

LDraw Tutorial (IX)

Anatomy of an LDraw part.

Text and images by Jetro

We all know what our beloved bricks are made of (in case anyone isn't sure: ABS), but what are virtual bricks made of? The easy answer would be 'bytes', but in this article we'll learn a little more about the internal structure of LDraw elements and how they are made.

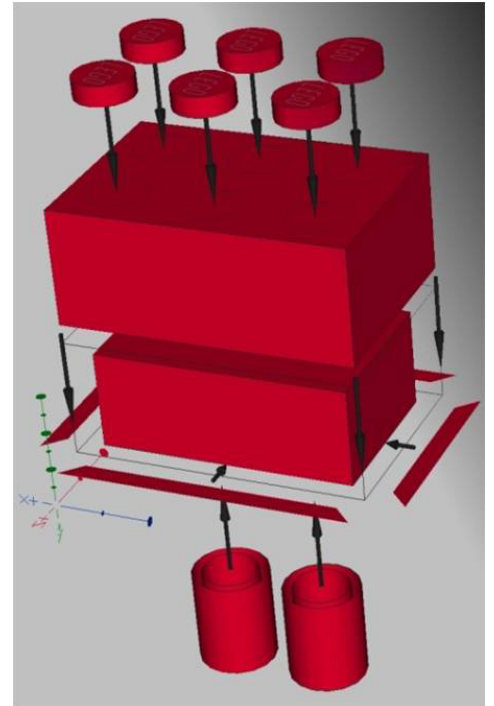
One of the major strong points of the way James Jessiman designed what we now know as LDraw is that the system feeds itself. When LDraw was created computers had little power compared to what we are now used to and it was necessary to make the most of what was available to ensure everything would work well. Graphical applications require a lot of memory and processor power and it was therefore necessary to create a system that was both simple and efficient. At the same time, rendering a single brick may not require a lot of resources, but creations tend to get bigger, and the bigger, the more complicated to render.

In CAD (Computer Aided Design) the designer normally has to draw an object line by line. In MLCad we are presented with bricks and other LEGO® elements that have been completely predesigned, but which are originally also made up of just lines. LDraw does not include the possibility to draw circles or curves. For this reason a single stud is made up of a 16-agon that represents the top of the stud and 16 quadrilaterals (or quads) representing the side of the stud. If you look at a 2x4 brick (LDraw reference 3001) you will see it contains 8 of these studs. In order to simplify matters and since the stud is a recurring element, it has been converted into a 'primitive' or shape that can be recycled and serves as a basis for other elements. If you turn the brick over you will see three identical tubes. These are also available as primitives. In this way they only need to be drawn once after that you only need to indicate how many you need for each LEGO element and where they need to be placed. This simplifies the design process of new elements enormously. The concept of the recycled studs and cylinders can be further expanded. In addition to studs and tubes, a brick is made up of boxes, one to describe the outside shape and one for the inside shape. Combine studs, cylinders and boxes and all you need are four quads to bridge the gap between the boxes on the bottom side of the brick.

It sounds simple (and doesn't need to be much more complicated), but evidently that's not all parts are quite that easy to convert to LDraw and the design process needs to follow some basic rules to ensure the final quality of the parts. To learn a little more about this process and what it involves I conducted a short interview with Alex Taylor, an experienced LDraw Parts Author:

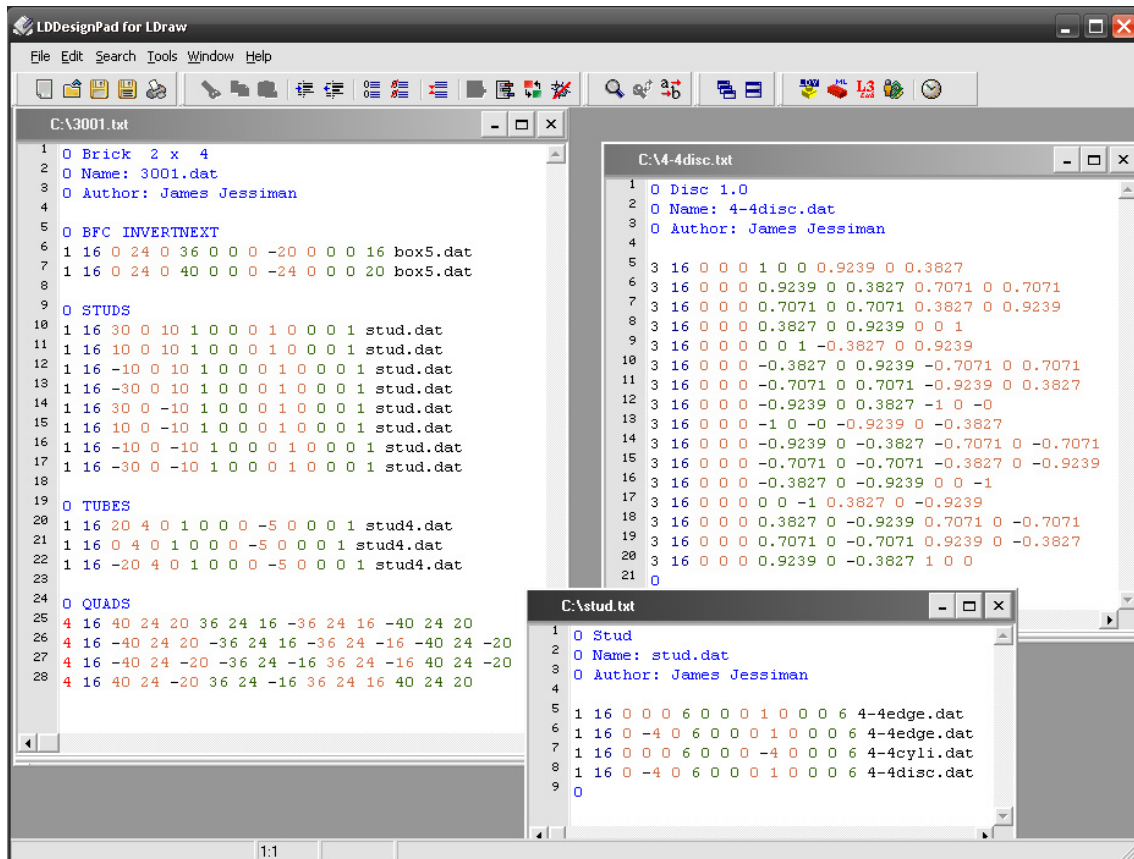
- Can you describe the process of creating a new part?

It depends heavily on the part - sometimes it's possible to start out with an existing part and modify it, other times you have to start from scratch. For patterned parts, including stickers, the



starting point for me is a high-resolution scan of the pattern which can then be 'drawn' over with LDraw elements. For a physical shape I usually start by adding common elements like the studs and then work from there.

In all cases it's important to get the dimensions as accurate as possible, within the limits of the LDraw system, since the part has to mate with others. Unfortunately, there's no definitive way



to convert from real-world measurements to LDraw units - a good approximation is that one LDraw unit (LDU) is 1/64 of an inch - so compromises have to be made from time to time.

The next step is then to see what areas of the part can be represented using LDraw's library of 'primitives' - common shapes such as boxes, cylinders, cones, studs and so on[1] - and 'subparts' - sections of parts which are intended for reuse. Using these both saves time and keeps the filesize down!

With this done, any remaining areas need to be filled in, and this process can range from simply adding a couple of triangles to freehand 3D modelling.

Some examples:

Part 3001, the ubiquitous 2x4 brick, consists of two five-sided boxes (one for the outside, one for the inside), four quadrilaterals (to make up the base), eight studs and three stud-tubes. This part is almost entirely built from LDraw primitives, with only the quads needing to be drawn by hand.

47990, a skull brick, uses a small number of primitives (e.g. cylinders, the Technic pins), but the bulk of it was drawn by hand.

3069bpa4.dat, a 1x2 tile with a pattern, uses a subpart (3069s01, the 1x2 tile but without its top surface) and a pattern painstakingly drawn by hand from a 640dpi scan of the actual part.

There are a variety of tools available to assist parts authors, ranging from simply generating an array of triangles to cover a defined area all the way up to taking a 'pattern' and warping it to fit onto a non-flat surface. So far as I know, the only graphical editor currently available which supports parts authoring at all is MLCad (although due to bugs in the current

release (v3.3) it is necessary to use v3.2) but even with these tools there's still a fair bit of manual work involved! More recently it has become possible to perform 3D scans of actual LEGO® bricks - the Fabuland figures which have appeared recently had their heads created in this manner.

Finally, the LEGO Universe Team have begun releasing 3D data to us, so we have a number of parts which would have been otherwise extremely difficult to model. A good example of this is 2543, the Minifig Rag Hat.

- On average, how long does it take you to model a part?

Again, it depends on the part :) Something like 3001 would take just a few minutes to complete, whereas 3069bpa4 took several hours to draw the pattern. On occasion I've knocked out half a dozen parts in a single evening; other times I've spent days working on a single piece.

- What is the most difficult part you have ever modeled and why?

Well...some of the patterned parts I've drawn were tedious to do, but I don't think I'd call them 'difficult' :) I'd say probably x948 and x949, the blue-era railway points (or 'switches' if you're American) due to their complex shapes.

- What special techniques and programs did you use to model that part?

Sheer bloody hard work! As I recall, I started out by drawing the basic shapes - the straight rails and similar - and then spent some time calculating the radii of the curved rails. These were then divided up into segments to simulate a (reasonably) smooth curve, and a subpart was created which could then be replicated around as required. The whole process took a couple of weeks.

- Why isn't a part immediately available after you model it?

Technically it's available as soon as it's uploaded to the LDraw Parts Tracker, but it doesn't become 'official' until it appears in a release of the LDraw Parts Library. Releases happen two or three times a year on average and the number of parts in a release varies depending on how much activity there's been since the last one.

Once a part goes on the Tracker, it needs to be reviewed by other authors before it can be released. The reviews are to check the part for accuracy (both to the original LEGO® part and to make sure there are no technical errors in the modeling), compliance with the LDraw library standards and to allow other people to make suggestions. A reviewer can either 'certify' or 'hold' the part; a part must have at least two 'certify' reviews and no 'holds' before it can move on to the next stage.

After being reviewer-certified, one of the Parts Tracker administrators must also certify the part. At this point the part is eligible to go into the next Parts Library release, provided that it does not make use of any subparts or primitives which have not yet been admin-certified. If the part passes all these hurdles, it will most likely be included in the next release, at which point it becomes 'official'.

So long as a part remains on the Tracker, it is considered 'unofficial'. Anyone may download and use these parts in their models, so long as it is understood that these parts are subject to change and that changes may result in your model no longer looking quite right :-)

'Official' parts may still be modified, but with some restrictions: the origin and orientation may not be altered (so as not to 'break' models which are using the part).

- What are the requirements for someone who'd like to become a part author?

None - anyone is welcome to jump in! You do need a login on www.ldraw.org, but once you've got that simply drop an email off to the admins via the LDraw website[2] to request authoring privileges on the site. You're now able to upload your creations to the Parts Tracker.

Parts authors don't automatically get 'reviewer' status - this is requested separately, and usually requires that you've done a bit of authoring first.

[1] <http://www.ldraw.org/library/primref/>

[2] <http://www.ldraw.org/library/tracker/>

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