

THE LEGO® PARTS GUIDE

Understand how LEGO® *really* works.

TOM ALPHIN



BRICK ARCHITECT
brickarchitect.com

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PREFACE

Why I created this guide

My goal in creating The LEGO Parts Guide is to help you understand how LEGO really works. Each of the 12 chapters explores a broad category of parts through a mix of history, technical illustrations, and a gallery of parts organized by their appearance and function.

Understanding how LEGO works makes it a lot easier to organize your collection. You can use this guide as a starting point or adapt it to meet your needs.

SORTING UNLOCKS CREATIVITY

I spent the last decade creating resources to help LEGO builders understand, organize, and store their collection. Along the way, I've talked with hundreds of LEGO builders through surveys, online communities, and at LEGO conventions. I learned that choosing the right sorting strategy is one of the most common challenges for LEGO enthusiasts. A collection that's well-organized for what you like to build makes it easier to stay in a creative flow.

The way you sort and store your collection is highly personal and depends on many factors: the size of your collection, the age and experience of the builders in your home, your patience for sorting things, the amount of space you have, and your budget for storage products. There's no one-size-fits-all answer, but some common strategies emerged in my research.

Common sorting strategies:

- **By Color** - Families with young kids and mosaic builders often decide to organize their collection by color.
- **By Category** - Folks with smaller collections may prefer to sort into broad categories by shape instead of color.
- **By Part** - Builders with very large collections benefit from sorting most pieces by part, with separate containers for most unique parts.

BUILD SOMETHING AWESOME

I hope this book earns a place wherever you are most creative, relying on the parts catalogue for ideas when you get stuck, and the illustrations for technical details that are hard to remember. **Most of all, I hope this book helps you build something awesome — I can't wait to see it!**

The LEGO Storage Guide offers strategies to organize a LEGO collection of any size.



brickarchitect.com/guide



Learn more about each part and download printable labels online:



brickarchitect.com/parts

INTRODUCTION

What is LEGO?

From a small-town carpentry shop, to a wooden toymaker, to a pioneer in plastic toys, the LEGO Group of the 1950s had plenty of successful products but no central focus. On the ferry home from a disappointing toy fair in the UK, second-generation LEGO owner Godtfred Kirk Christiansen had a chance discussion with a Danish toy buyer who changed the company's trajectory. The buyer lamented that the problem with toys is that there's no system to them.¹ This sparked Godtfred's quest to look beyond the latest fads and develop a **system of play**: a whole range of toys that work well together.

While the company had been producing interlocking plastic bricks for several years, these early products were not a commercial success. Godtfred doubled down on its iconic *Town Plan* set which contained a play mat and interlocking bricks to build several buildings. Families had the option to expand their town by purchasing additional buildings. Innovations such as improved clutch power, functional wheels, motors, and minifigures fueled decades of growth — resulting in the LEGO Group becoming the world's largest toy company in 2015. Today, they produce thousands of *unique* parts every year, yet brand-new parts still connect with the first bricks produced more than 70 years ago.

As you will learn in this book, the evolution of the LEGO parts library is driven by the desire to introduce new ways of building and playing. Many of these innovations required part designers to invent new ways for LEGO parts to connect to one another. Wheels needed a way to rotate, motors needed a way to connect to batteries, and minifigures needed parts that could fit in their tiny claw-shaped hands. Each of these resulted in the introduction of new **connector pairs**; new ways for two parts to connect and achieve new goals.

This slow but steady progress has led to a golden age of beautifully designed LEGO sets and a vibrant fan community pushing the limits of what's possible. This guide gives you the tools to push the limits too, by exploring thousands of current LEGO parts and understanding how LEGO *really* works.

LEGO is a visual language: parts are the words, connections are the grammar, and this guide is your new dictionary. **It's time to write your next great story using LEGO bricks!**

LEGO shouldn't be used in isolation to describe products produced by the LEGO Group. Rather, it should be used descriptively: LEGO sets or LEGO bricks.

Small numbers throughout this book are bibliographic citations. Learn more in the **APPENDIX**.

An adult LEGO builder is sometimes referred to as an **AFOL** or Adult Fan of LEGO. (TFOL or KFOL is sometimes used to describe Teens or Kids.)

BASIC

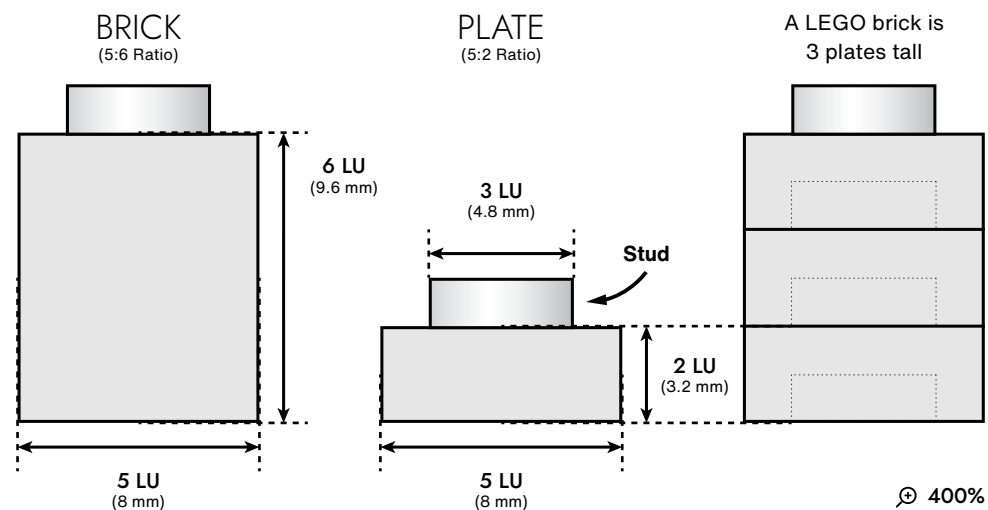
Classic LEGO bricks, plates, and tiles form the core of the LEGO building system. These basic elements can be stacked vertically by pushing the round studs on the top of each brick into the underside of another part. This creates a surprisingly strong connection, which is commonly called clutch power.

SNAPPING INTO PLACE

The LEGO Group began selling plastic bricks in 1949 under the name *Automatic Binding Bricks*.² These early bricks had studs on top to aid in stacking, but they lacked enough friction to bind tightly and prevent models from toppling when moved. The introduction of tubes on the underside of each brick made LEGO models stable enough to be lifted and even ‘swooshed’ around the room. This breakthrough laid the foundation for the company’s success in the 1960s and beyond.

The connection between a stud and an antistud (the space where a LEGO stud attaches on the underside of another LEGO brick) is the first of many **connector pairs** we will explore in this book. As we will learn in subsequent chapters, there are other parts that can act like a stud and attach to the bottom of a brick, including a minifigure’s hand. There are also other parts that a LEGO stud can attach to, such as a Technic pin hole.

When stacked, LEGO bricks are slightly taller than they are wide. The actual ratio is 5 LU wide to 6 LU tall. **Plates**, which are $\frac{1}{3}$ of the thickness of a brick, were introduced eight years later. Their thinner profile tripled the vertical resolution, increasing the amount of detail which was possible. The introduction of large plates made it easier to build bigger models.



LEGO bricks have unusual proportions that are slightly taller than they are wide.

The Stud and Tube connection was patented by the LEGO Group on January 28, 1958.³

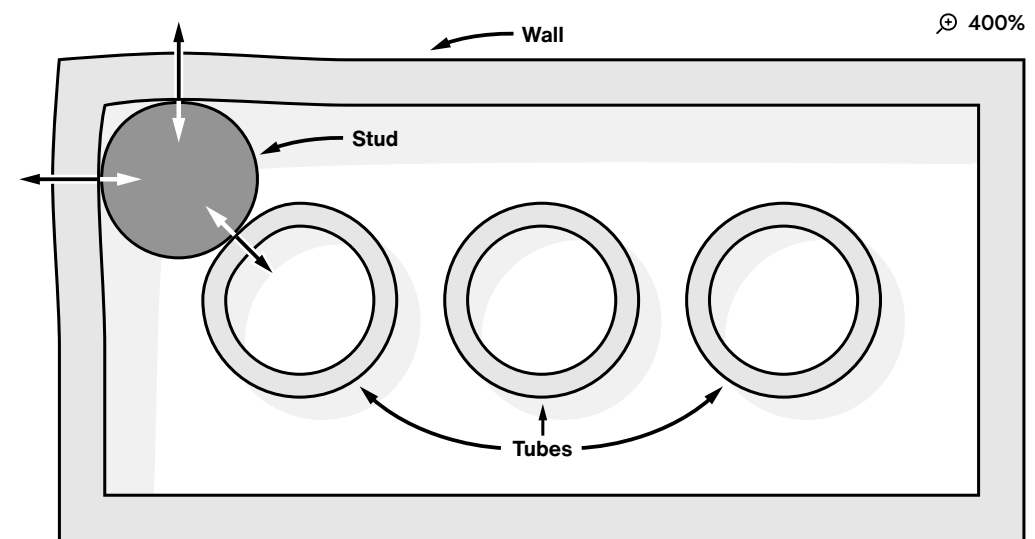
Connector Pair is the term used by the LEGO Group to describe the many ways that two different parts can connect with one another.⁴

In this guide, I refer to the width of a LEGO brick as a **stud**, but the LEGO Group often refers to this width as a **module**.⁵

Smooth **tiles** were added to the parts catalog soon thereafter. They made it possible to cover up the round studs and achieve a much more streamlined aesthetic with your LEGO creations. An increased reliance on tiles in recent years has coincided with a push for increasingly realistic models, especially in sets aimed at adult builders.

WHAT IS ‘CLUTCH POWER’?

You may not realize it, but a LEGO stud is slightly larger than the opening in the underside of a LEGO brick. When you push on the top of a LEGO brick to attach it to another piece, the stud forces the plastic it is touching to deflect slightly. This subtle pressure creates friction, which results in a tight connection between a stud and antistud.



The walls, tube, and the stud itself deflect slightly when inserted, creating a strong connection. (Stud size exaggerated for effect.)

While clutch power is usually used to describe how bricks with studs connect to one another, the same concept applies to most of the connector pairs we will explore in this guide.

*Parts with additional features are included in subsequent chapters. For example, bricks with an outward-facing stud are in the **SNOT** chapter, plates with a clip are in the **ARTICULATION** chapter, and bricks with a Technic pin hole are in the **TECHNIC** chapter.*

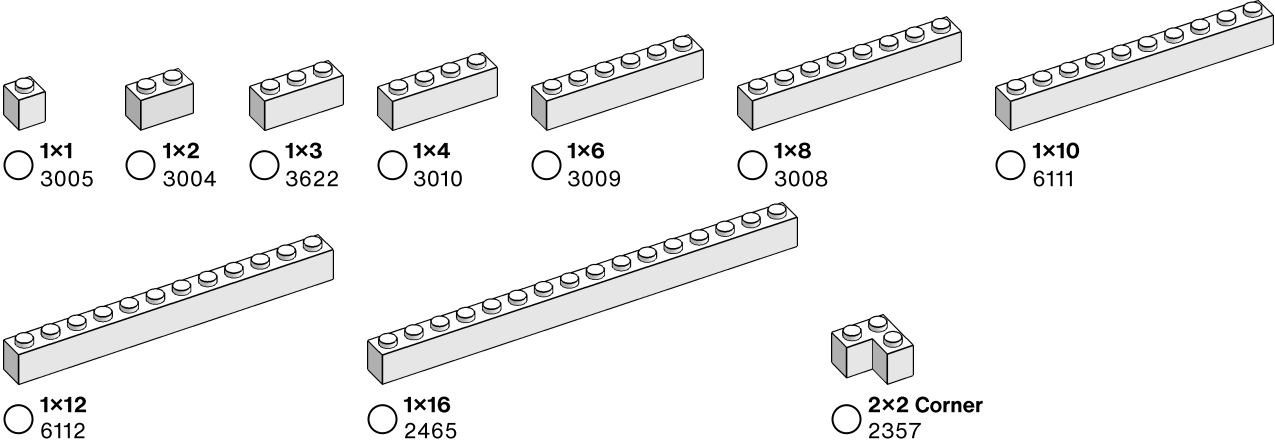
A connection caused by the friction between tight-fitting parts is also called an **interference fit**.

The LEGO Group uses custom testing tools to verify the clutch power of every new part.⁶ The optimal force is measured in Newtons.⁷

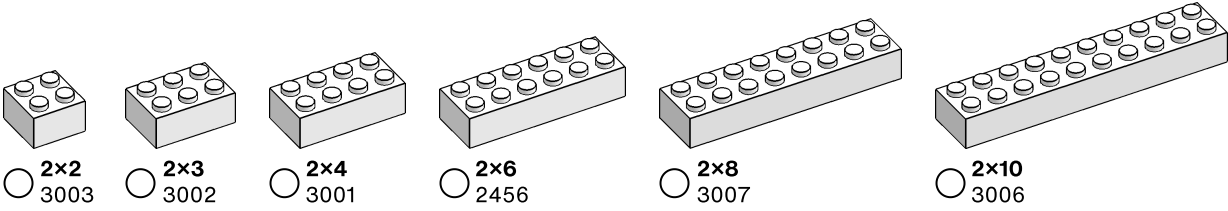
SNOT (Studs Not On Top) means building sideways.

BASIC PARTS

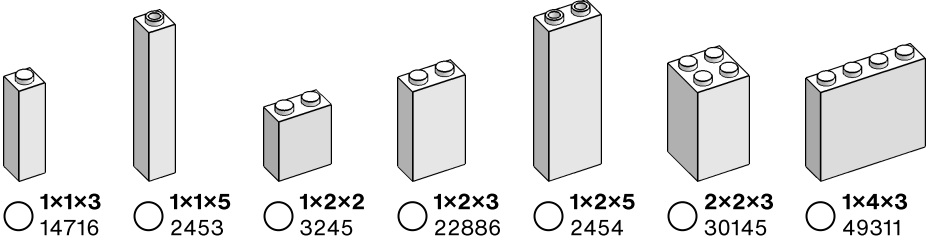
BRICK > 1x BRICK



BRICK > 2x BRICK



BRICK > TALL BRICK



BRICK > HOLLOW BRICK

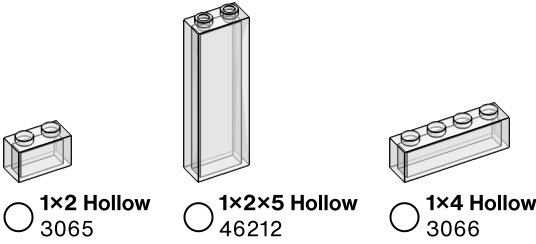


PLATE > 1x PLATE

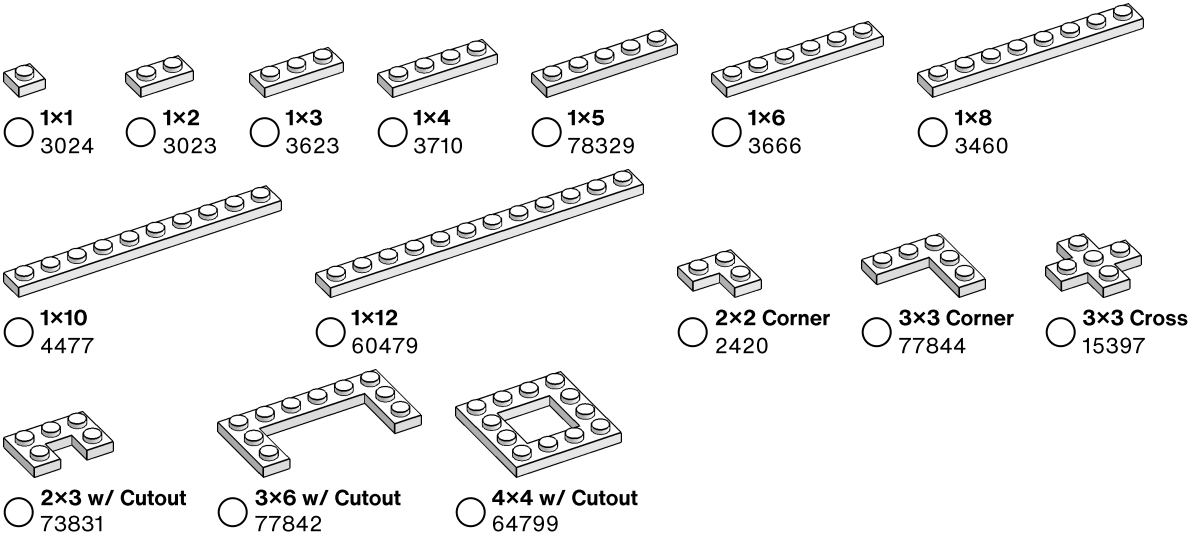


PLATE > 2x PLATE

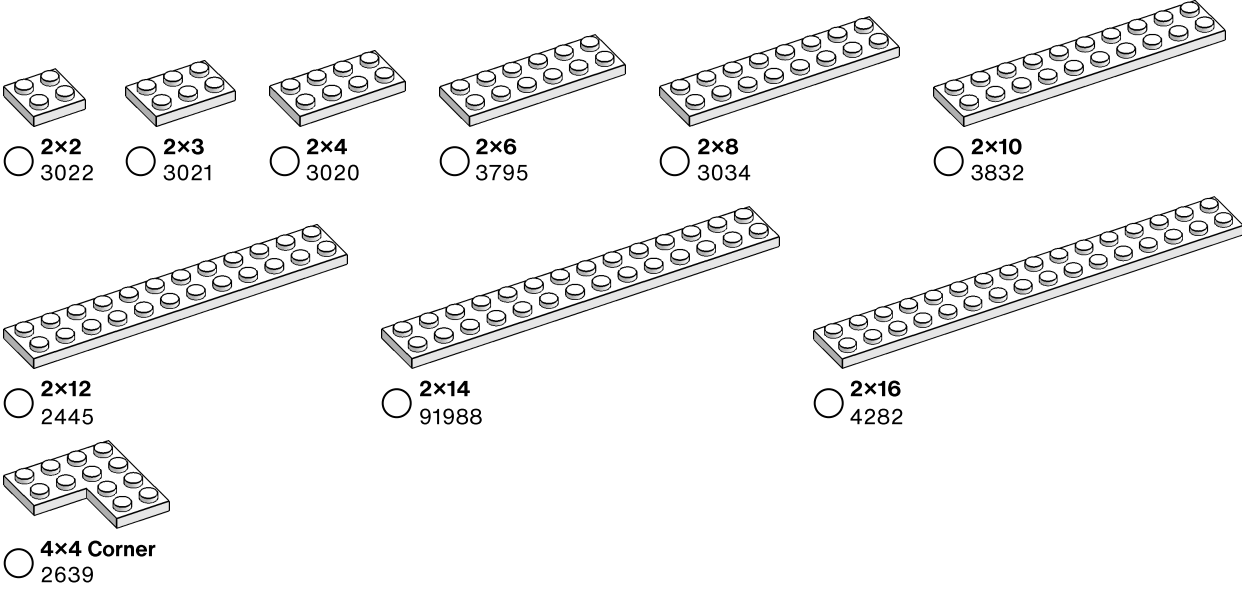
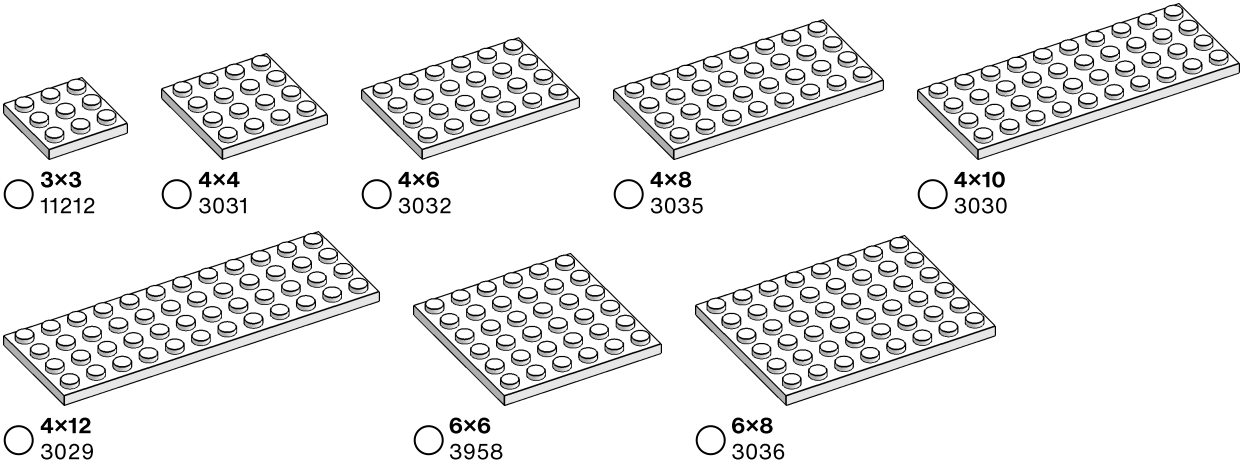


PLATE > LARGE PLATE



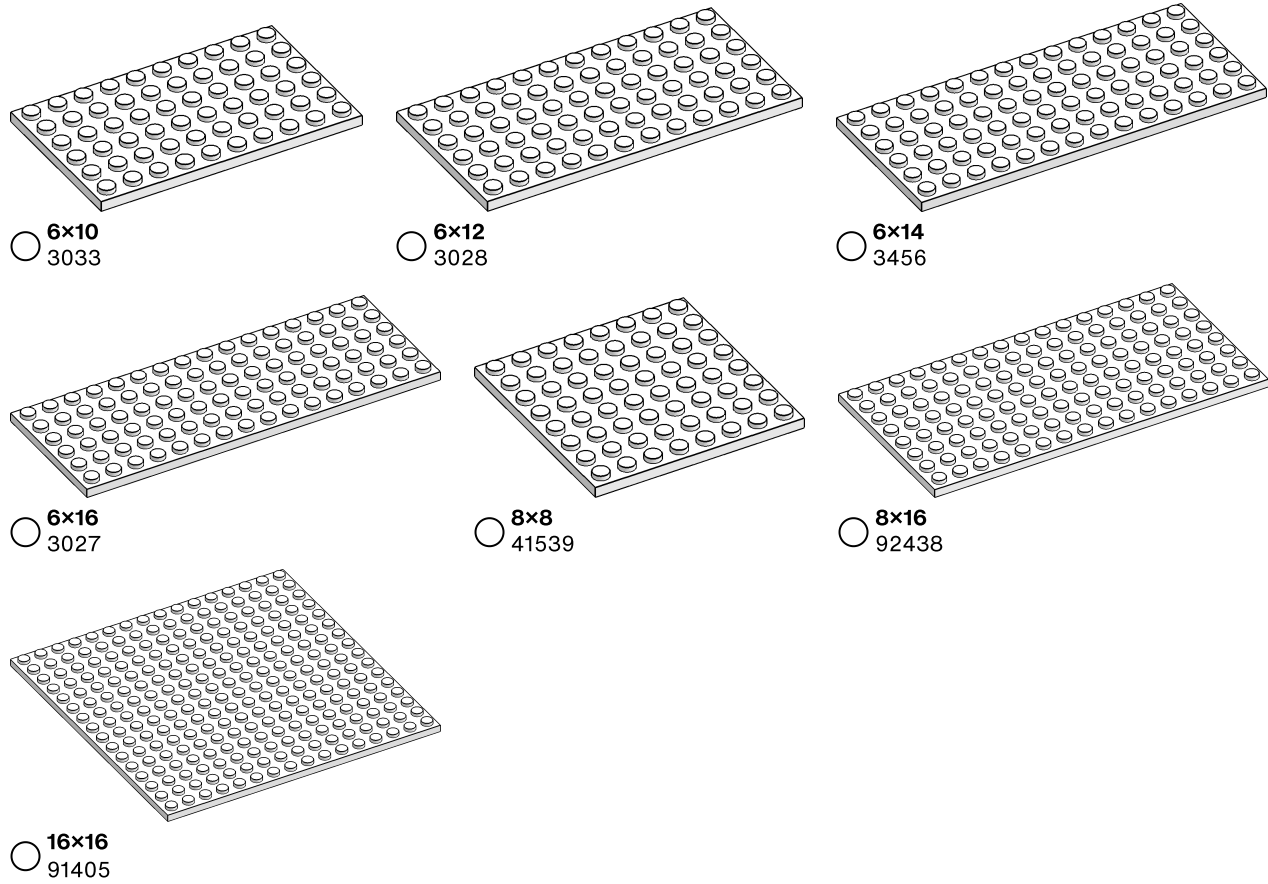
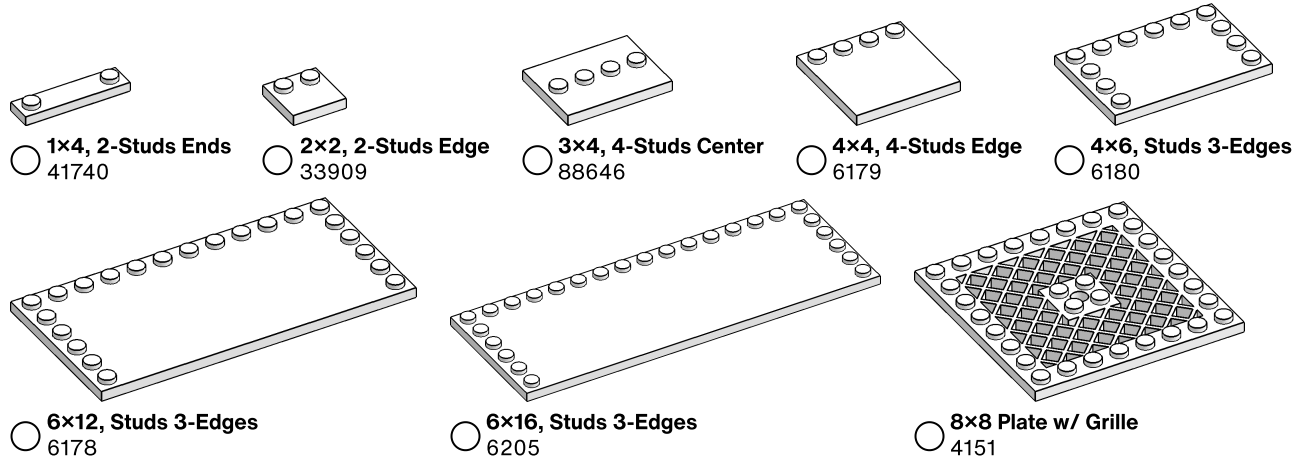
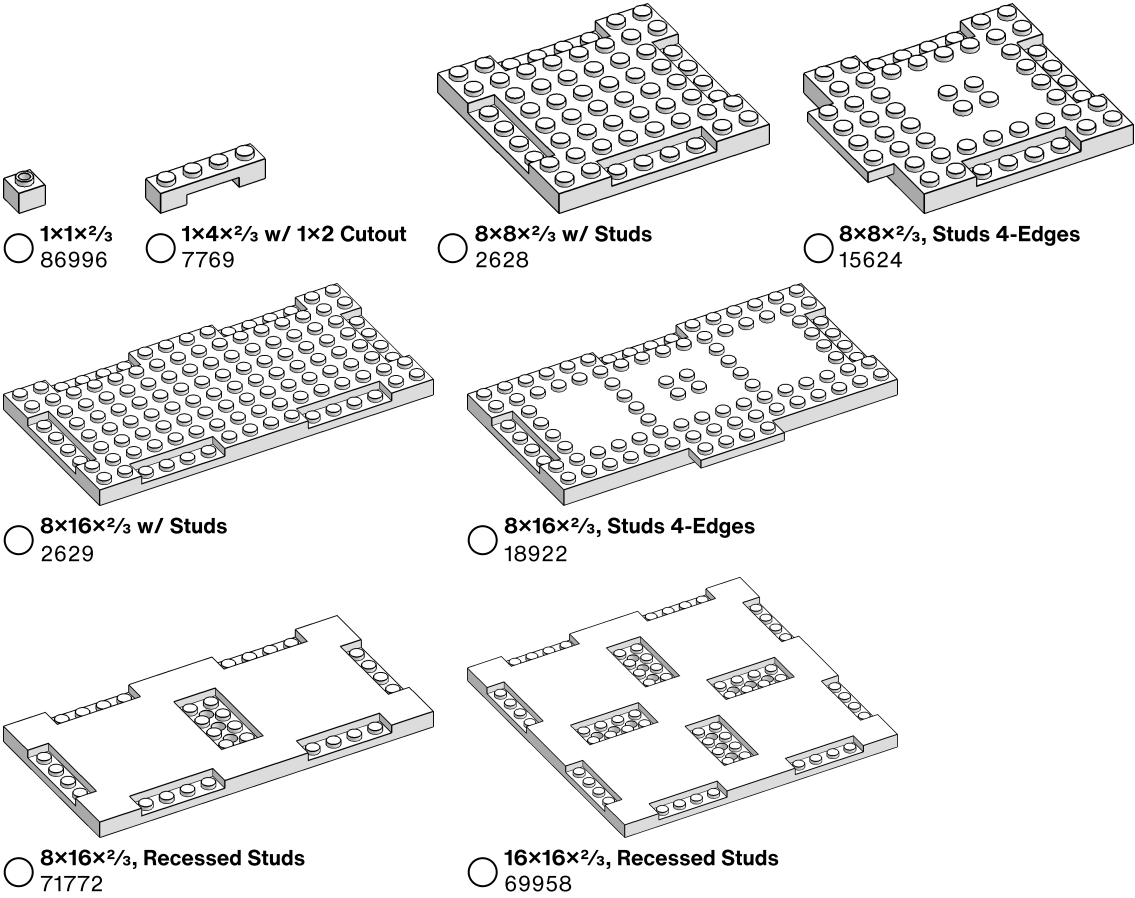


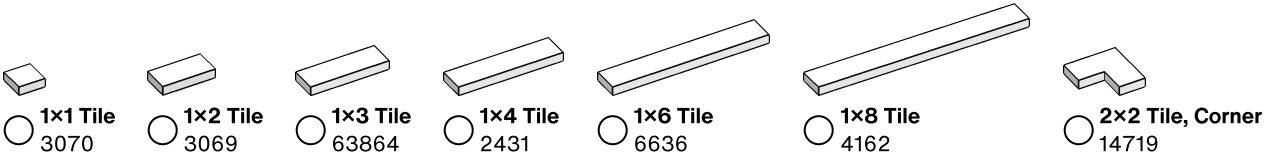
PLATE > OTHER PLATE



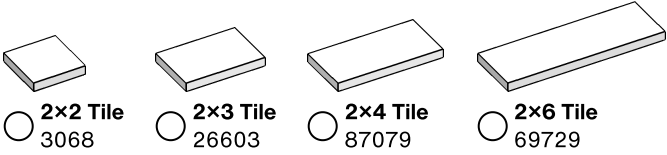
BLATE



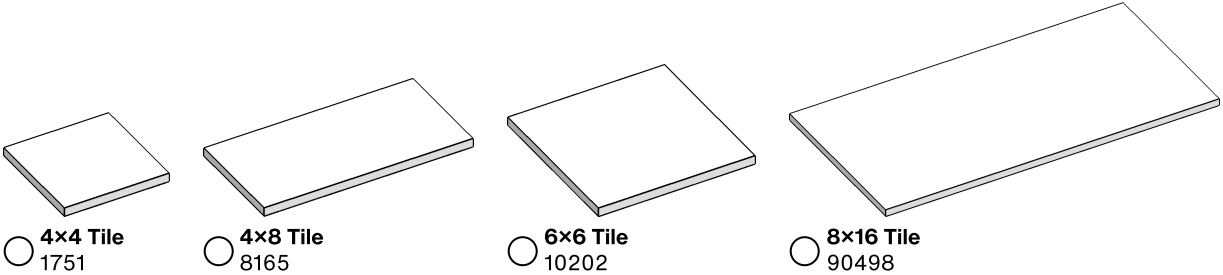
TILE > 1x TILE



TILE > 2x TILE



TILE > LARGE TILE



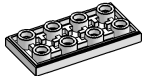
TILE › INVERTED TILE



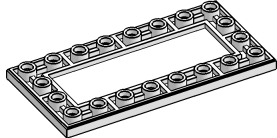
○ **1×3 Tile, Inv. w/ Hole**
35459



○ **2×2 Tile, Inv.**
11203

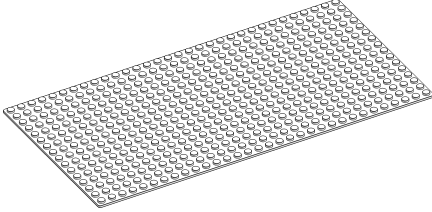


○ **2×4 Tile, Inv.**
3395

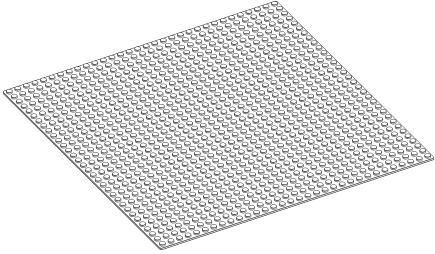


○ **4×8 Tile, Inv.**
83496

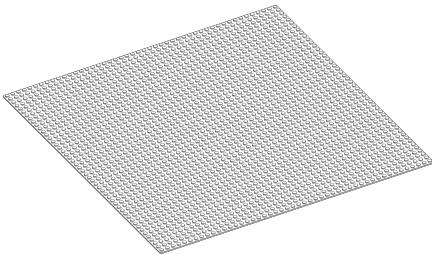
BASEPLATE



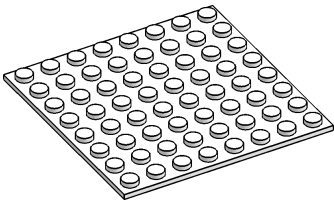
○ **16×32 Baseplate**
3857



○ **32×32 Baseplate**
3811

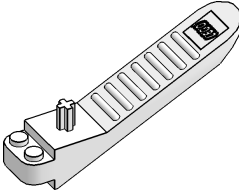


○ **48×48 Baseplate**
4186

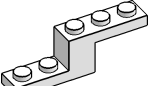


○ **8×8 Baseplate w/ Adhesive**
80319

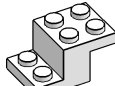
OTHER



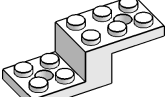
○ **Brick Separator**
96874



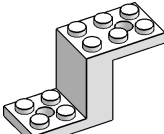
○ **5×1×1¹/₃ Bracket**
5712



○ **3×2×1¹/₃ Bracket**
73562



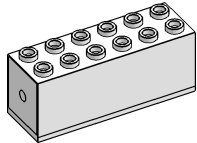
○ **5×2×1¹/₃ Bracket**
11215



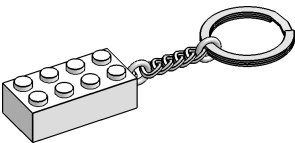
○ **5×2×2¹/₃ Bracket**
76766



○ **2×2×2¹/₃ Rubber Foot**
109373



○ **2×6×2 Brick, Counterweight**
73090



○ **2×4 Keychain**
49757

NOTES

ANGLE

Slopes are angled on a vertical axis, making them well suited for use on roofs and vehicles. By contrast, **wedges** are sloped on a horizontal axis, making them perfect for wings. **Wedge slopes** combine a wedge shape on the horizontal axis with a sloped profile, often resulting in a pointed shape.

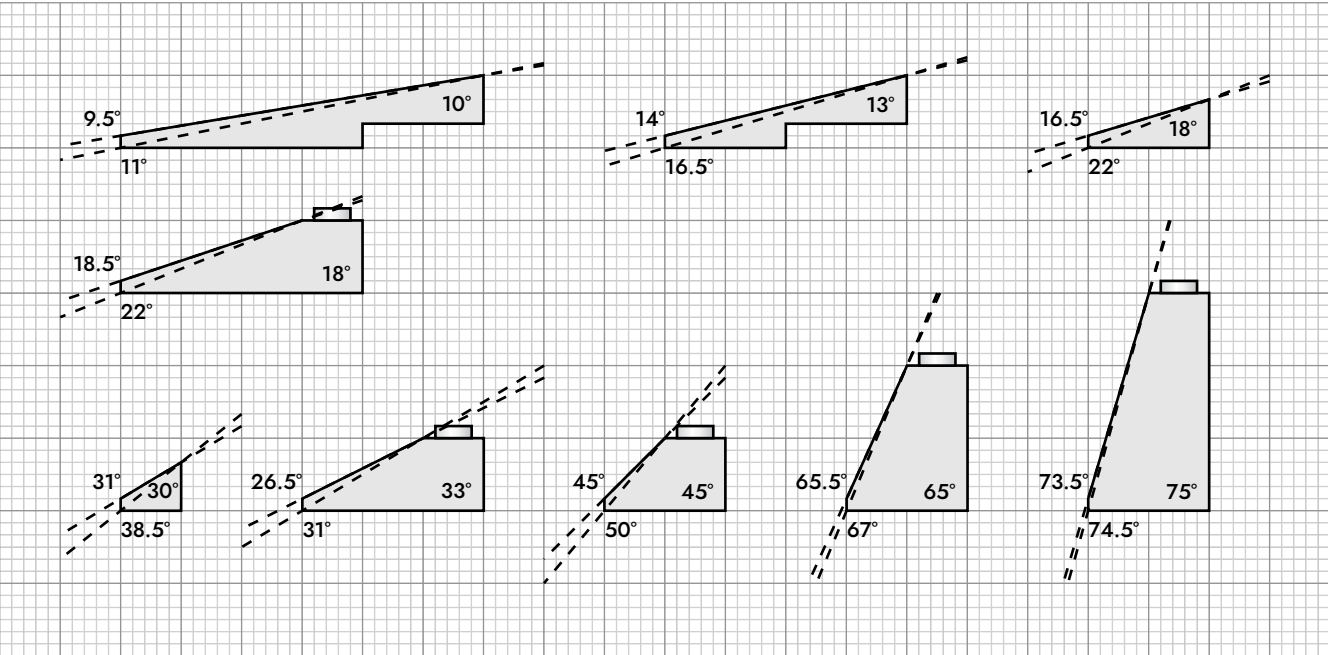
SLOPES (ANGLED UP & DOWN)

The earliest *Automatic Binding Brick* sets (the tubeless precursor to the modern LEGO brick) showed simple rectangular homes, but the sloped roofs were approximated by stacking rectangular bricks toward the center of the roof.

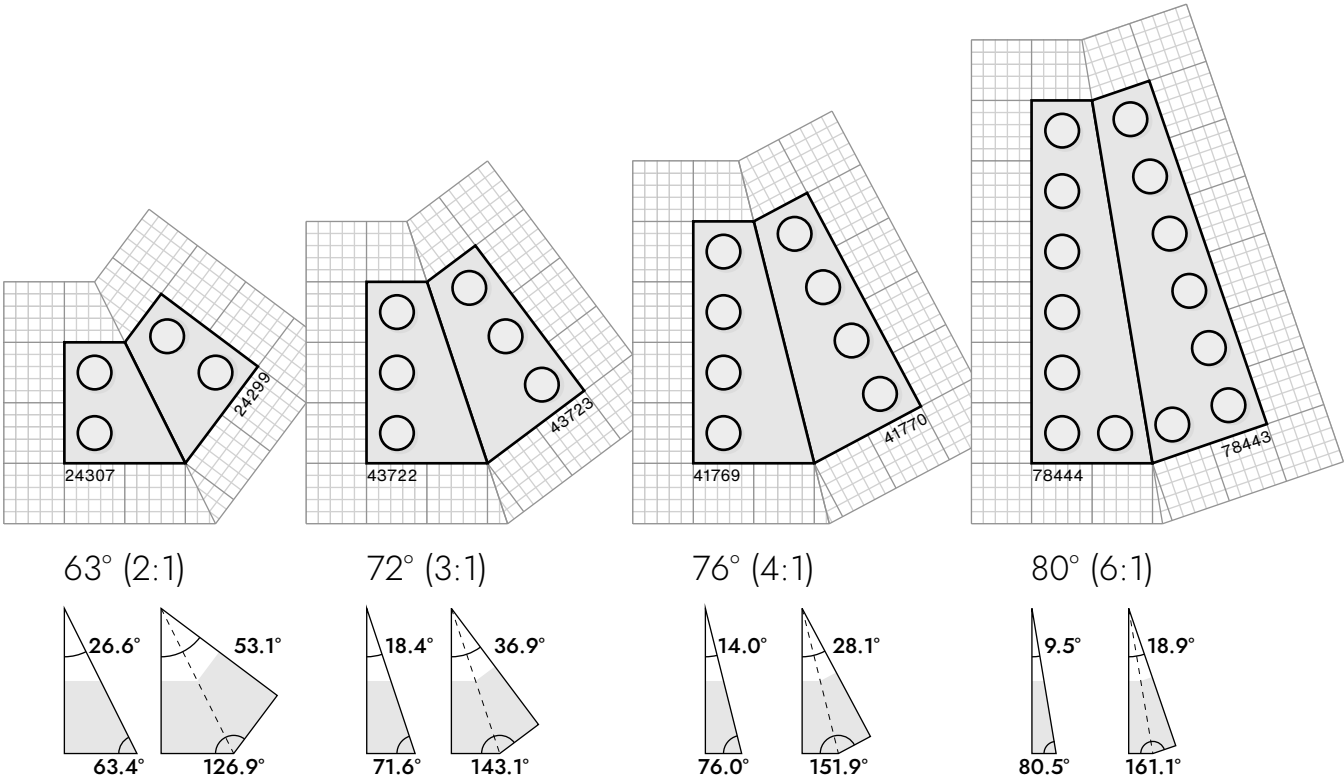
By 1958, the LEGO Group made it possible to achieve a smoother angled roof by releasing a supplemental pack of *Angle and Valley Corner Tiles* featuring bricks with a 45° angle. It took more than 10 years before they introduced sloped pieces with different angles: a more gently sloping 33° roof in the early 1970s and steeper 65° and 75° slopes by the late 70s.

Within this category you will also find several windscreens: sloped parts which are the same thickness as a panel (1 unit thick), typically transparent, and often used in vehicles.

Samsonite produced the first *Town Plan* set for the US market in 1961, but it still did not include these early slopes.



Slopes labeled with angle used in part names (right), actual slope (left), and slope when stacked (bottom).



Left and right wedges can be combined to connect parts outside of the normal grid.

WEDGES (ANGLED SIDEWAYS)

Plates that are angled along the horizontal plane were introduced for airplane wings in the early 1970s and expanded alongside *Classic Space* and *City* themes. The angle for each part describes the larger of the two angles.

It is possible to create models that are not bound to the rectangular grid using a pair of wedge plates. As shown in the illustration above, each pair allows you to attach sections at a different angle.

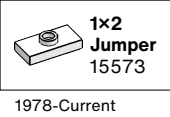
WEDGE SLOPES (ANGLED BOTH WAYS)

Even more complex angled parts combine a wedge profile on the horizontal axis and a sloped profile on the vertical axis. These compound shapes are sometimes called a nose because they resemble the front of an aircraft or spacecraft.

Designers of the short-lived *NEXO Knights* theme created a unique aesthetic by spending most of their budget on a selection of pointed parts, including a pair of pointed wedge slopes: *6×8 Wedge, Pointed w/ Cutout*, and *4×4 Wedge, Pointed*.¹³ Outside of the new parts introduced with that theme, the number of new parts in this chapter has grown very slowly in recent years, especially compared to the selection of curves that has skyrocketed.



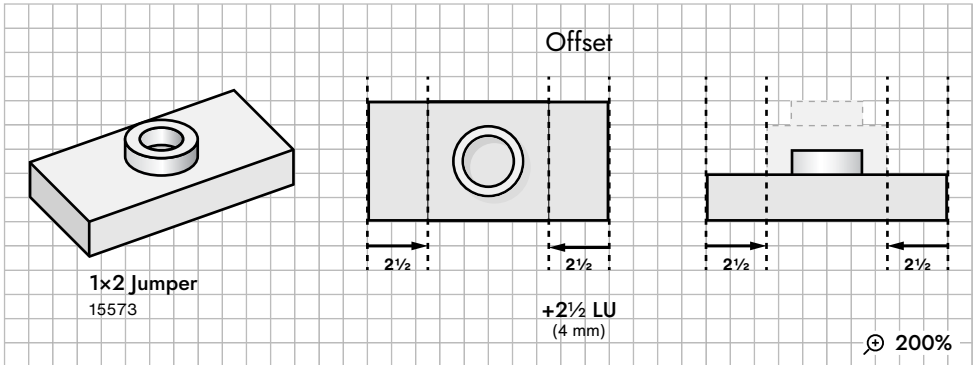
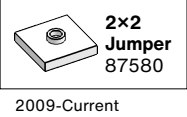
Parts introduced with new themes like *NEXO Knights* (2016) are meant to be exclusive to that theme for a few years before becoming available in sets from other themes.



JUMPERS

The *1x2 Jumper* was created as part of early experiments that led to the LEGO minifigure; it was needed to attach a head at the middle of a *1x2* piece.¹⁸ The ability to position a LEGO brick halfway between two studs can be very convenient, but it also highlights some of the quirks of a building system with an unusual 5:6 ratio of brick width to height.

Since a LEGO brick is 5 LU wide, half of that width is just $2\frac{1}{2}$ units; an unusual offset in a system where almost everything aligns to whole-unit increments. In some cases, you can ignore this unusual offset by attaching a whole assembly with multiple jumpers and have no gap at all. In other cases, you can end up with a gap that is just $\frac{1}{2}$ -unit wide, which is pretty small because it is just a quarter of the thickness of a LEGO plate. Despite their quirks, both the *1x2 Jumper* and *2x2 Jumper* are extremely useful parts because they allow a $2\frac{1}{2}$ -unit offset in one or both directions, respectively.

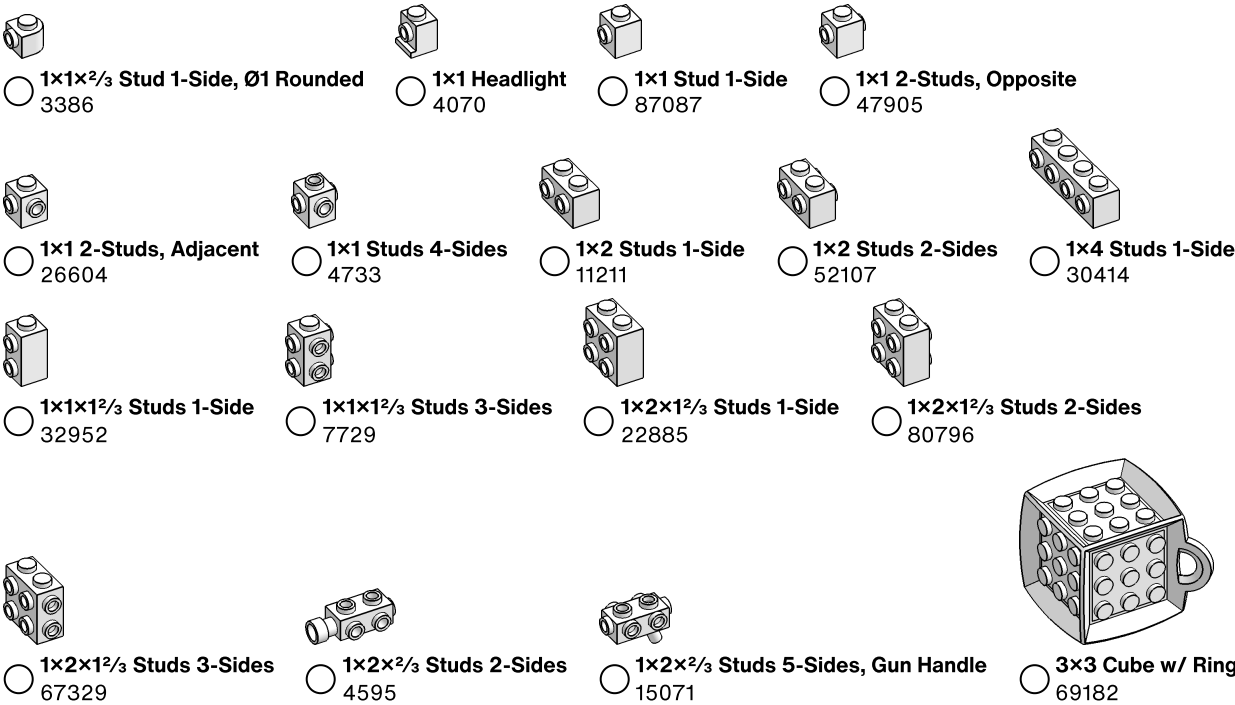


A jumper allows you to shift bricks sideways by $2\frac{1}{2}$ LU (or $\frac{1}{2}$ of a brick's width).

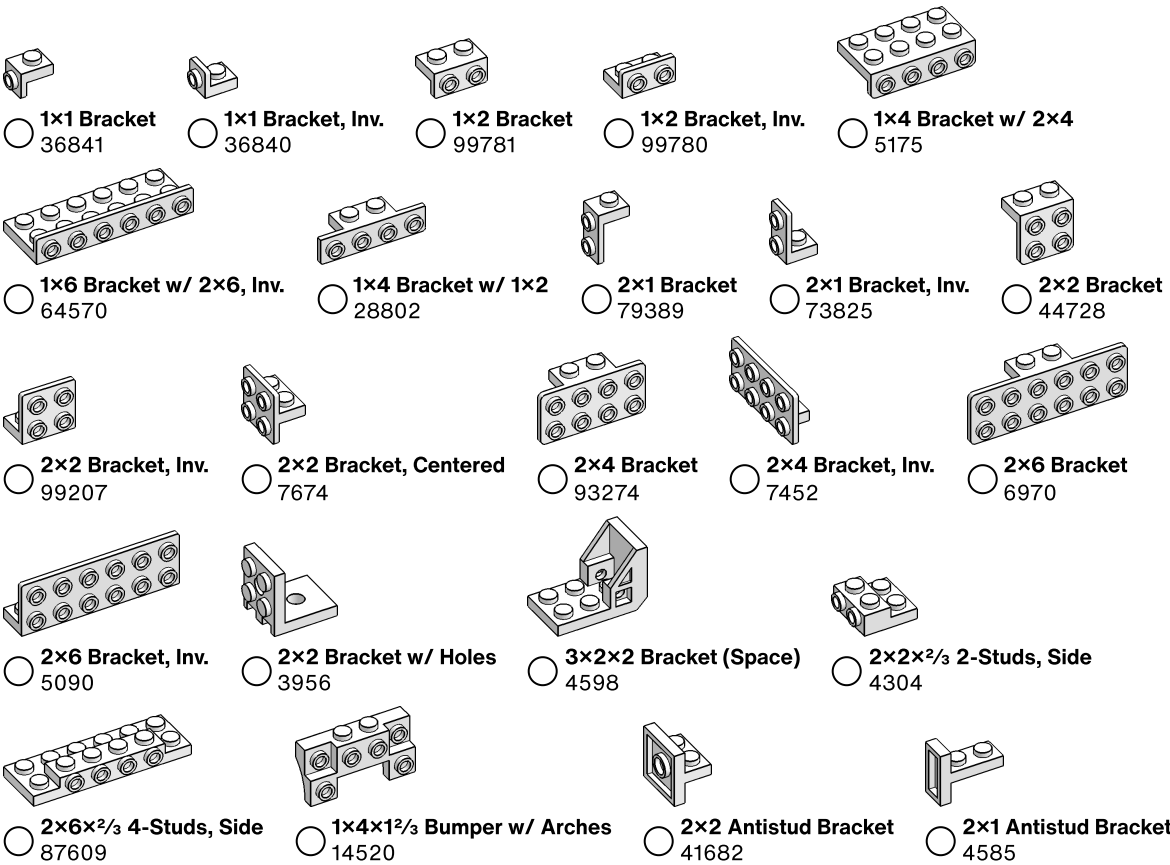
Mastering the use of SNOT and jumper pieces is a key milestone in learning how to build complex LEGO models. Refer back to these illustrations of horizontal and vertical offsets when using these parts.

SNOT PARTS

BRICK



BRACKET



ARTICULATION

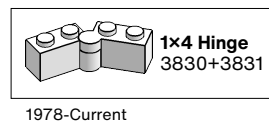
One of the most powerful ways to catch someone's attention is with movement. Even in a static model, you can imply motion by arranging objects in a dramatic posture. For example, running figures are implied by posing arms and legs in opposite directions, an explosion is represented by pieces radiating from a central location, or wind is suggested by the trees and branches leaning to one side.

The ability to position parts at any angle is one of the most powerful tools in your LEGO building arsenal. Articulation simply means the ability for something to rotate, bend, or slide. This chapter introduces several connector pairs that allow for articulation in your models.

ROTATION

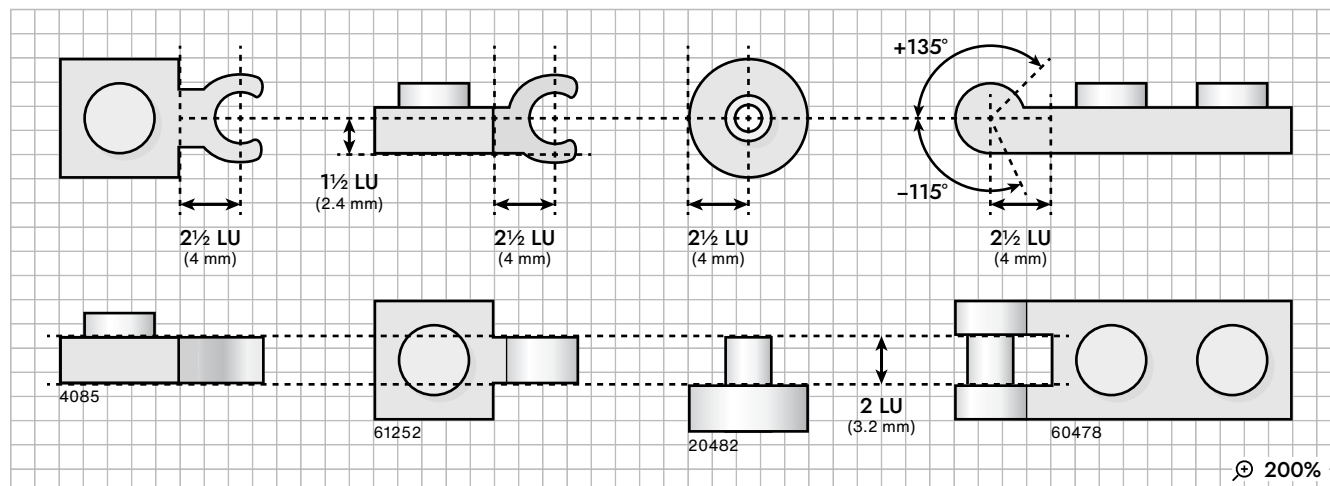
There are many LEGO parts that allow rotation on a single axis. The first of these parts was a simple **hinge** that pivots horizontally. It was used in the very first *Castle* set, allowing children to open the model to reveal interior details on the opposite side. These horizontal hinges allow 180° of rotation, vertical hinges allow only 90° of rotation, and **turntables** allow parts to rotate all the way around.

One of the most versatile ways to attach parts at an angle is through the use of the **bar** and **clip** connector pair. Clips can rotate around the bar or handle they are connected to, allowing you to position them at any angle. The only challenge is that this connection cannot hold very much weight, so it only really works for decorative details. That said, you can use multiple clips attached at different angles to create rigid triangles.



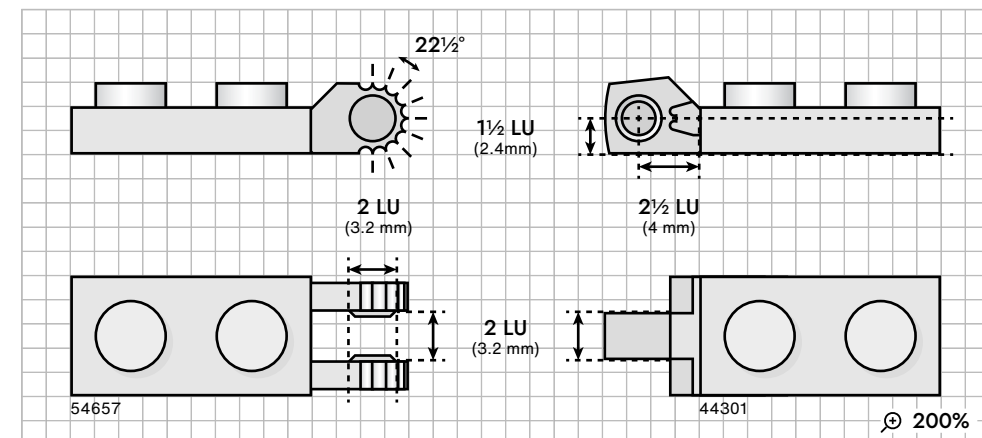
1978-Current

The first prototype of this part was made by cutting and gluing a Technic pin to a pair of 1x2 bricks.¹⁹



Clips can hold anything with a 2-LU diameter such as a bar or handle and allow a wide range of motion.

Click hinges were introduced with *LEGO Star Wars* to ensure wings remained locked in place at specific angles.²⁰ This stronger hinge can be positioned straight upward, straight downward, or at four positions for every 90° of rotation. (22½° per click.)



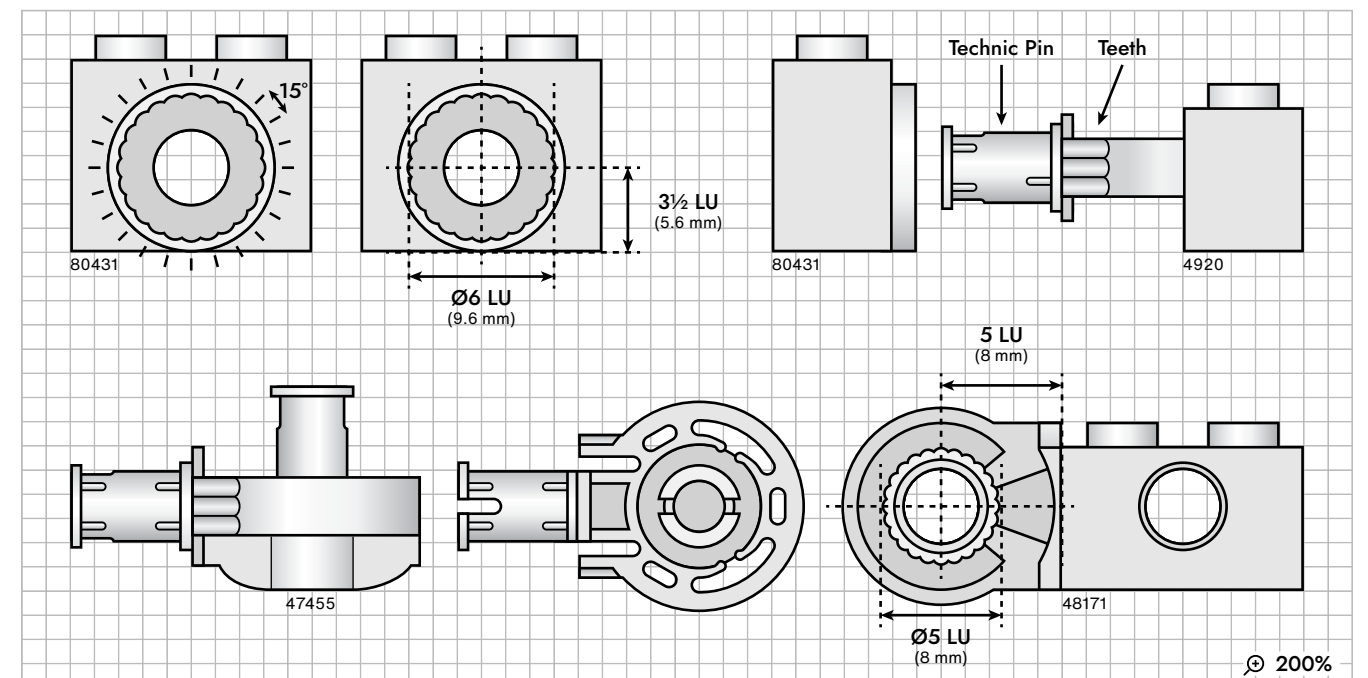
Click hinges allow parts to attach at 9 different positions which are 22½° apart.

The **click socket** is an even stronger connection that uses a modified Technic Pin and Pin Hole connection with teeth on both sides of the connection. They allow six positions for every 90° of rotation (15° per click). The larger socket is 6-LU in diameter with inward-facing teeth. The smaller socket is 5-LU in diameter with outward-facing teeth. Both of these sockets can be connected using *Click Joint, 2-Pins* to create a compound joint with two different angles of rotation.

The click socket was created for an unreleased project called *Genesis*, which inspired the famously unsuccessful *Galidor* TV show and LEGO sets.²¹



2004-Current

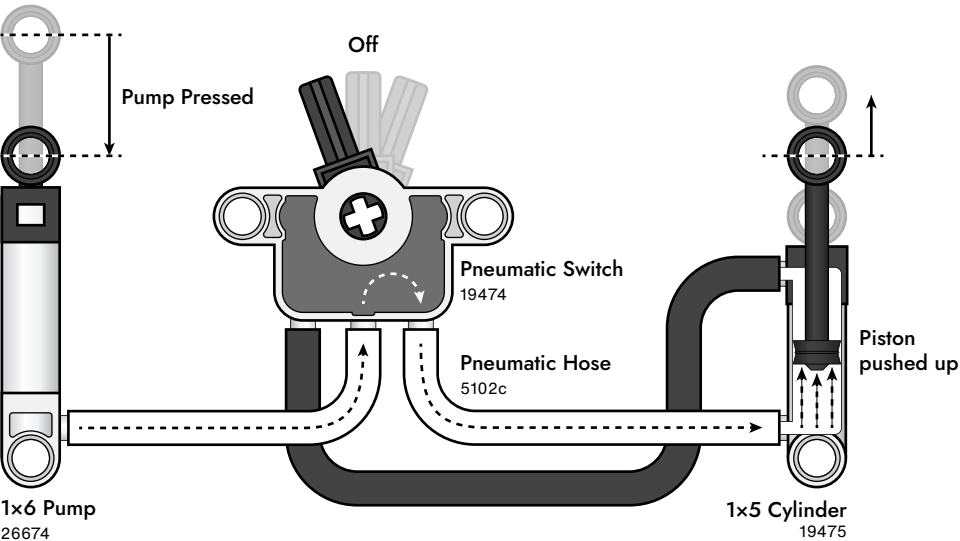


Both the larger (top) and smaller (bottom) click sockets snap into 24 different positions which are 15° apart.

PNEUMATICS

There are situations where you need to transfer mechanical energy over longer distances where gears or chains aren’t practical. Heavy machinery reveals another way to do this: using a slender tube filled with liquid or gas.

The way it works is simple: a pump creates pressure within the pneumatic hose, and this pressure needs somewhere to go. When the hose is connected to a cylinder, the pressure forces the piston in the chamber to move, moving whatever is connected to the end of the piston rod up or down. The cylinder extends when pressure is applied to the bottom of the cylinder, and it retracts when you apply pressure to the top of the cylinder.



The pump produces air pressure which goes through the switch and into the bottom of the cylinder, forcing the piston upward. Reversing the switch forces air through the black tube, pushing the piston down.

LEGO uses pneumatics, which means that the tube is simply filled with air, while most heavy equipment uses hydraulics, which means that the tube is filled with hydraulic fluid. Because air compresses much more easily than liquids, it can take several pumps to create enough pressure for your model to respond. Many builders find pneumatics frustrating because the connectors sometimes come loose and models can be slow to respond to your actions. Despite these limitations, pneumatic parts offer a great way to learn how pressure can be used to create motion in realistic brick-built models.

*This chapter introduces the mechanical systems enabled by LEGO Technic. The next chapter explores **ELECTRONICS** that allow you to add lights, motion, and custom programming.*

TECHNIC PARTS

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