CONTRIBUTOR'S GUIDE TO BRL-CAD

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A CALL TO ARMS (AND CONTRIBUTORS)

"The future exists first in the imagination, then in the will, then in reality." - Mike Muuss

Welcome to BRL-CAD! Whether you are a developer, documenter, graphic artist, academic, or someone who just wants to be involved in a unique open source project, BRL-CAD has a place for you. Our contributors come from all over the world and use their diverse backgrounds and talents to help maintain and enhance one of the oldest computer-aided design (CAD) packages used in government and industry today.

WHAT IS BRL-CAD?

BRL-CAD (pronounced be-are-el-cad) is a powerful, cross-platform, open source solid modeling system that includes interactive three-dimensional (3D) solid geometry editing, high-performance ray tracing support for rendering and geometric analysis, network-distributed frame buffer support, image and signal-processing tools, path tracing and photon mapping support for realistic image synthesis, a system performance analysis benchmark suite, an embedded scripting interface, and libraries for robust high-performance geometric representation and analysis.

For more than two decades, BRL-CAD has been the primary solid modeling CAD package used by the U.S. government to help model military systems. The package has also been used in a wide range of military, academic, and industrial applications, including the design and analysis of vehicles, mechanical parts, and architecture. Other uses have included radiation dose planning, medical visualization, terrain modeling, constructive solid geometry (CSG), modeling concepts, computer graphics education and system performance benchmark testing.

BRL-CAD supports a wide variety of geometric representations, including an extensive set of traditional implicit "primitive shapes" (such as boxes, ellipsoids, cones, and tori) as well as explicit primitives made from collections of uniform B-spline surfaces, non-uniform rational B-spline (NURBS) surfaces, n-manifold geometry (NMG), and purely faceted polygonal mesh geometry. All geometric objects may be combined using Boolean set-theoretic CSG operations such as union, intersection and difference.

Overall, BRL-CAD contains more than 400 tools, utilities, and applications and has been designed to operate on many common operating system environments, including BSD, Linux, Solaris, Mac OS X, and Windows. The package is distributed in binary and source code form as Free Open Source Software (FOSS), provided under Open Source Initiative (OSI) approved license terms.

HISTORY AND VISION

BRL-CAD was originally conceived and written by the late Michael Muuss, the inventor of the popular PING network program. In 1979, the U.S. Army Ballistic Research Laboratory (BRL) (the agency responsible for creating ENIAC, the world's first general-purpose electronic computer in the 1940s) identified a need for tools that could assist with the computer simulations and analysis of combat vehicle systems and environments. When no existing CAD package was found to be adequate for this specialized purpose, Mike and fellow software developers began developing and assembling a unique suite of utilities capable of interactively displaying, editing, and interrogating geometric models. Those early efforts subsequently became the foundation on which BRL-CAD was built. Development of BRL-CAD as a unified software package began in 1983, and its first public release came in 1984. Then, in 2004, BRL-CAD was converted from a limited-distribution U.S. government-controlled code to an open source project, with portions licensed under the LGPL and BSD licenses.

The ongoing vision for BRL-CAD development is to provide a robust, powerful, flexible, and comprehensive solid modeling system that includes:

1. Faithful high-performance geometric representation.
2. Efficient and intuitive geometry editing.
3. Comprehensive conversion support for all solid geometry formats.
4. Effective geometric analysis tools for 3D CAD.

KEY STRENGTHS

All CAD packages are not alike. Among the many strengths of the BRL-CAD package are the following:

1. BRL-CAD is **open source**! Don't like something? You can make it better.
2. You can leverage **decades of invested development**. BRL-CAD is the most feature-filled open source CAD system available, with hundreds of years time invested.
3. **Your work will get used**. BRL-CAD is in production use and downloaded thousands of times every month by people all around the world.
4. You have the ability to create extensively **detailed realistic models**.
5. You can model objects on scales ranging from (potentially) the subatomic through the galactic, while essentially providing **all the details, all the time**.
6. You can leverage **one of the fastest** raytracers in existence (for many types of geometry).
7. You can convert to and from a wide range of **geometry file formats**.
8. BRL-CAD has a powerful, **customizable scripting interface** with many advanced editing and processing capabilities.

CREATING PRIMITIVE SHAPES

- LAUNCHING THE MGED PROGRAM
- ENTERING COMMANDS IN THE COMMAND WINDOW
- OPENING OR CREATING A NEW DATABASE WHEN LAUNCHING MGED
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LAUNCHING THE MGED PROGRAM

To launch the MGED program, type ***mged*** at the Terminal (tty) prompt and then press the ***ENTER*** key. This brings up two main windows: the MGED Command Window and the MGED Graphics Window (sometimes called the Geometry Window). Both windows will initially be blank, awaiting input from you. To leave the program at any time, at the Command Line type either the letter ***q*** or the word ***quit*** and then press the ***ENTER*** key.

ENTERING COMMANDS IN THE COMMAND WINDOW

You can type in commands at the ***mged> prompt***. Many experienced UNIX users prefer this method because it allows them to quickly create a model (which we sometimes refer to as a "design") without having to point and click on a lot of options.

USING THE GUI

Users who are more familiar with Microsoft Windows may prefer to use the GUI pull- down menus at the top of the Command or Graphics Window (they are the same in either window). The menus are divided into logical groupings to help you navigate through the MGED program. Before you can create a model, you need to open a new database either through the Terminal Window when starting MGED or through the GUI after starting MGED.

OPENING OR CREATING A NEW DATABASE WHEN LAUNCHING MGED

When launching MGED, you can open or create a database at the same time. At the shell prompt (usually a $ or %), in the Terminal Window, type mged followed by a new or existing database name with a .g extension.

For example:

mged sphere.g<ENTER>

USING THE GUI TO OPEN OR CREATE A DATABASE

Alternatively, once you have launched MGED, you can open an existing database or create a new database using the GUI menus (at the top of the Command or Graphics Window) by clicking on ***File*** and then either ***Open*** or ***New***. Both options bring up a small dialog box. The ***Open*** dialog box will ask you to type in the name of an existing database. The ***New*** dialog box will ask you to type in the name of a new database. Click on ***OK*** to accept the database.

For this lesson, create a new database called ***sphere.g***. To do this, type ***sphere.g*** at the end of the path name, as shown in the following illustration. Click on ***OK*** to accept the database name.

One advantage to using the GUI, if you aren't familiar with UNIX file management, is that this will show you your current path name, so you will know exactly where your database is going to be located. This can be especially helpful if you have a lot of directories or files to manage.

ASSIGNING A TITLE TO YOUR DATABASE

You can title your new database to provide an audit trail for you or others who might use your database. After the prompt, in the Command Window, type **title** followed by a space and a name that reflects the database you are going to make. When you are done, press the **ENTER** key.

For example: ***mged> title MySphere<ENTER>***

Note that in BRL-CAD versions prior to release 6.0, the title is limited to 72 characters.

FEATURE OVERVIEW

- SOLID GEOMETRY
- RAYTRACING
- GEOMETRY CONVERSION
- PROCEDURAL GEOMERTY
- BOUNDARY REPRESENTATION
- PATH TRACING
- HIDDEN LINE RENDERING
- SCRIPTING INTERFACE
- MISCELLANEOUS

SOLID GEOMETRY

BRL-CAD focuses on solid modeling CAD. Solid modeling is distinguished from other forms of geometric modeling by an emphasis on being physically accurate, fully describing 3D space. Shown is a 3D model of a Goliath tracked mine, a German-engineered remote controlled vehicle used during World War II. This model was created by students new to BRL-CAD in the span of about 2 weeks, starting from actual measurements in a museum.

RAYTRACING

Raytracing is central to BRL-CAD as a means for performing geometric analysis (e.g., calculating weights and moments of inertia) and for rendering images for visualization purposes. The image shown is a BRL-CAD 2D framebuffer screenshot displaying the rendering of a ball bearing. The bearing is modeled with a material appearance resembling acrylic glass, and this raytracing result shows reflection, refraction, shadowing, and some caustic effects.

GEOMETRY CONVERSION

As shown, a BRL-CAD target description can be converted to a finite element mesh (FEM) using the BRL-CAD g-sat exporter and Cubit from Sandia National Laboratories

This screenshot shows a model imported from the Rhino3D 3DM file format into BRL-CAD as NURBS boundary representation geometry, visualized via OpenGL.