



August 29, 2008

At WCU in the ET Program, course content is brought to life through collaborative projects at our **Center for Rapid Product Realization** where students come into contact with industry leading equipment. The following section outlines equipment available to both students and faculty.

Reverse Engineering Equipment:

1. **ATOS 3-Dimensional, White Light Interferometric Imager:** ATOS is a high-end 3-Dimensional imaging and digitizing system. This flexible optical measuring machine is based on the principle of triangulation. Projected fringe patterns are observed with two cameras. 3-Dimensional coordinates for each camera pixel are calculated with high precision, and a polygon mesh of the object's surface is generated. Three-dimensional digitizing with the mobile ATOS system may be applied for all object sizes (up to full vehicle scanning), with smooth to complex surfaces and geometries. The ATOS system digitizes the objects and converts the images into an STL data set. The STL data sets may then be used to create precise Rapid Prototype models. Thus, a part may be scanned, imaged, stored, converted to STL, and then prototyped without having a TDP or other part drawings or descriptions. This system has applicability in defense and security for reverse engineering and prototyping obsolete parts without drawings or acquired parts from unknown or undisclosed systems.
2. **Zeiss Contura High Temperature Gradient (HTG):** The Zeiss Contura HTG is a bridge-type coordinate measuring machine (CMM) that has a measuring range of 0.7m X axis, 1.0m Y axis, and 0.6m Z axis. This machine employs direct contact scanning technology to measure geometric features with an accuracy of ± 0.2 microns between 18C– 26C, with 40% - 60% relative humidity. The Contura is well-suited for classical quality assurance and reverse engineering applications.
3. **Optical Gaging Products (OGP) SmartScope Flash 200 Video Measuring System:** The OGP SmartScope Flash 200 is an automatic measuring system with a measuring range of 200mm x 200mm x 150mm. Accuracy of this machine is 1000 μm for the X and Y axis, and 1000 μm for the Z axis. This machine is a non-contact measuring device that may be used when the use of a contact probe would be undesirable. The technology may be used in traditional quality assurance applications as well as in reverse engineering.

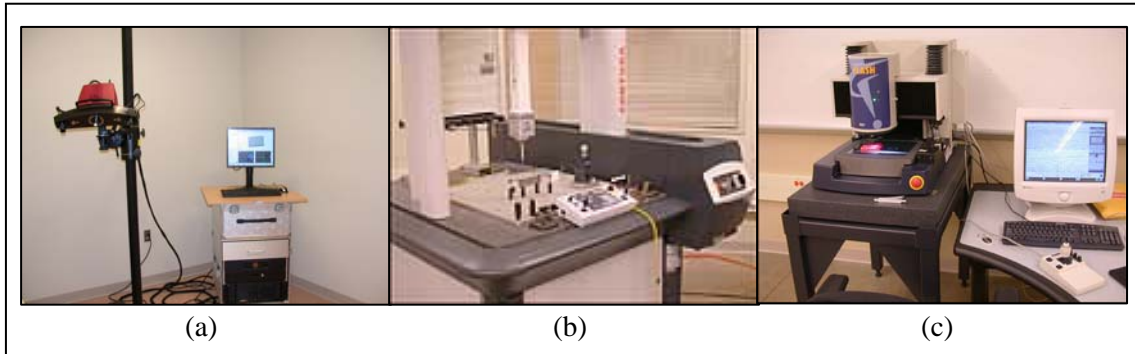


Figure 6. Reverse engineering and inspection equipment at the Center for Rapid Product Realization. (a) ATOS 3-Dimensional, White Light Interferometric Imager; (b) Zeiss Contura High Temperature Gradient (HTG); (c) Optical Gaging Products (OGP) SmartScope Flash 200 Video Measuring System.

Rapid Prototyping and Direct Digital Manufacturing Equipment:

1. **Stratasys Fused Deposition Modeling (FDM) Titan:** The Titan creates models using engineering materials such as polycarbonate, polyphenylsulfone, and ABS plastic. Parts up to 400mm x 350mm x 400mm can be fabricated in this machine, and parts that exceed the size of the Titan's build envelope may be built in sections and assembled to form a complete unit. Models are produced within an accuracy of $\pm 0.127\text{mm}$ up to 127 mm. Accuracy on models greater than 127 mm is $\pm .0015$ mm per mm. Ideal wall thickness of ABS and polycarbonate is 1mm. The minimum wall thickness with any material is approximately 0.5mm. Parts built in the Titan are 60% to 80% as strong as those made of injection molded plastic.
2. **Stratasys Eden 333:** The Eden 333 uses photopolymer jetting technology to precisely deposit ultraviolet (UV) resins in fine layers down to 16 microns. Parts up to 340mm x 325mm x 200mm can be fabricated in this machine. Building materials are cured by exposure to UV light. Build resolution is 600 dots per inch (dpi) for the X-axis, 300 dpi for the Y-axis, and 1600 dpi for the Z-axis. The Eden 333 can produce smooth surface and fine featured parts very quickly, and with minimum post-build cleanup.
3. **ZCorp Z400:** The Z400 is designed to be incorporated into the production of early-stage 3-Dimensional appearance models and prototypes. It can produce parts made from plaster or starch that are bonded with a cyanoacrylate adhesive. This machine can build parts up to 550mm x 250mm x 200mm with an operator selectable layer thickness of 76-250microns. The recommended observed wall thickness is 2.5mm. This machine produces concept models quickly and inexpensively.

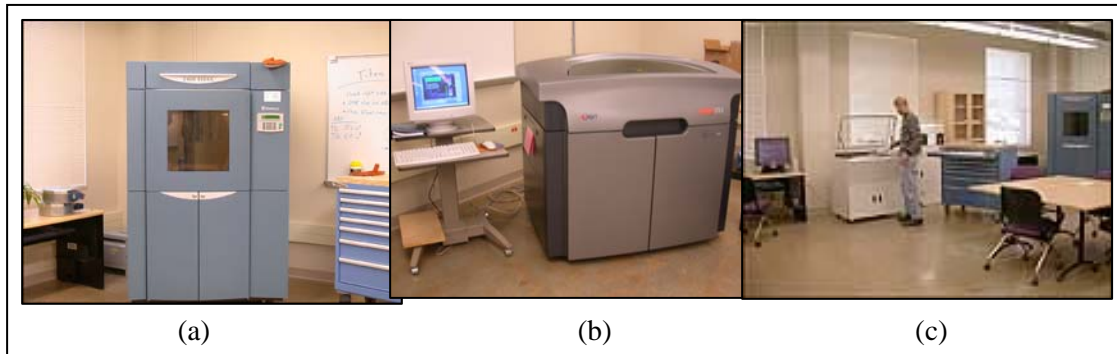


Figure 7. Rapid Prototyping and Direct Digital Manufacturing Equipment at the Center for Rapid Product Realization. (a) Stratasys Fused Deposition Modeling (FDM) Titan; (b) Stratasys Eden 333; (c) ZCorp Z400.

Metal Machining and Prototyping Equipment:

The machining facilities enable students to learn Computer Numerical Control (CNC) problem solving as well as manual machining techniques using state-of-the-art Haas machines. Facilities are maintained by dedicated engineering staff with extensive prototyping and custom machining experience. The Sinterstation® Pro DM250 SLM, with its 3-dimensional, additive prototyping capability, will complement this suite of machining tools. A summary of machining capability follows:

1. **Haas CNC and Manual Machining:** The Rapid Center's array of modern Haas CNC and manual machine tools is used to generate prototype and custom pieces. The Center's CNC capabilities include:
 - **Haas VF-3 with TR-160 Trunnion Table:** The Haas VF-3 vertical machining center has 1016 x 508 x 635 mm of x-y-z travel and is built utilizing cast-iron components. The VF-3 produces 75 ft-lb of torque at a low 1400 rpm, and will run up to 7500 rpm in 1.2 seconds for finishing aluminum. This machine is equipped with a dual-spindle trunnion table for machining helical parts, giving the machine 5-axes of motion.
 - **Haas TM-1 Toolroom Mill** - The Haas Toolroom Mill combines the ease and simplicity of a manual machine with the power and flexibility of full CNC. The instrument has x-y-z travels of 762 x 305 x 406 mm. It is easily moved with a pallet jack and takes up very little floor space. The instrument is considered an open machine. It may be run in the CNC or manual mode and is intended to handle small parts.
 - **Haas Mini Mill** – The Haas Mini Mill is a compact machine which features a 40-taper spindle, speeds to 6000 rpm, 600-ipm rapids and a 10-pocket automatic tool changer. The Mini Mill handles small-parts

manufacturing – it is ideal for finishing work and cutting aluminum, yet also provides enough low-end torque to cut steel.

- **Haas TL-1 Toolroom Lathe** - The TL-1 operates in four modes, ranging from fully-manual to fully-automatic. In all modes, the Haas control provides extremely accurate digital read-out of position, displayed to 0.0005" when using the manual handwheels or to 0.0001" when using the electronic jog handle.
- **Haas SL-10 CNC Lathe** - The SL-10 takes up only 6.5' x 4.5' of floor space, yet provides an 11" turning diameter, 14" turning length and a 16.25" swing over the front apron. This compact machine is well-suited as a "second-op" machine. It is also ideal for start-up shops, or as a first step into CNC turning. Tailstock provides rigid support between centers.
- **Haas SL-20 CHC Lathe** - Haas SL Series offers a wide range of capacities, and the SL-20 increases capacity further while retaining the original footprint. The SL-20, with a max turning capacity of 10.3" x 20" and an 8.3" chuck, has a bar capacity of up to 2.0".
- **Haas VF-1 with HRT-210 rotary table:** The Haas VF-1 machining center has 508 x 406 x 508 mm x-y-z travel and is built utilizing cast-iron components. This machine employs a 20-position tool changer and has 4th-axis capability provided by an HRT-210 rotary table.

2. **Oxford DP100-5S Laser Micromachining:** Laser micromachining is used for drilling small, accurate holes (5-200 microns diameter), cutting precisely (kerf widths down to 5 microns), and 2.5D milling of microfeatures. The heart of the customized Oxford DP100-5S micromachining system is a dual-wavelength, diode-pumped solid state laser. This laser operates at 532nm or 266nm.



Figure 8. The Center for Rapid Product Realization is equipped with a suite of subtractive metal machining and prototyping equipment. To date the Center does not have an additive metal prototyping machine.



Figure 9. The Center for Rapid Product Realization is equipped with the Oxford DP100-5S Laser Micromachining system.

Other Equipment - Inspection, Test and Quality Assurance:

1. **ADE Phase Shift MicroXAM Surface Mapping Microscope:** The MicroXAM system can measure roughness, finish and textures of surfaces ranging from highly polished optics to rough surfaces such as steel, aluminum, paper, plastics, magnetic media, ceramics, and silicon wafers. The system has repeatability (precision mode) of 0.1 nm and a field of view of 8x10mm (at 78x magnification) to 0.084x0.063mm (at 100x magnification).