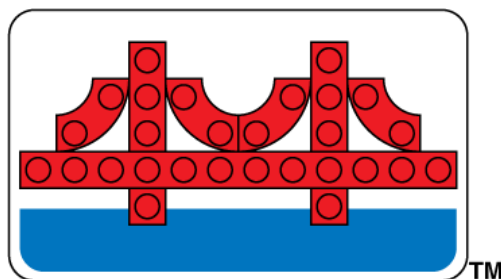


# Brick Geometry

**Bricks by the Bay 2013**



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**www.brickpile.com**



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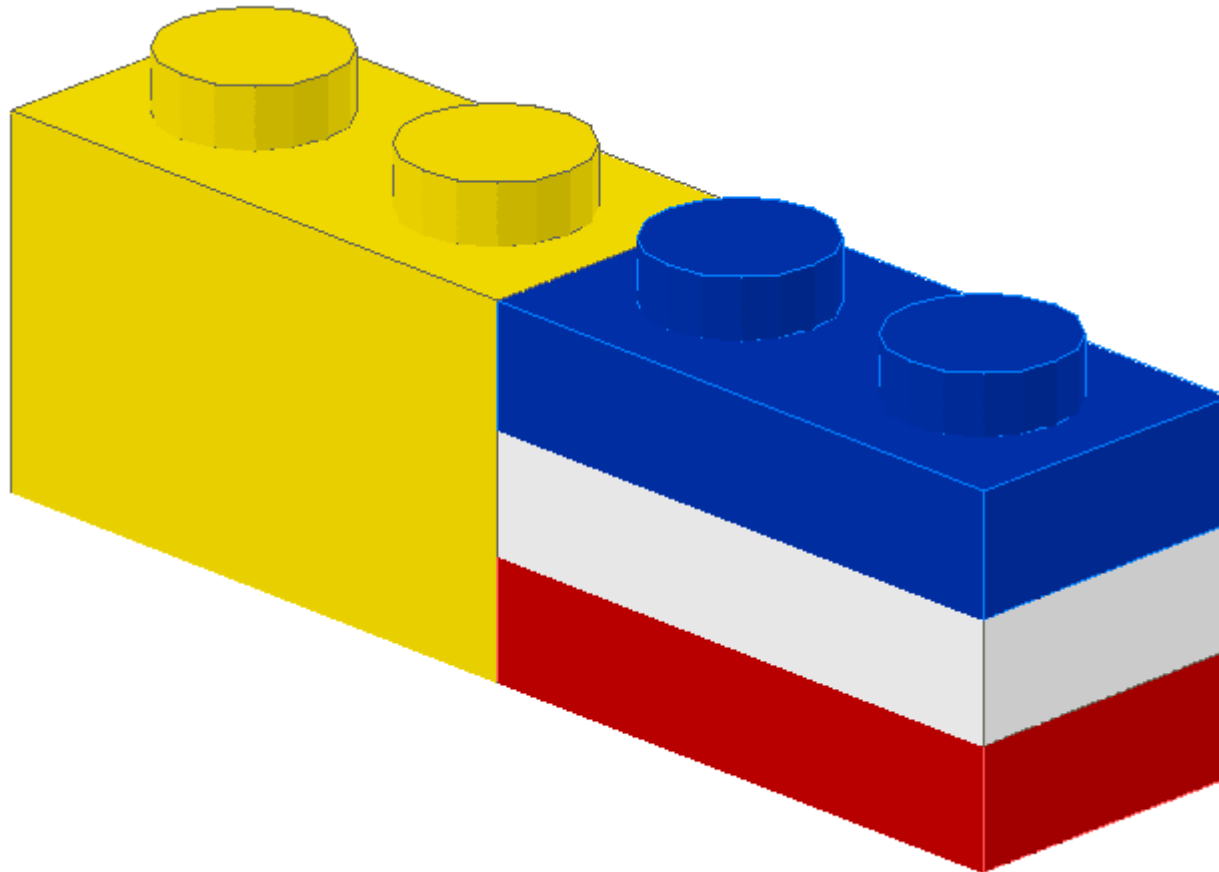
Some Rights Reserved

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# Basic LEGO Geometry

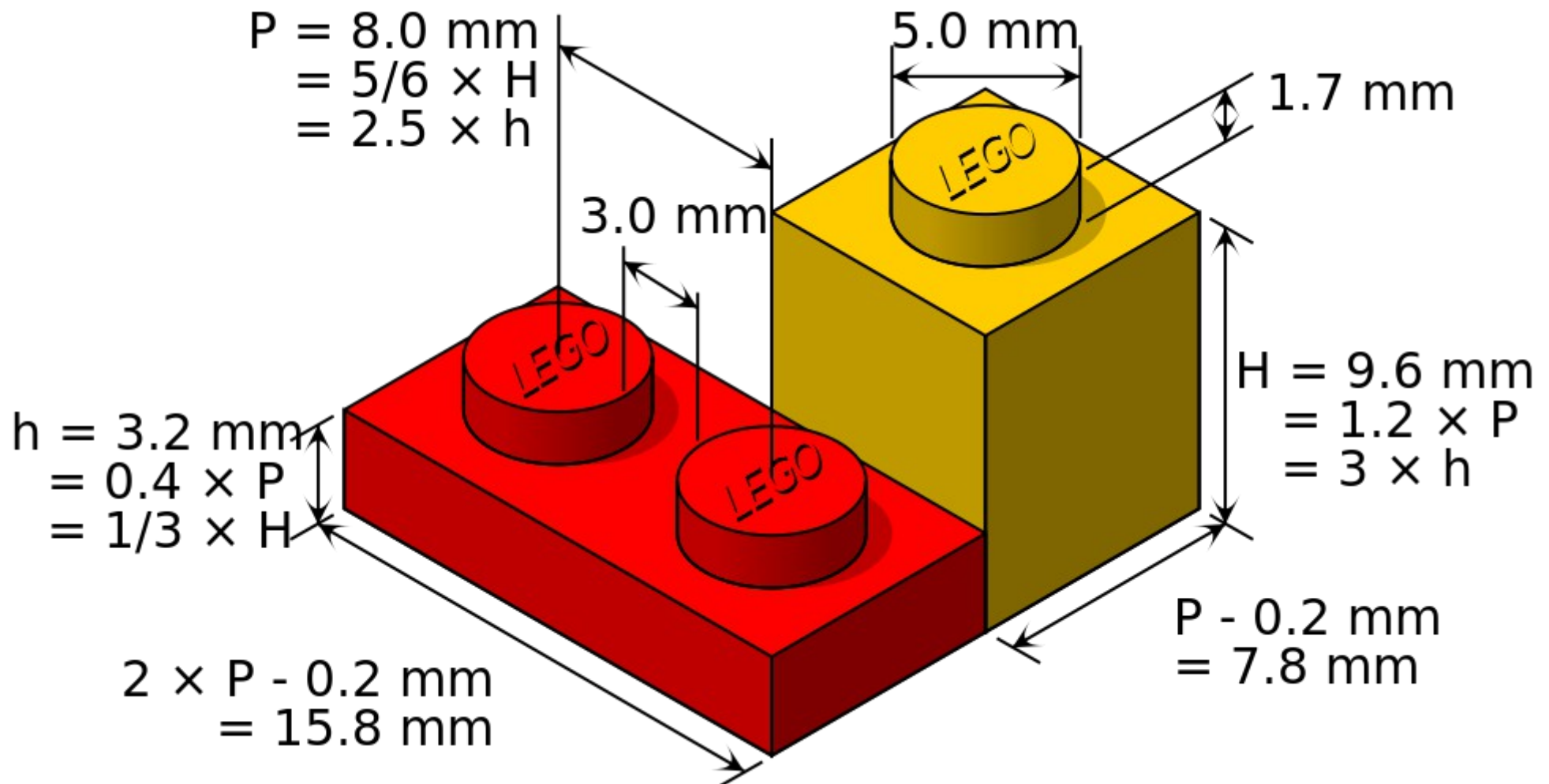
## 1 brick = 3 plates

*Everyone knows this, I hope...*



# LEGO Dimensions

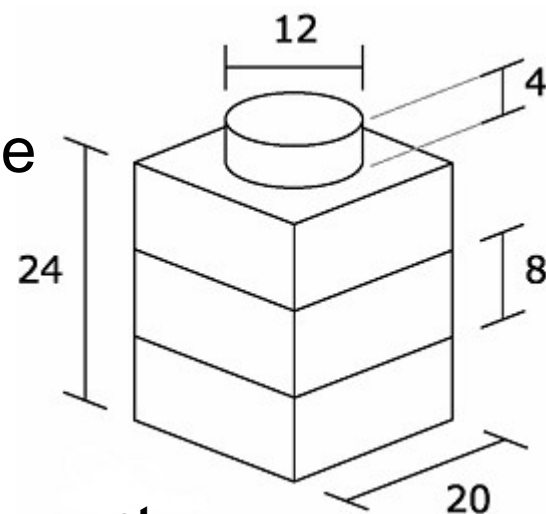
*Quick! Memorize all these numbers. There will be a quiz later.*



# Math is Hard!

## LDU = LDraw Unit

- A 1x1 stud brick or plate is 5/16" or 8mm (0.8cm)
- The height is 6/16" or 9.6mm (0.96cm)
- To make the math easier, LDraw designers came up with the LDraw Unit (LDU)
- Everything is a nice, easy integer this way!



	<u>LDU</u>	<u>studs</u>	<u>bricks</u>	<u>plates</u>	<u>cm</u>	<u>inch</u>	<u>pt</u>
<b>LDU</b>	1	1/20	1/24	1/8	0.04	1/64	9/8
<b>studs</b>	20	1	5/6	5/2	0.8	5/16	45/2
<b>bricks</b>	24	6/5	1	3	0.96	6/16	27
<b>plates</b>	8	2/5	1/3	1	0.32	2/16	9
<b>cm</b>	25	1.25	1.04	3.125	1	0.39	28.3
<b>inch</b>	64	3.2	8/3	8	2.54	1	72
<b>pt</b>	8/9	2/45	1/27	1/9	0.0353	1/72	1

# Ratio of Stud Width to Brick / Plate Height

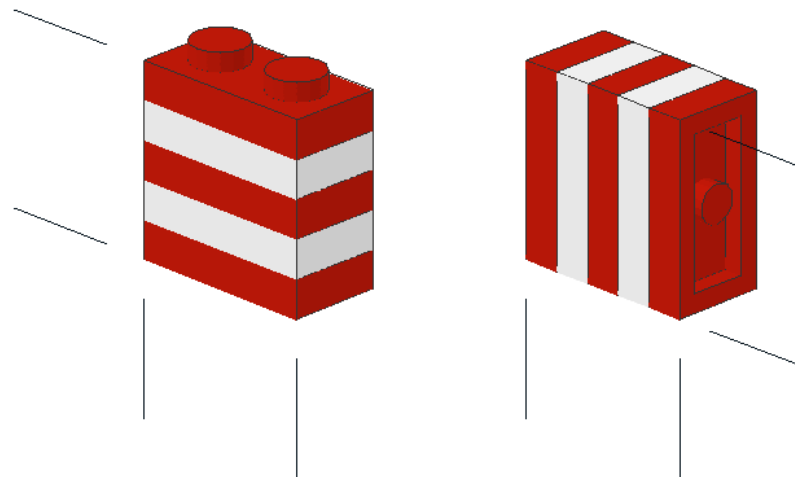
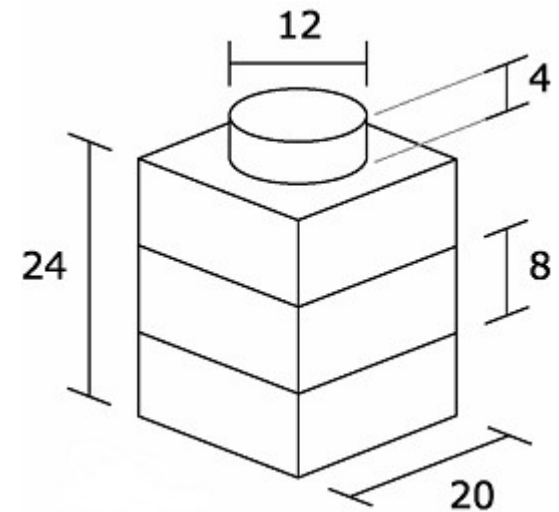
Bricks are 8mm wide by 9.6mm high

How do you make widths and heights match?

LDU makes the math easy....

How many plates = how many studs?

- 2 studs =  $2 \times 20 = 40$  LDU
- 5 plates =  $5 \times 8 = 40$  LDU



# Examples - Mosaic Dates on LEGO Modular Sets

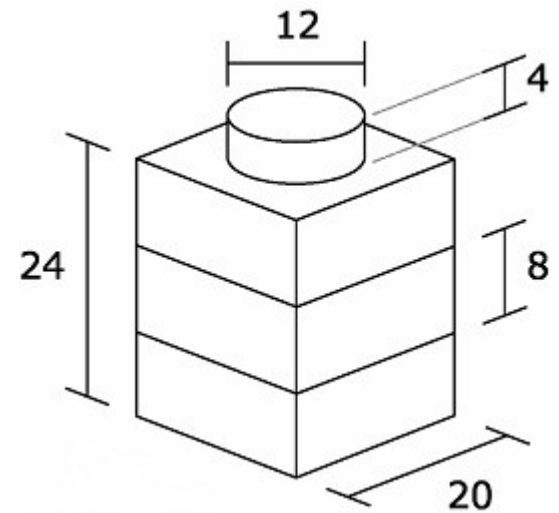
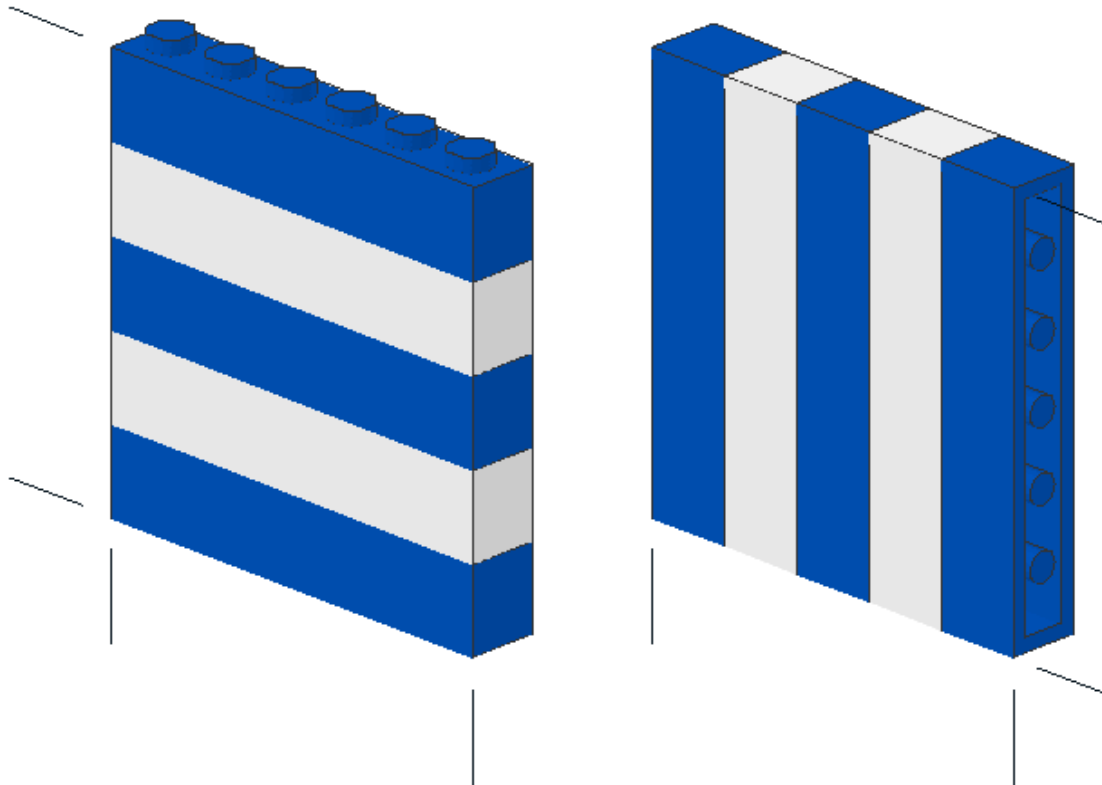


[http://commons.wikimedia.org/wiki/File:Lego\\_Modular\\_-\\_Set\\_10197\\_Fire\\_Brigade\\_%286817665156%29.jpg](http://commons.wikimedia.org/wiki/File:Lego_Modular_-_Set_10197_Fire_Brigade_%286817665156%29.jpg)  
[http://commons.wikimedia.org/wiki/File:Lego\\_Modular\\_-\\_Set\\_10224\\_Town\\_Hall\\_%288310511639%29.jpg](http://commons.wikimedia.org/wiki/File:Lego_Modular_-_Set_10224_Town_Hall_%288310511639%29.jpg)

# Ratio of Studs to Bricks

How many bricks = how many studs?

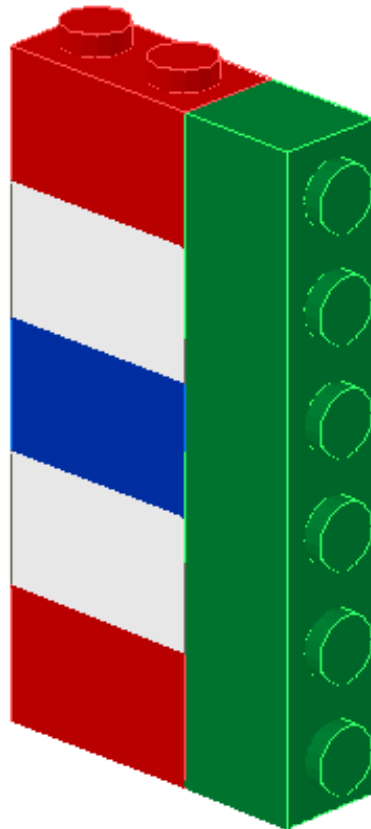
- 6 studs =  $6 \times 20 = 120$  LDU
- 5 bricks =  $5 \times 24 = 120$  LDU



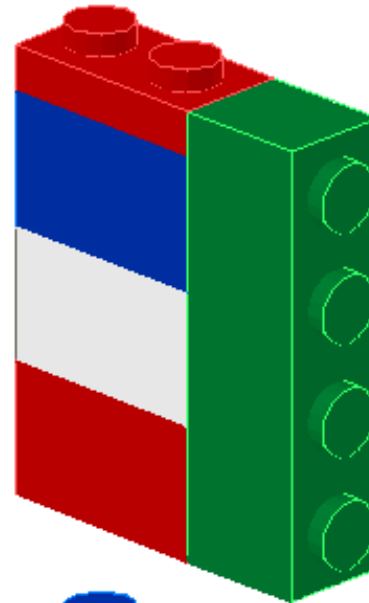
# More Easy Ratios

Any even number of studs corresponds to a combination of bricks and plates, since  $2 \text{ studs} = 5 \text{ plates}$

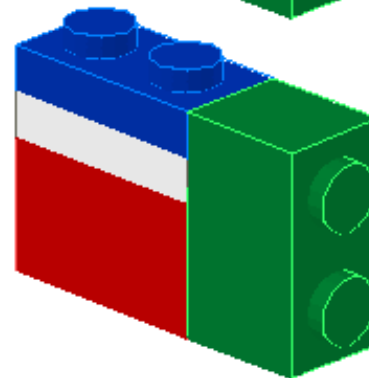
6 studs =  
5 bricks  
or 15 plates



4 studs =  
 $3 \frac{1}{3}$  bricks  
or 10 plates



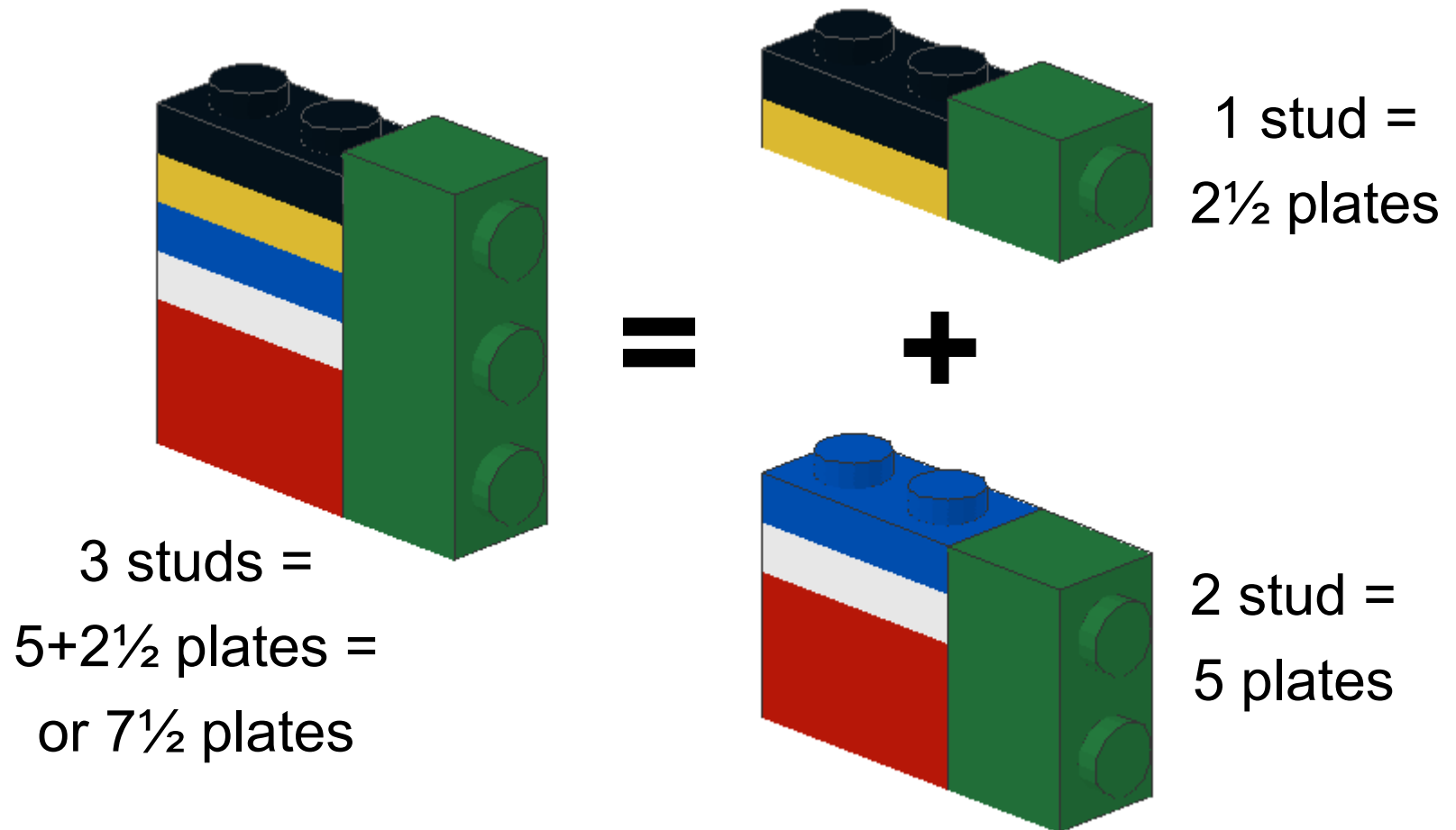
2 studs =  
 $1 \frac{2}{3}$  bricks  
or 5 plates





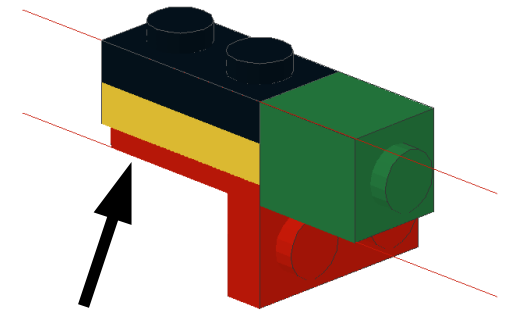
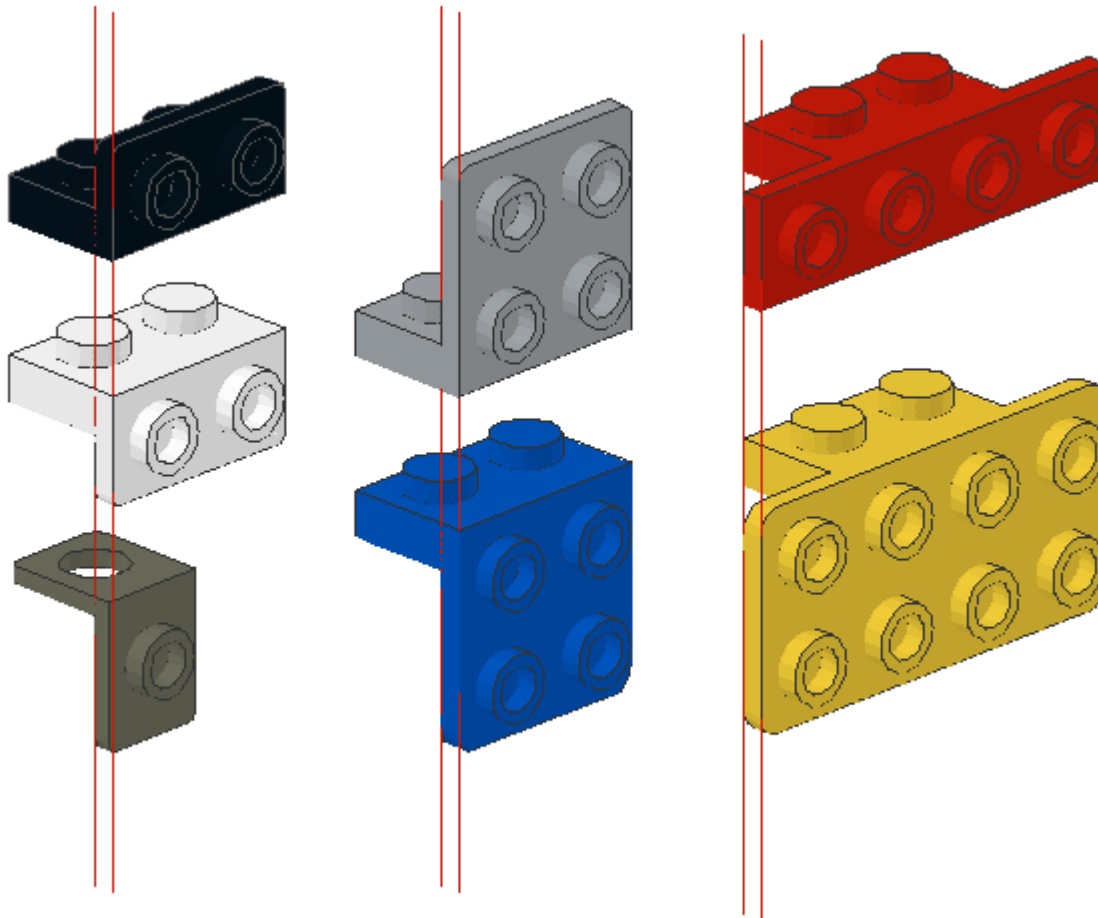
# Odd numbers are harder

Odd number of studs N is the same as even number N-1 plus a single stud. 2 studs = 5 plates, so 1 stud =  $5/2 = 2\frac{1}{2}$  plates???



# But where do you get $\frac{1}{2}$ plate?

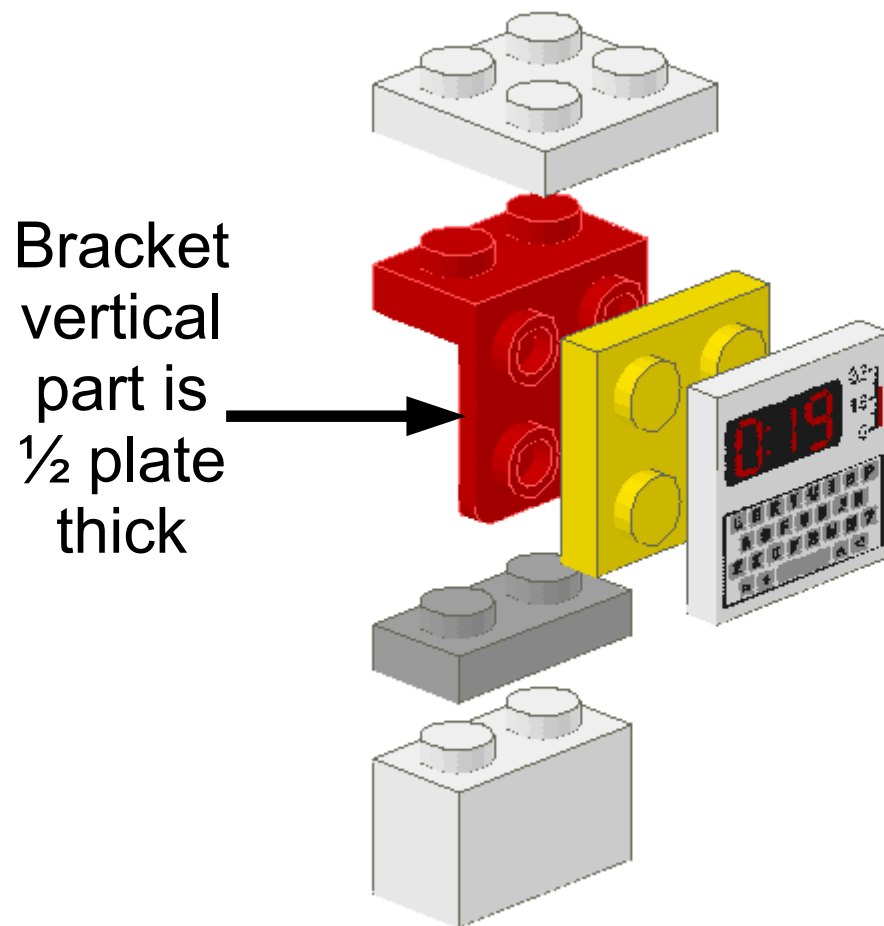
One answer: brackets. The thin vertical plate is  $\frac{1}{2}$  the thickness of a normal plate, or 4 LDU



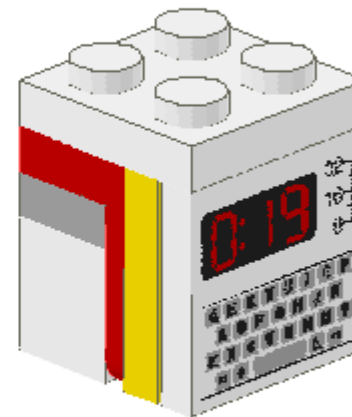
1 plate = 8 LDU thick  
1 stud brick = 20 LDU

2 plates + bracket =  
 $8 * 2 + 4 =$   
20 LDU

# Using $\frac{1}{2}$ plate thickness from brackets

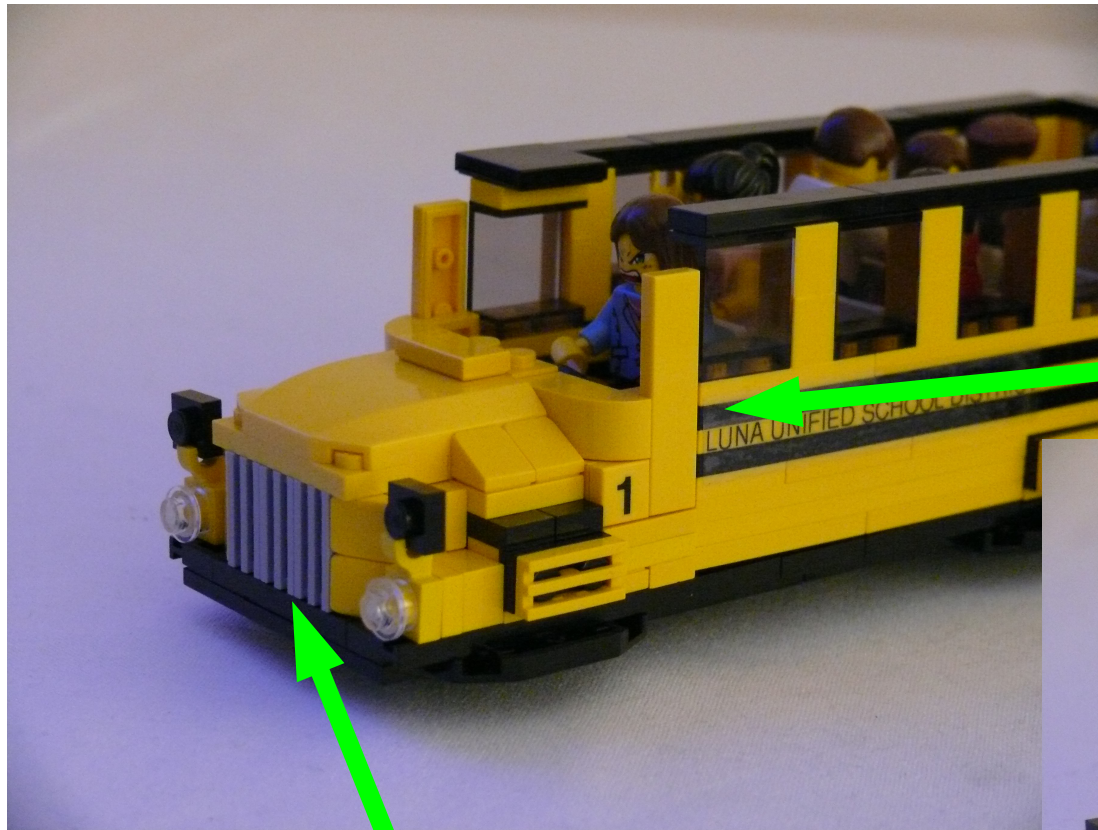


$\frac{1}{2}$  plate from bracket  
+ 1 plate + 1 tile  
=  $2 \frac{1}{2}$  plates, same as 1 stud



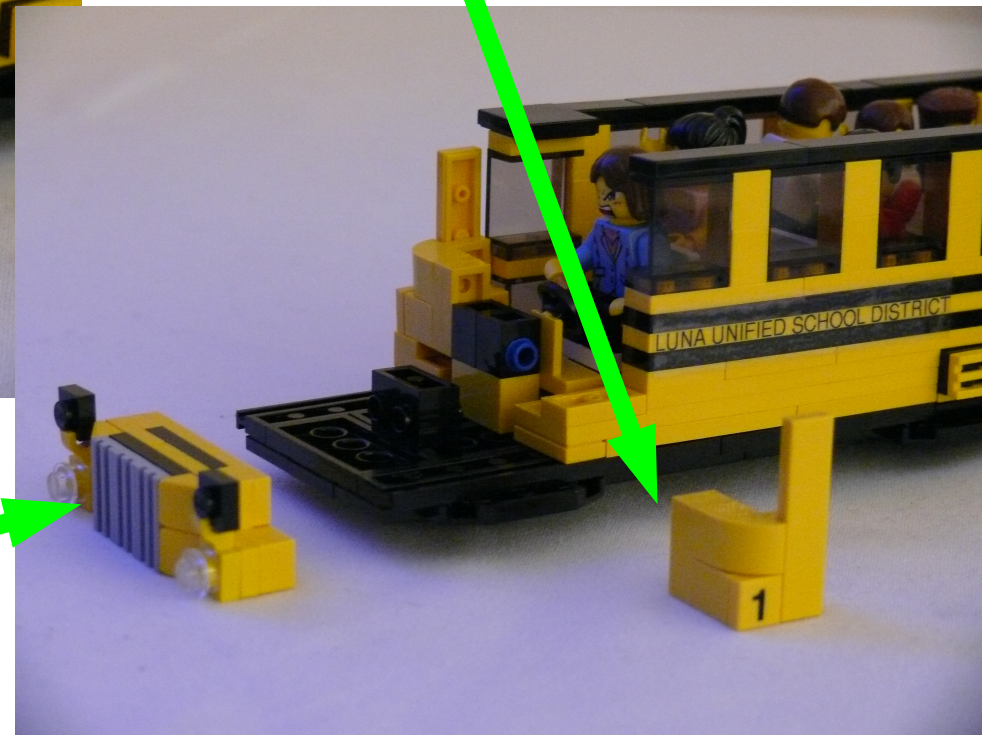
Computer tile is  
flush with edge  
of white 2x2  
plate.

# Flush tile examples



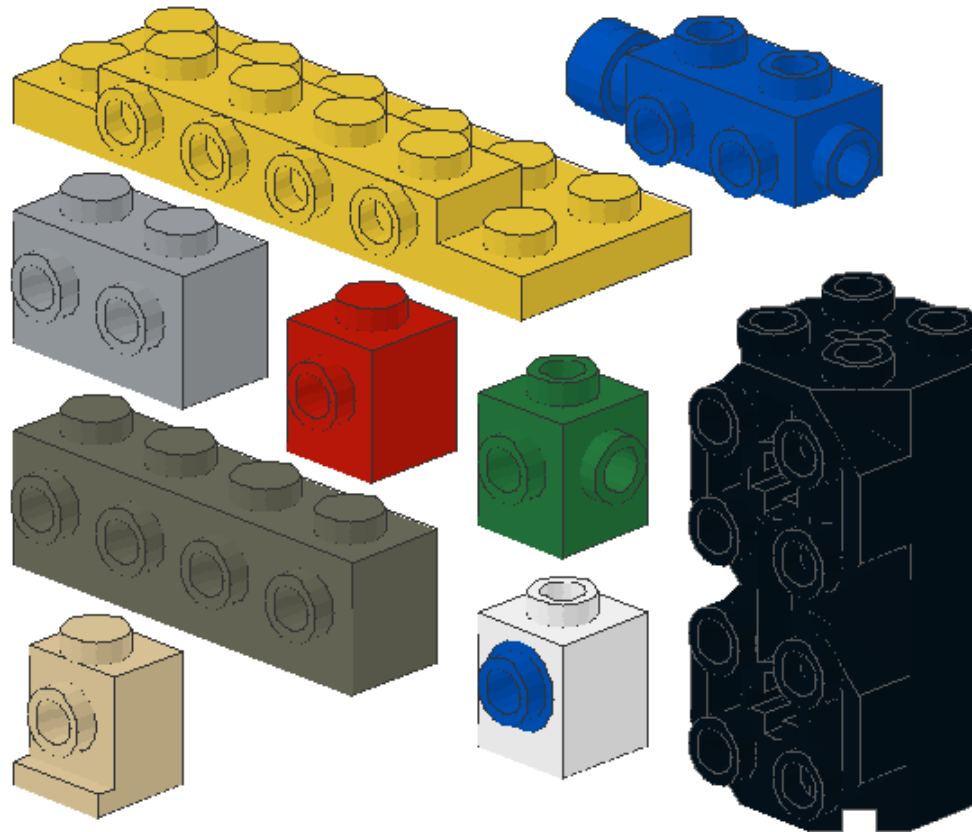
Grille and headlight assembly is 4 plates and a tile, same as 2 studs, so it lines up flush

Lunar School Bus uses this technique in two places  
Side panel is made of bricks and plates and tiles 2 studs wide, lines up flush



# Bricks with Studs on the Side

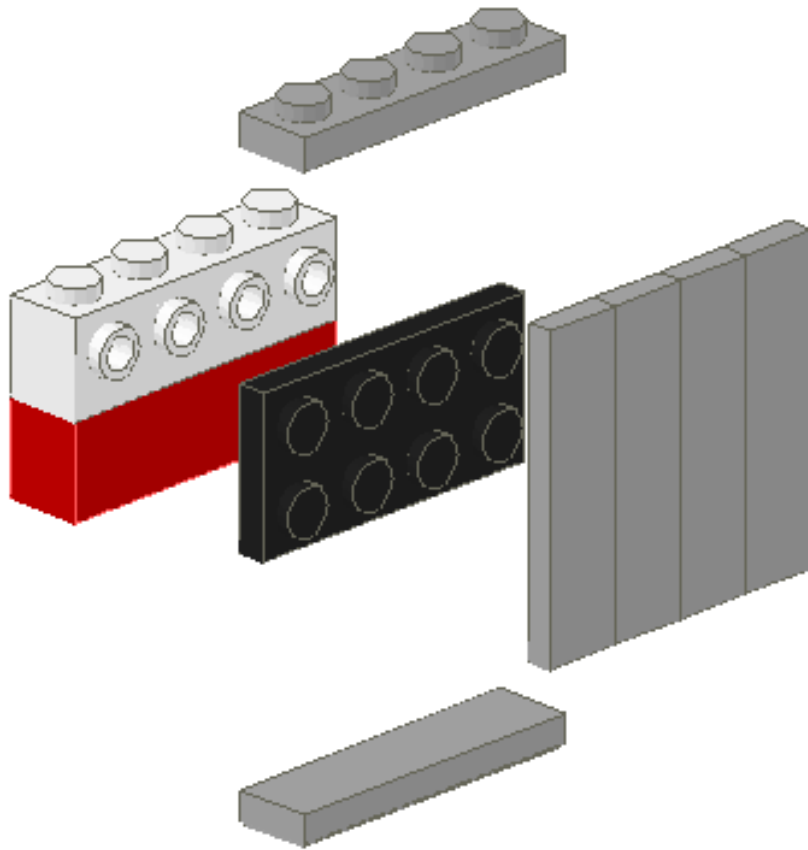
*LEGO has plenty of parts that have studs on the side, useful for SNOT (Studs Not On Top) design, similar to the brackets.*



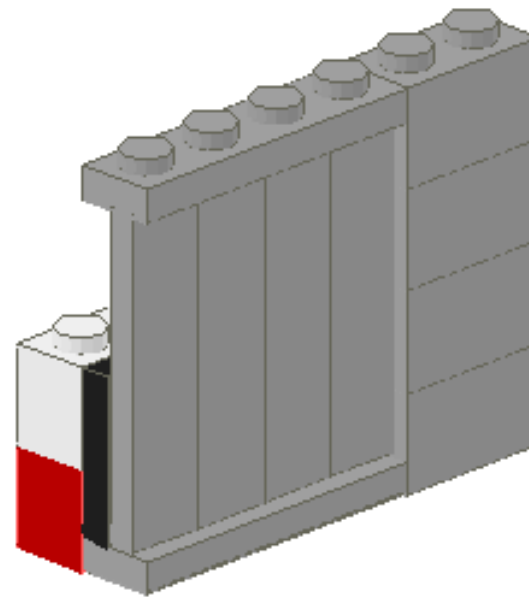
*...but what are the LDUs?*

# Half-plate offset #1: inset panels

Use half-plate offsets to add texture to an otherwise flat wall



1 plate + 2 studs (1  $\frac{2}{3}$  brick)  
= 2 bricks



Tiles are  $\frac{1}{2}$   
plate inset

2 plates + 4 studs (3  $\frac{1}{3}$  bricks)  
= 4 bricks

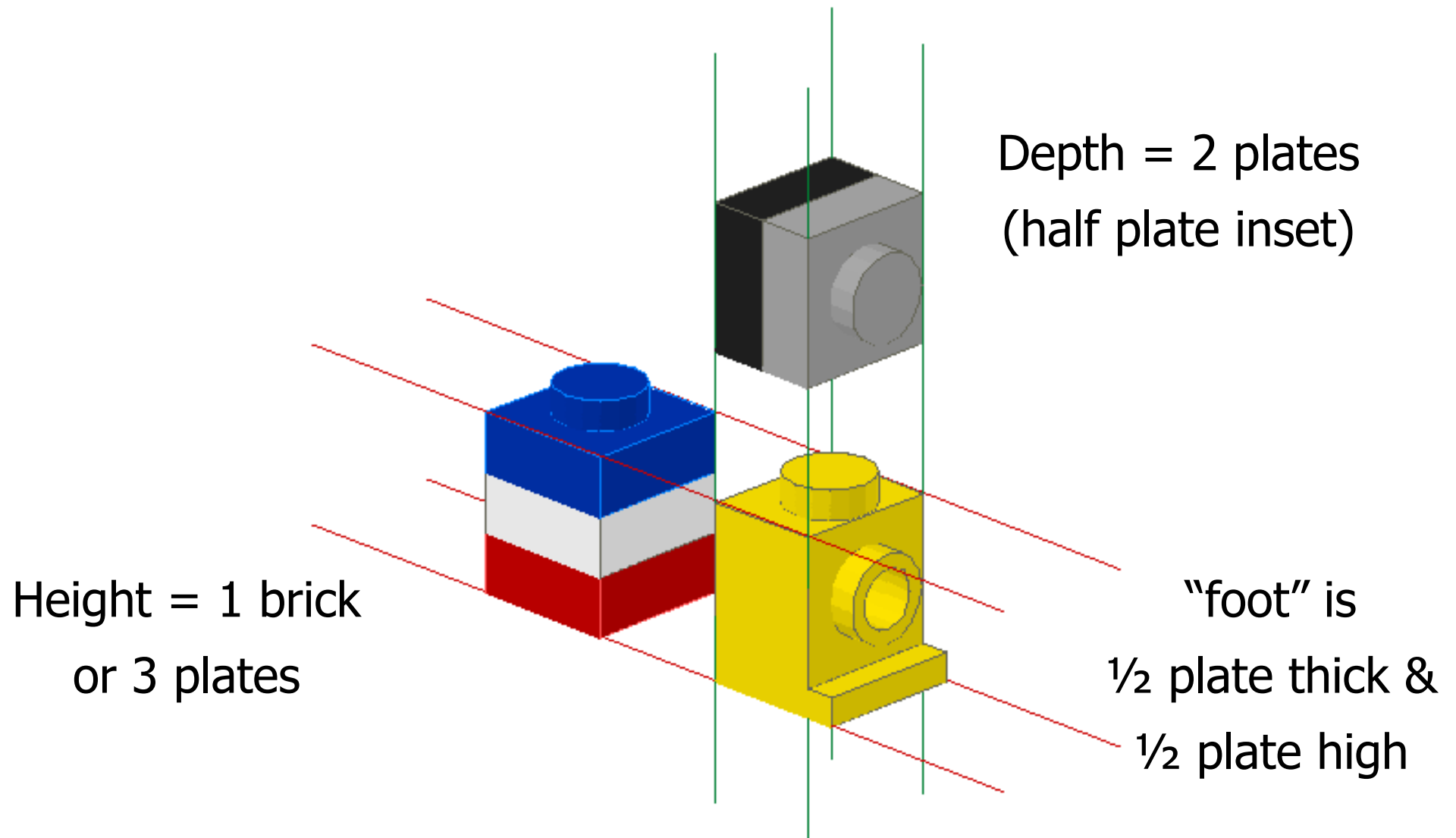


# Inset panels example



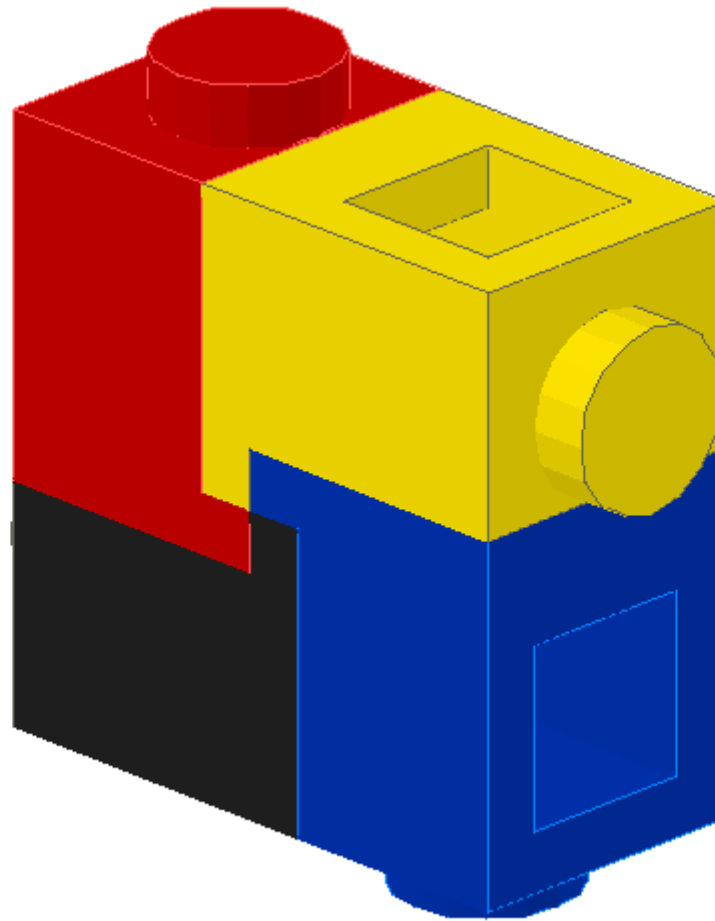
My F40PH Caltrain locomotive

# Headlight Brick Dimensions





# Four headlight bricks



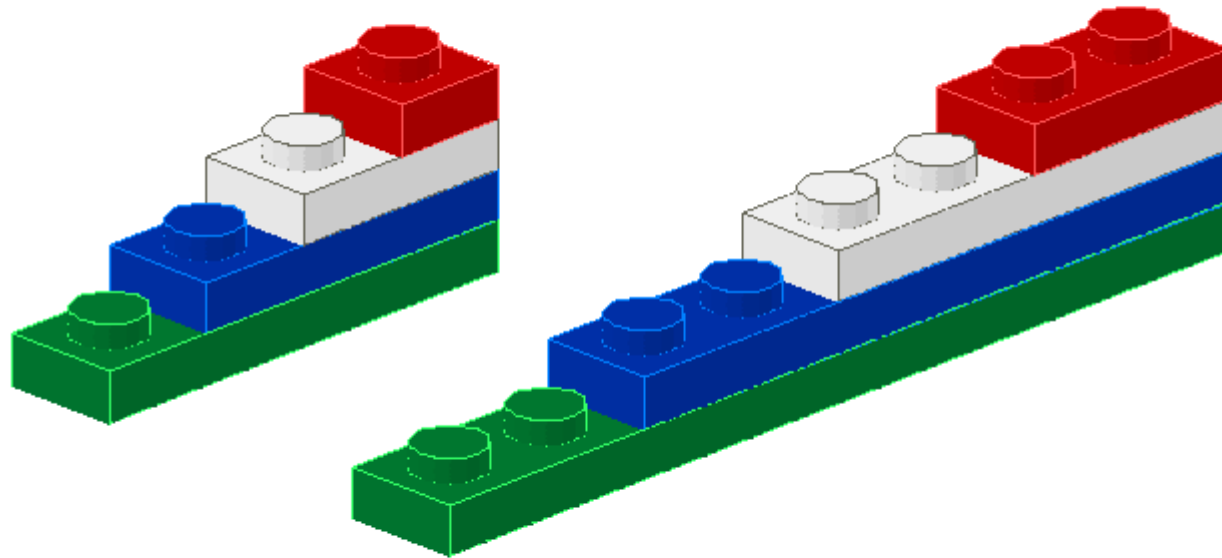
2 plates (red) +  
3 plates (yellow) =  
5 plates = 2 studs

Result: 5 plates or 2 studs in each of 4 directions.

# Problem: Gradual Steps

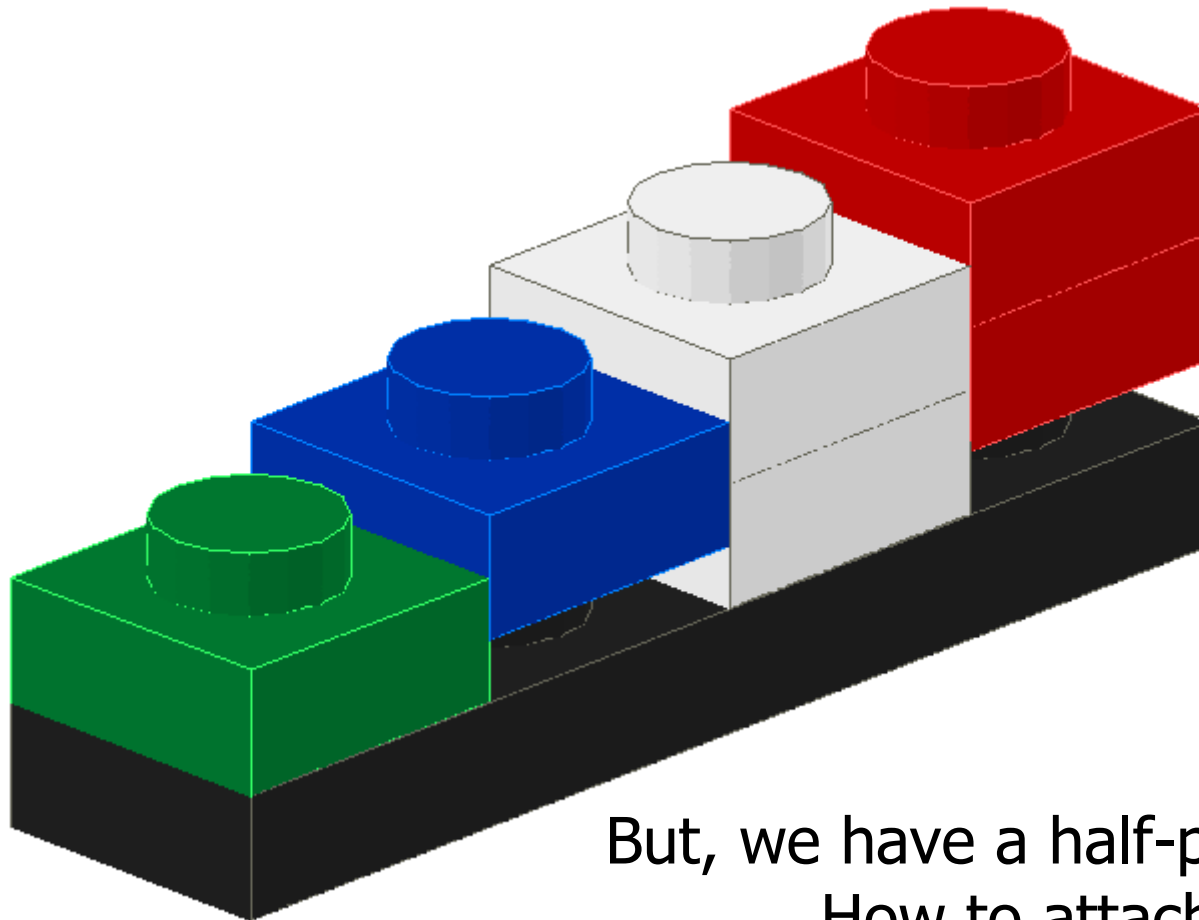
How do you make a gentle slope?

What if these are too steep?



# Gradual Steps

For a more gradual slope, we'd like to mount  
every other one  $\frac{1}{2}$  plate higher

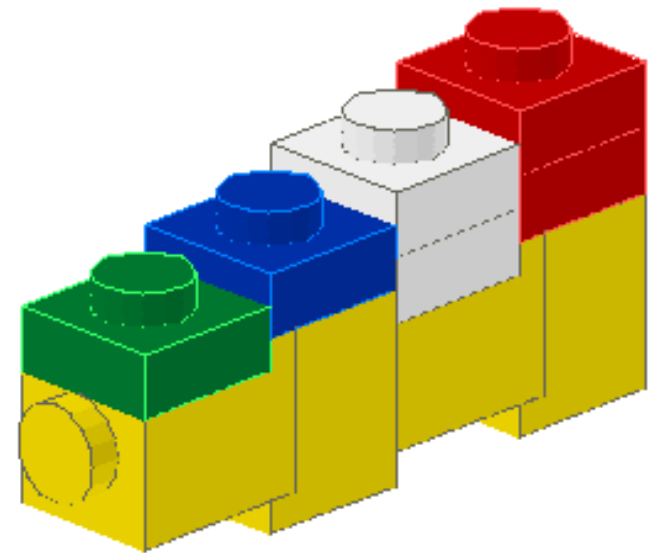
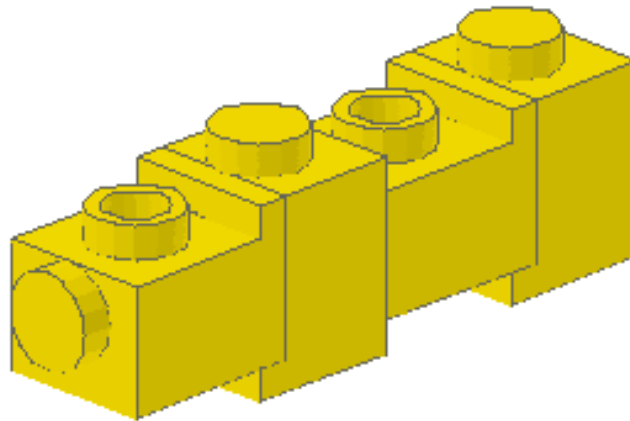


But, we have a half-plate hole to fill!  
How to attach these?

# Solution: Headlight Bricks

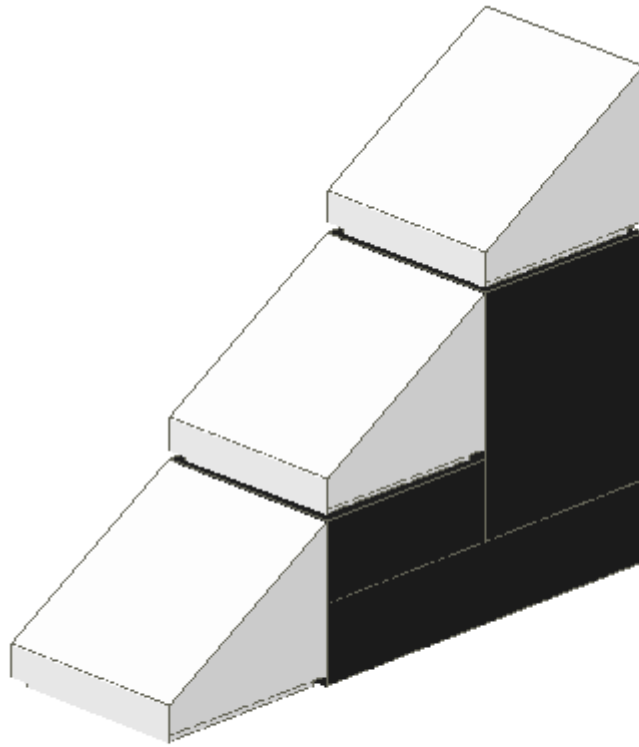
Alternate rotations for headlight bricks to take advantage of  $\frac{1}{2}$  plate offset in "foot"

2 plates +  $\frac{1}{2}$  plate = 1 stud



Half-plate lift from "foot"

# Problem with “cheese slope”: Stairstep effect

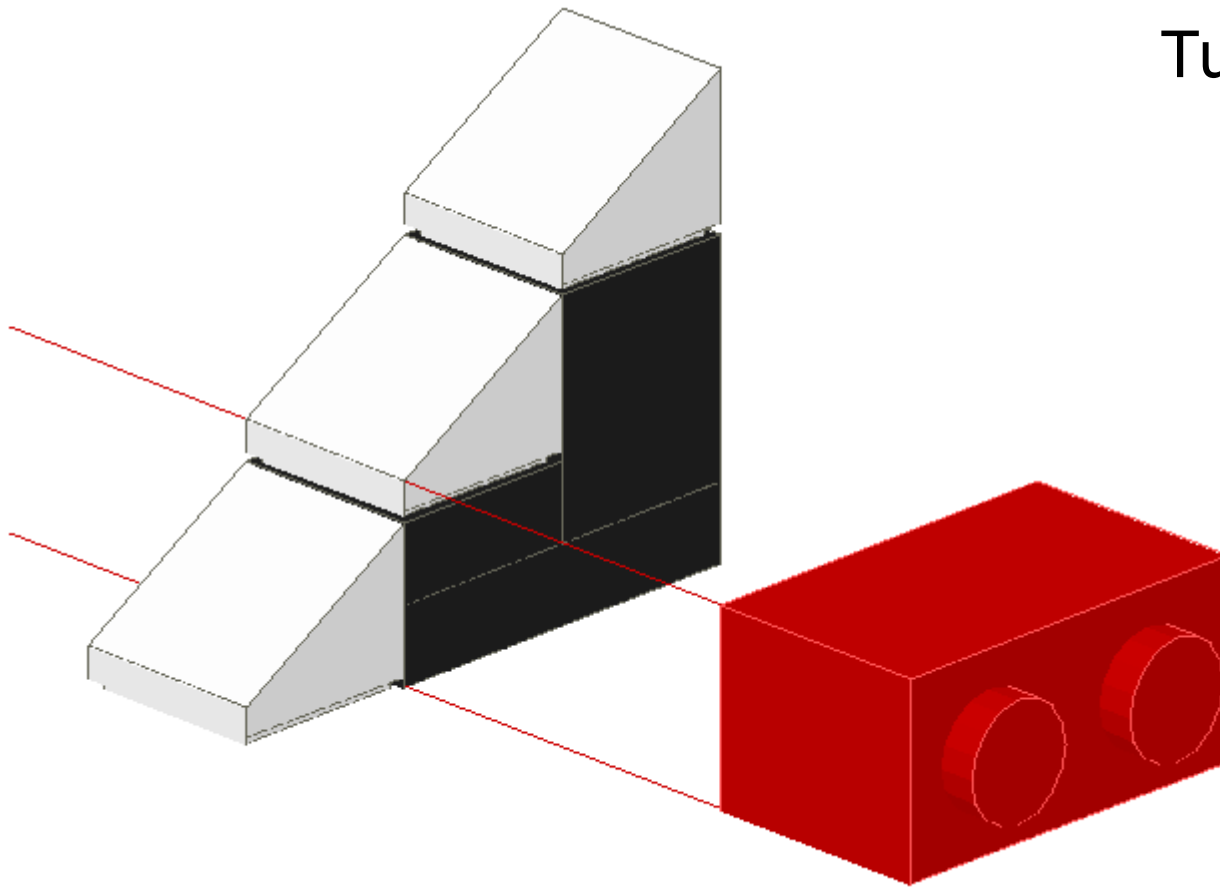


The 1x1 “cheese slope” is a very useful part but doesn't combine well with others of its kind to make a smooth slope.

This notch is needed for it to fit a stud inside, but is ugly.

# Problem with “cheese slope”: Stairstep effect

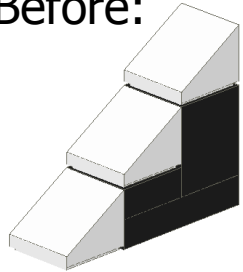
Turns out that “notch”  
is  $\frac{1}{2}$  plate thick.



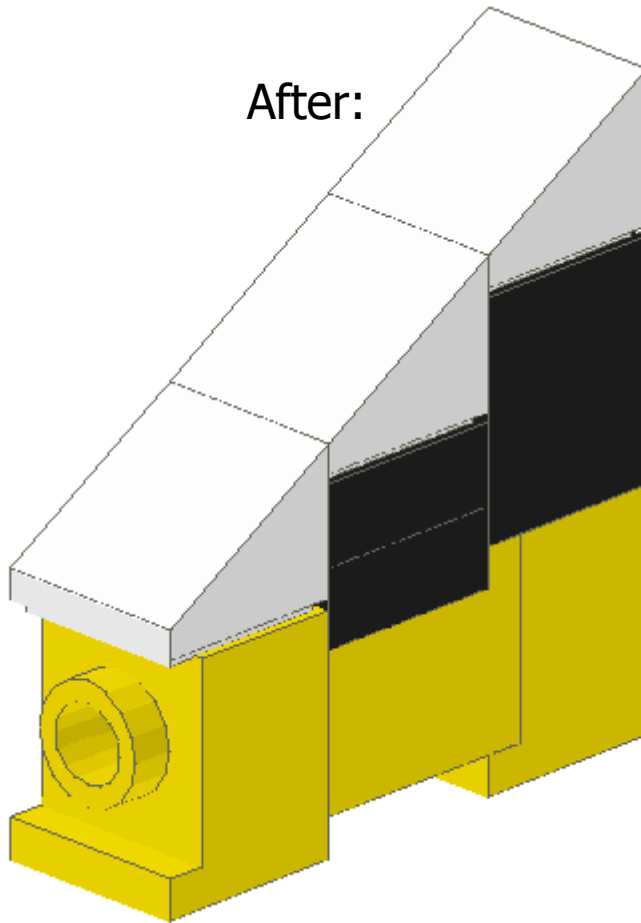
2 plates (height of cheese slope) +  $\frac{1}{2}$  plate  
= 1 stud

# Solving the stairstep effect

Before:



After:



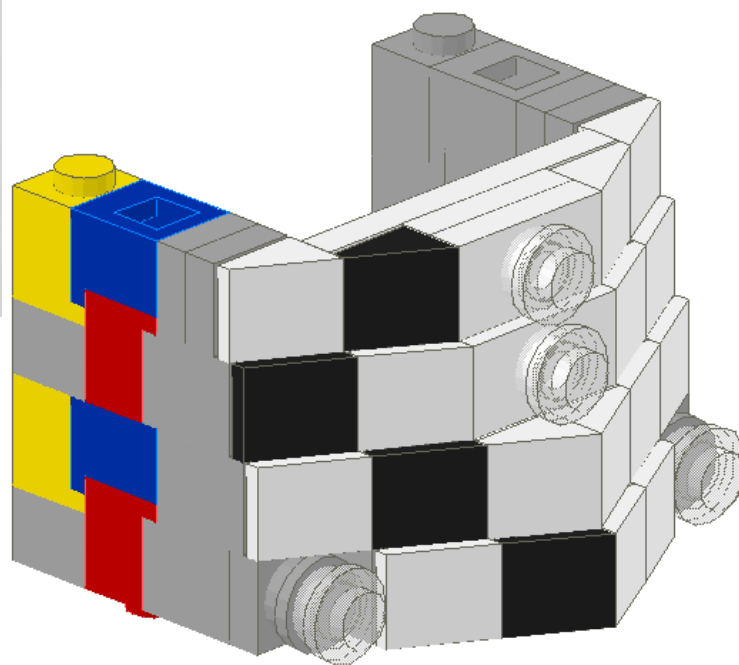
Used in Bram Lambrecht's  
"Legoland Spacelines 979"  
seen at BrickCon 2007

<http://www.flickr.com/photos/bram/1461137007/>

(used with permission)

Mount the center slope  $\frac{1}{2}$  plate lower for a smooth surface!

# Useful for trains, too



My F40PH Caltrain locomotive





# Q&A



Thank you

**Bill Ward**

`bill@wards.net`

`www.brickpile.com`