# Menacing Drivetrain

Aaron Fagan, Senior Editor

Most power transmission engineers spend their careers making sure mechanisms run quietly, efficiently, and invisibly inside a housing, but Mark Setrakian built one that punches demons on camera. A recent episode of Adam Savage's *Tested*, the YouTube channel run by the former *MythBusters* host, features Setrakian with the original animatronic hand built for Mr. Wink, the cave troll who serves as muscle for the villain of Guillermo del Toro's *Hellboy II: The Golden Army* (2008). Wink's right hand is a giant mechanical fist, a weapon he can launch on a chain, use to grapple or strike a target, and retract into his forearm. Del Toro, who prefers practical effects to CGI whenever physics will cooperate, wanted a prop that actually did all of that on set. The job went to Setrakian, mechanical department chief at Spectral Motion, the Glendale, CA, creature effects studio run by Mike Elizalde. The segment has drawn close to a million views, and anyone who watches it will understand why.

What Setrakian built is a complete, self-contained drivetrain. Servo motors actuate the finger joints through bevel gear sets, which let him turn motion through right angles inside the cramped interior volume of fingers scaled for a troll. Each finger curls, grips, and gestures independently under remote control. Motors, gearing, the chain deployment system, and the retraction hardware all live inside the fist. Nothing is tethered. The design brief, though, inverted the priorities this magazine usually covers. Nobody cared much about efficiency or rated load. The gearing had to be expressive. It had to translate fine servo inputs into believable finger movement at several times human scale, without lurching or stalling, because on film the mechanism is the performance.

The chain drive is the showpiece. Setrakian has called it the chain nozzle: a spinning gear and winding assembly that pays the chain out through an opening in the wrist when the fist deploys as a projectile, then reels it back in. He has recalled that people who saw it assumed he had sourced some existing piece of industrial equipment. Readers here may take that as a compliment. The scariest object in the movie passes for something out of a power transmission catalog.

The fabrication story holds its own interest. The structural and mechanical components were printed on a Stratasys Titan, a large-format FDM machine that in the mid-2000s cost about as much as a house, back when industrial additive manufacturing was still a niche and expensive proposition. Printing bought Setrakian geometric complexity that would have been miserable to machine conventionally, but the parts came off the platter looking like printed parts, layer lines and all. So the team finished them by hand, working every surface with Dremel rotary tools to carve in the battle-worn industrial texture del Toro's creature designs demand.

And the prop still works. Nearly twenty years after fabrication, the servos respond, the fingers articulate, and the chain mechanism runs as designed. For a one-off built under deadline pressure, that longevity says something about the quality of the design and assembly, and it confirms what power transmission professionals already know. Electronics age out through obsolescence and capacitor decay, but a properly meshing gear set just keeps turning.

The full segment (*youtu.be/qKMFdbspHZ4*) is on the Adam Savage's Tested YouTube channel under the title "Adam Savage Shocked by This Practical Effects Prop From Hellboy!" For anyone who has ever wanted to see a bevel gear set and a chain drive get a standing ovation, it is twelve minutes well spent.

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