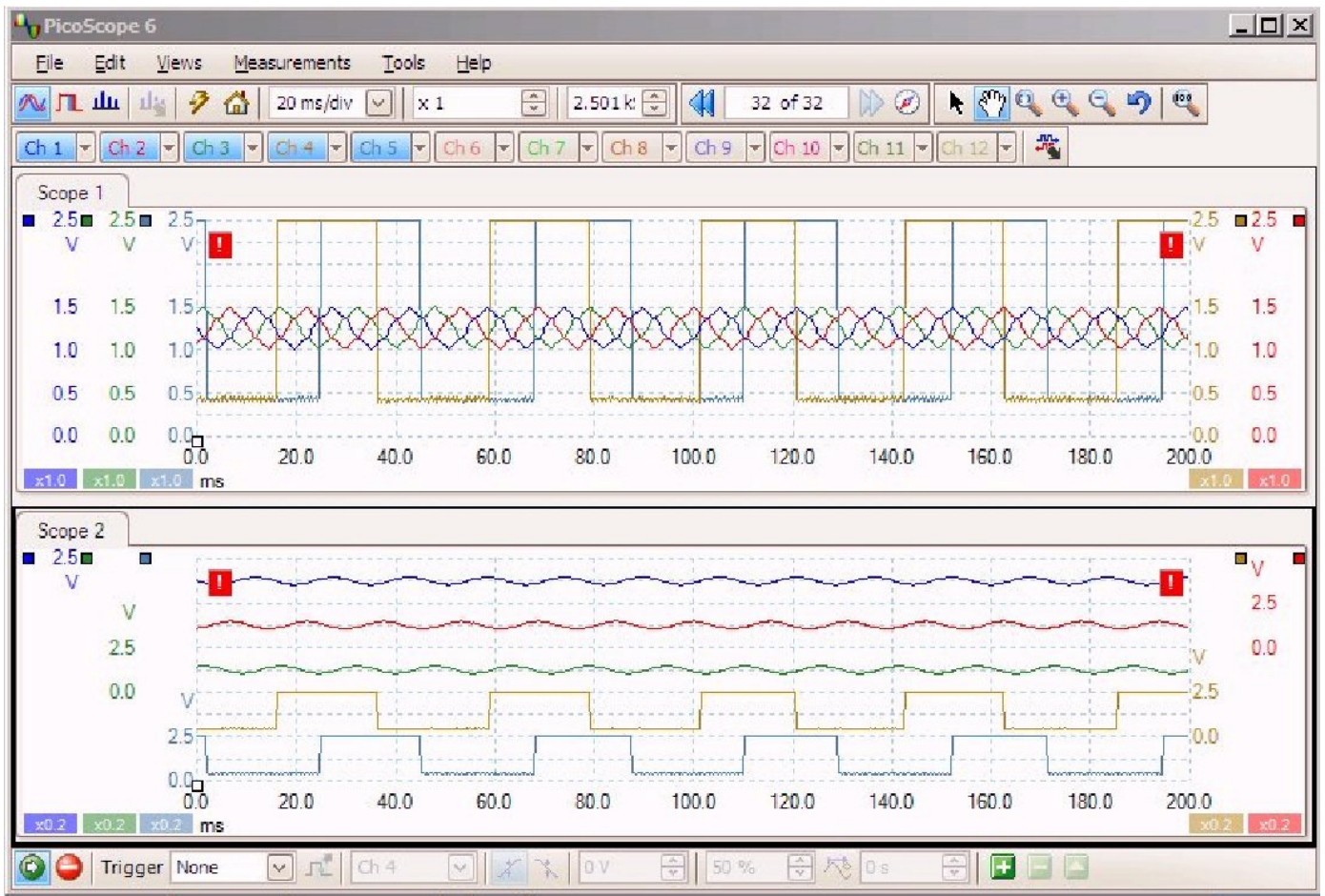
Clear Gearbox/  
generator combo. In-  
cludes 2 dual channel  
digital encoders for  
mounting to interme-  
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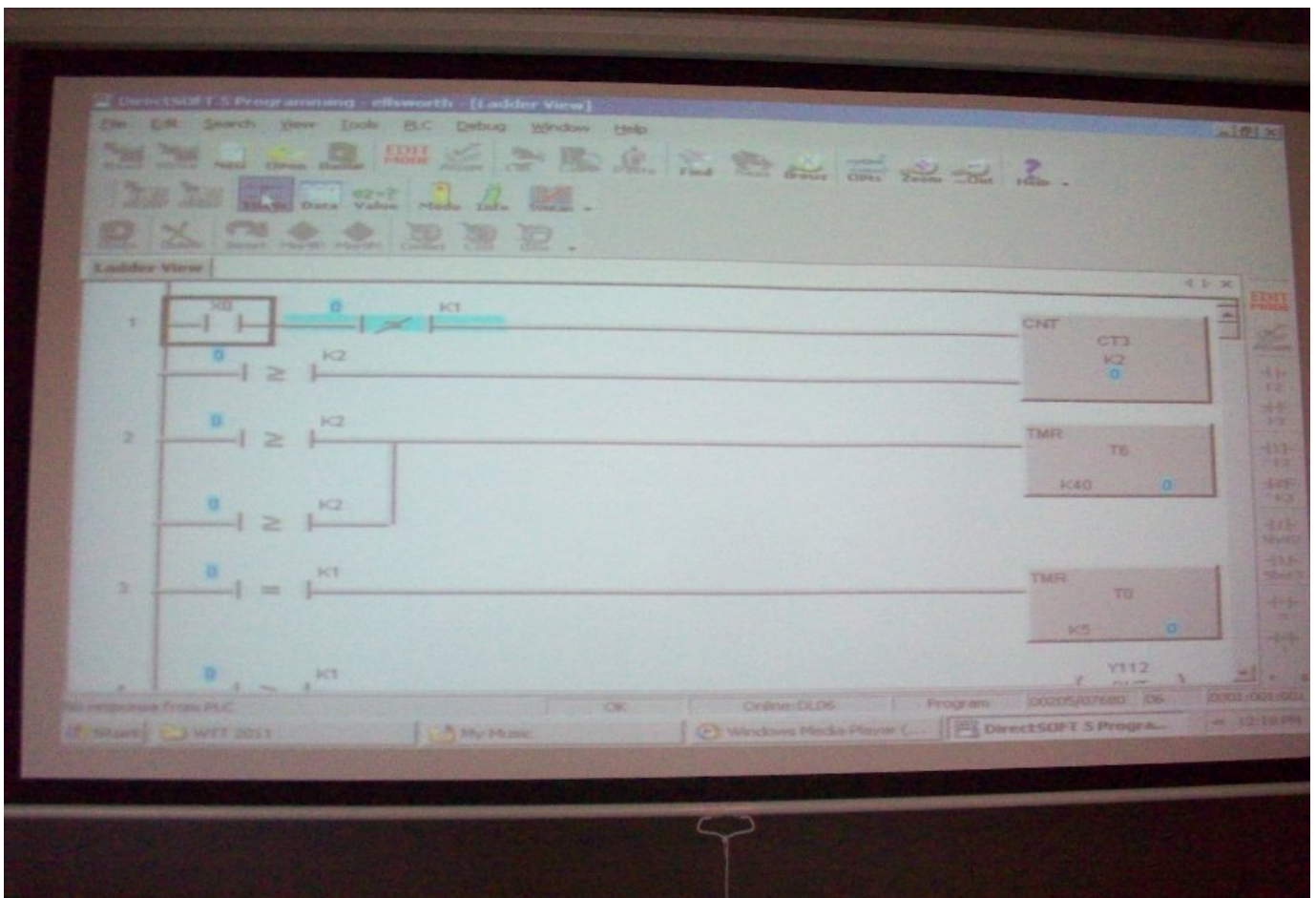
Planetary gearbox view from mini cam  
directly ported to video projector.

Yaw gear view from mini cam ported  
into pc via DVR capture device and  
then into video projector.





Real-time WTT signals ported into pc via data logger & o-scope software.



WTT ladder logic program displayed in real-time to video projector.