

Empirical findings regarding the length of 1 LDU

Stefan Gustavson, Linköping University, Sweden (stegu@itn.liu.se), March 2, 2005

Abstract

We prove beyond doubt that the length of 1 LDU is *not* exactly 1/64", and we find that the hypothesis that 1 LDU is exactly 0.4 mm cannot be disproven within the accuracy of our measurement device. We also present circumstantial evidence to further support the hypothesis that 1 LDU is exactly 0.4 mm.

Introduction

The LDraw community (<http://www.ldraw.org>, not affiliated with the Lego Group, <http://www.lego.com>) creates and maintains a set of virtual models of Lego building blocks and a set of tools for building and distributing virtual Lego models, for the benefit of Lego enthusiasts all over the world. The LDraw library of parts uses a basic measurement unit of 1 LDU, where the spacing between the centres of two adjacent Lego studs is defined as exactly 20 LDU. Measured with a standard office ruler by a casual European observer, this distance is easily estimated to approximately 8 mm, but by Americans, accustomed to the use of Imperial inches, it is just as easily estimated to approximately 5/16". The length of 1 LDU is commonly assumed to be either 0.4 mm or 1/64". We will refer to these two estimates as the *metric hypothesis* and the *Imperial hypothesis*, respectively. The difference between the two distances is insignificant for most common uses of Lego, but their relative proportion is 127/128, a difference of almost one percent. This is definitely big enough to matter for some applications, and certainly big enough to be empirically measured with low cost, standard equipment. It is a scientifically disturbing fact that the community has so far been unable to agree on the size of the fundamental unit of the LDraw system. This article is an attempt to clear things up.

Measurement method

A Lego model stays together with interference fit, and studs and stud receptacles fit together very snugly. However, two bricks placed side by side in a model will have a small but noticeable gap between them. Thus, the width of any one individual brick is not a good measure to empirically test our hypotheses. To get an accurate and correct measurement of the spacing between two stud centres, we chose a different approach with two 2 x 4 bricks placed on a 16 x 32 baseplate, as demonstrated in *figure 1, top*. Provided that the two bricks are equal (care was taken to pick two mint condition bricks of similar age from the same mould), the orthogonal distance between the two side faces (the arrow in the figure) will be exactly 16 stud spacings, or 320 LDU. This 320 LDU distance was measured using the depth gauge of a digital caliper, as demonstrated in *figure 1, bottom*.

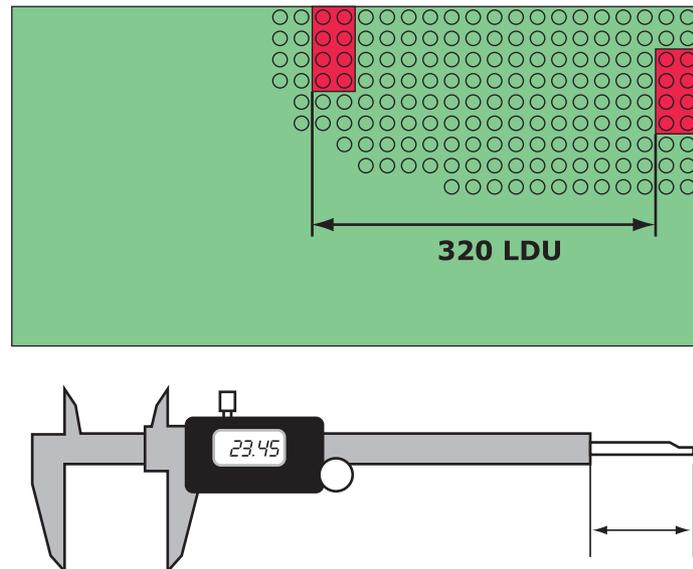


Figure 1: experimental setup

Results and conclusion

Using different baseplates and different pairs of 2 x 4 bricks, making the measurement very carefully several times and averaging, we found that 320 LDU equalled 128.0 mm, with an estimated maximum margin of error of plus or minus 0.04 mm. The Imperial hypothesis implies that $320 \text{ LDU} = 5'' = 127.0 \text{ mm}$. This is undisputably inconsistent with our empirical findings and can thus be ruled out with a very high level of confidence. The metric hypothesis that $320 \text{ LDU} = 128.0 \text{ mm}$ can not be falsified within the accuracy of our measuring equipment, and thus still holds.

Further support for the metric hypothesis can be found by noting that Lego is an original Danish design, that Danish engineers were extremely unlikely to use Imperial inches as late as in the 1960's when the Lego System was designed, and that Danish engineers, like most engineers, tend to favour reasonably round numbers for standards whenever possible. Thus, it seems highly plausible that 1 LDU is in fact *exactly* 0.4 mm. We invite future research to investigate this theory and possibly prove it wrong, but we strongly emphasise that the Imperial hypothesis, to the best of our ability, can be ruled out beyond doubt.

Thus, *1 LDU is definitely not 1/64"*.

Acknowledgements

The author wishes to extend his thanks to the entire LDraw community, without whose efforts the concept of 1 LDU would not even exist, and this would never have been a problem. Thanks also go to the Lego Group for the ingenious design of Lego bricks. And yes, this is article is a joke. But the facts and findings are real, and are meant to be taken seriously.