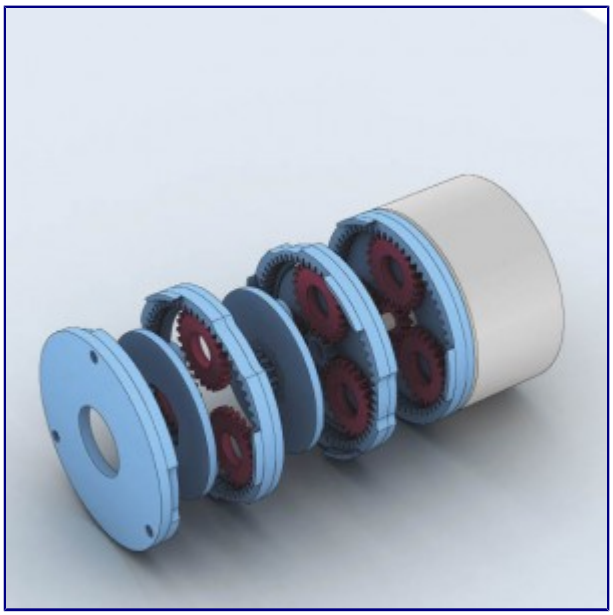
CNC machining speeds the development of custom gearwheels

Posted by Leslie Langnau on Monday, December 5, 2011



Michal Zalewski is a multitalented guy – a successful software engineer by day, and robotics hobbyist in the evening and on weekends. He became serious about robotics almost six years ago, and quickly realized that the most significant limitation is the need to rely on expensive pre-made or made-to-order structural components to move assemblies, custom gearwheels, and so forth. Waiting a week and paying $50-$100 for a small part is simply impractical.

He investigated a number of options for manufacturing functional components quickly and inexpensively, and decided that precision CNC machining was the best option for his needs. However, because the available documentation on the relevant CNC processes was limited, he chose not to make a substantial investment up front.

The Roland MDX-15 milling machine was affordable and had all the right features, especially with the bundled Modela Player software, which processes 3D CAD files for output on the MDX mill. It compared very favorably to other, typically bare bones products in that price range.

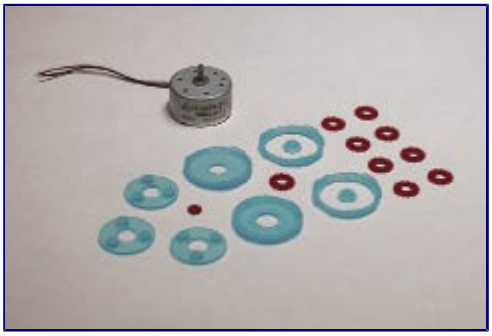
After some trial-and-error with the MDX-15, Zalewski discovered the optimal process for his manufacturing needs: quickly machining positive master molds in RenShape prototyping boards, making flexible negative molds in 60-80 Shore A silicones, and casting final parts from high-strength, low-cost engineering plastics. Although this approach may seem unnecessarily complicated at first, it is cost and time efficient, the materials are highly predictable and you eliminate many of the stock material sizing and holding woes. Additionally, the parts can be quickly duplicated later on.

Rough machining of the mold for gearbox components on Roland Modela MDX-540 in Huntsman RenShape 460 prototyping board, with a 3 mm diameter square end mill at 12,000 RPM. This step took about 30 minutes to complete.

Zalewski found that he could benefit from the faster machining speeds and greater movement range afforded by the larger MDX-540 benchtop CNC mill. The long-term returns of using the MDX-540 on part manufacturing costs, even in hobbyist uses—and simply the ability to experiment with designs at a whim—justified the upgrade. The CNC yields a dimensional accuracy 0.0002 in. or better, and helps him machine features as thin as 0.0015 in.

Perhaps the two most demanding applications Zalewski deals with routinely are custom-machined subminiature gearwheels and snap-fit sleeve bearings. In these applications, dimensional accuracy must stay within 0.0004 in. Fortunately, the MDX-540's accuracy is several times better.

Noted Zalewski, "Since I'm pursuing robotics as a hobby, every project is unique. I try to experiment with new ideas and push my own limits when it comes to electronic and mechanical design. I have experimented with everything from miniature quadruped robots to a variety of wheeled designs with various conventional and unconventional steering systems."



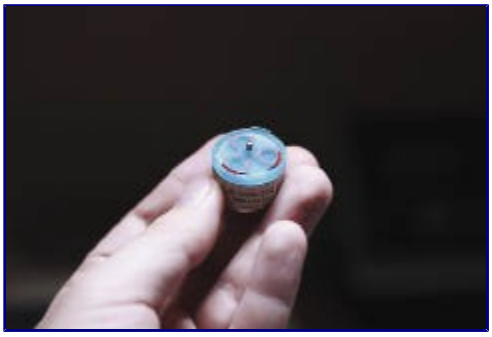
Zalewski decided to use a more revealing color scheme for the final assembly: a translucent turquoise body (solvent blue 70) with opaque, cerise gears (quinacridone pink). This photo shows all the parts with the post-casting film removed.

Measurement taken after post-cure. Original CAD dimensions of this part: 19.000 mm. In general, accuracy better than 0.005 mm (0.0002 in.) can be expected if the process is carried out right.

He typically designs projects in Rhino CAD software, although he has used other programs for some projects.

Precision and resolution were the two most significant selling points for him; high cutting speeds and a very generous movement range were next. The MDX's handy panel (hand-held control panel) is a minor feature in the grand scheme of things, but also a helpful one: it's useful to be next to the working area when configuring origins, measuring tool height, adjusting cutting speed, or verifying process parameters.

His current project started with a custom-made planetary gearbox for each of the motors; every gear in that mechanism is barely 0.035 in. thick, and has 0.015 in. teeth that need to mesh perfectly at that scale.



Final assembly of the translucent gearbox.

Said Zalewski, “In terms of the impact, I simply think that most of the designs I worked on in the past few years would be completely impossible without this tool: even though custom parts can be mail-ordered, that approach simply does not allow for any trial-and-error or continuous refinement of your projects.”

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