MAKER INNOVATIONS SERIES

The Ultimate LEGO Technic Book

How to Build Complex Vehicles and Machines

Mark Rollins

Apress®

Maker Innovations Series

Jump start your path to discovery with the Apress Maker Innovations series! From the basics of electricity and components through to the most advanced options in robotics and Machine Learning, you'll forge a path to building ingenious hardware and controlling it with cutting-edge software. All while gaining new skills and experience with common toolsets you can take to new projects or even into a whole new career.

The Apress Maker Innovations series offers projects-based learning, while keeping theory and best processes front and center. So you get hands-on experience while also learning the terms of the trade and how entrepreneurs, inventors, and engineers think through creating and executing hardware projects. You can learn to design circuits, program AI, create IoT systems for your home or even city, and so much more!

Whether you're a beginning hobbyist or a seasoned entrepreneur working out of your basement or garage, you'll scale up your skillset to become a hardware design and engineering pro. And often using low-cost and open-source software such as the Raspberry Pi, Arduino, PIC microcontroller, and Robot Operating System (ROS). Programmers and software engineers have great opportunities to learn, too, as many projects and control environments are based in popular languages and operating systems, such as Python and Linux.

If you want to build a robot, set up a smart home, tackle assembling a weather-ready meteorology system, or create a brand-new circuit using breadboards and circuit design software, this series has all that and more! Written by creative and seasoned Makers, every book in the series tackles both tested and leading-edge approaches and technologies for bringing your visions and projects to life.

More information about this series at https://link.springer.com/bookseries/17311.

The Ultimate LEGO Technic Book

How to Build Complex Vehicles and Machines

Mark Rollins

Apress®

The Ultimate LEGO Technic Book: How to Build Complex Vehicles and Machines

Mark Rollins
Pullman, WA, USA

ISBN-13 (pbk): 979-8-8688-0792-3 ISBN-13 (electronic): 979-8-8688-0793-0
https://doi.org/10.1007/979-8-8688-0793-0

Managing Director, Apress Media LLC: Welmoed Spahr
Acquisitions Editor: Miriam Haidara
Development Editor: James Markham
Coordinating Editor: Jessica Vakili

Cover designed by eStudioCalamar

Distributed to the book trade worldwide by Apress Media, LLC, 1 New York Plaza, New York, NY 10004, U.S.A. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail orders-ny@springer-sbm.com, or visit www.springeronline.com. Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

For information on translations, please e-mail booktranslations@springernature.com; for reprint, paperback, or audio rights, please e-mail bookpermissions@springernature.com.

Apress titles may be purchased in bulk for academic, corporate, or promotional use. eBook versions and licenses are also available for most titles. For more information, reference our Print and eBook Bulk Sales web page at http://www.apress.com/bulk-sales.

Any source code or other supplementary material referenced by the author in this book is available to readers on GitHub (https://github.com/Apress). For more detailed information, please visit https://www.apress.com/gp/services/source-code.

If disposing of this product, please recycle the paper

Table of Contents

About the Author

Mark Rollins has been an established writer for two decades, delving into tech and gadget blogging 20 years ago, contributing to various consumer electronics-related websites. Over the last 15 years, he has successfully managed TheGeekChurch.com, boasting a tech website, a YouTube channel (500+ subscribers), and a TikTok channel (20,000+ followers). Mark recently collaborated with Pullman Marketing, showcasing his skills. As a seasoned author, Mark has published six books with Apress, covering Android Marketing, LEGO, Kindle Fire, and UBTECH/Jimu Robots, displaying a diverse and comprehensive writing portfolio.

About the Technical Reviewer

Farzin Asadi received his B.Sc. in Electronics Engineering, his M.Sc. in Control Engineering, and his Ph.D. in Mechatronics Engineering. Currently, he is with the Department of Computer Engineering at the Ostim Technical University, Ankara, Turkey. Dr. Asadi has published over 40 international papers and 29 books. His research interests include switching converters, control theory, robust control of power electronics converters, and robotics.

CHAPTER 1

Introduction

When LEGO was first released, it was looked at as a better type of building blocks. Just another way to make structures, and you could make something to the extent of complex dollhouses. It wasn't until the Expert sets when LEGO realized the potential of their building bricks to create complex machines, but to achieve this, LEGO had to change from the brick up, creating a new type of building block for its new creations.

It wasn't just that the models were larger, but it was about what they could do. Not only could you create a car with some interesting bodywork, but you could also steer that car. You could even create construction machines like bulldozers and forklifts that had some very realistic properties of operation.

These "Expert sets," later rebranded as Technic, truly opened up the world of LEGO builders, and it has been going strong for over 35 years. The pieces have been continuously evolving, and the challenge keeps getting greater for experienced builders of LEGO.

If you're reading this book, then it means that you wish to take your LEGO Technic to the next level, even if you aren't certain what that is. When I wrote my first book about LEGO Technic, I was amazed to see how much I could do with these beams, levers, axles, and gears and the other basic and advanced LEGO hardware. I have written two books about LEGO Technic, and I really wanted to highlight what I have learned since then.

M. Rollins, *The Ultimate LEGO Technic Book*, Maker Innovations Series,
https://doi.org/10.1007/979-8-8688-0793-0_1

We will discuss the basics of LEGO Technic pieces later in this chapter; for now, I think it would be appropriate to discuss the history of LEGO Technic and what it has become since its initial release back in the late 1970s.

History of LEGO Technic

When it comes to who founded LEGO, it gets attributed to Ole Kirk Kristiansen in 1932, who actually made toys out of wood in his home country of Denmark. This family-owned business has since been passed down from father to son.

You will notice that LEGO is often used in all capitals, but it is not an acronym. It stems from two Danish words meaning "play well," and it also means "I put together" in Latin. The LEGO name was officially used in 1936, but only on their highly crafted wooden toys, and it wasn't until 10 years later when the Kristiansen family invests in plastic.

In about 1949, the LEGO bricks begin to look like what they are now…somewhat. Think of the basic 2 × 4 brick, but empty on the bottom, and you have it. It was called the Automatic Binding Brick, and the original catalog from that year has some of the early sets, which were small houses that looked very blocky, sort of like Minecraft. These houses had roofs that did not slope, but there were already window-like pieces that appeared to show off what type of detail these early LEGO construction sets were capable of.

By 1953, the LEGO name appears on every brick, just like it appears on every stud (the round section of the brick), with construction kits of LEGO Mursten (LEGO bricks) to encourage creative play. LEGO drops the name of Automatic Binding Bricks and begins to produce brochures that showed models that could be produced from extra sets. In 1955, there is a town plan that has bricks of all kinds of interesting shapes, even with curves. There are vehicles on these catalogs, but it doesn't look like the user could assemble these, like the buildings.

It wasn't until 1958 that the coupling principle is patented, which really highlights the "clicking together" that LEGO is truly known for. It was very apparent that the family realized its potential and encouraged building up of LEGO bricks in order to stimulate children's creativity.

Then in 1960, a fire destroys the company's wooden toy warehouse, which marks the time when LEGO begins to stop production of their wooden toys. The LEGO toys begin to flourish, with wheeled creations in 1962, and by 1965, new catalogs begin to come out each year that highlight the growth of the company.

If you look into these catalogs, you are going to see how Technic slowly starts to be conceived. Even as early as 1966, LEGO begins to market motorized bricks, which comes in really handy for making trains, which LEGO marketed very early with complex track systems. It is important to note the trains were much larger in scale than the buildings in the town playsets released at around the same time. By 1968, the vehicles started to become very detailed with hinge pieces and even cranes, but they were not very mechanical, but the scale that is visible in Technic is there.

Figure 1-1. *Early LEGO motors and trains, a definite grandfather of LEGO Technic*

In 1970, LEGO sets began to be smaller, as the buildings and cars were designed to be embraced by people who were 4–5 bricks tall. There was a set around this time (set number 140) called the Bricks and Motor set that was a set in the right direction to making creator-made vehicles that could run on battery-powered motors. Then, in 1971, LEGO gear pieces came in, creating the possibility of LEGO motion. These gears don't look like anything they would make today, but it was a start. Around this time, LEGO started to put out sets with axles, and this particular part has changed very little since its initial introduction.

In the 1974 catalog, there is a page that just says "Get Things Moving," and these are the first indicators of Technic. There is even a crane that has pieces with the holes on the sides, which were indicative of the first LEGO Technic bricks.

Figure 1-2. *From the 1976 catalog, this shows LEGO vehicles in a bigger scale*

Two years later, a catalog appears that is marked the LEGO Experts guide to 1976. This has a motorized kit that is a bit more advanced, and there are also some pretty advanced looking models in the regular catalog, and one of them, a Formula 1 racer, looks like a go-cart.

These were Hobby sets, and they got really detailed with cars like 1913 Cadillac, 1909 Rolls-Royce, and 1926 Renault and other projects like a Thatcher Perkins Locomotive.

It was in the late 1970s that Kjeld Kirk Kristiansen develops a "system with the system" to offer children the right products at the right age and the right purpose. This allowed the company to really look at children of all ages and create products for certain age groups.

From here, it was when the company began to branch in two separate directions as far as creating products for the audience of children that had outgrown Duplo. LEGO was really growing in popularity and profits, and the late 1970s were a time to create systems that still remain a part of the company, such as the Space systems, the Knight/Castle systems, and the Town system, which was later rebranded as City.

Figure 1-3. *One of the first appearances of LEGO Expert sets in the late 1970s, with all new versions of LEGO pieces*

This huge shift in LEGO is where the LEGO Expert Builder sets came about. This is when the company took full advantage of the LEGO bricks with holes in the sides, and it could create vehicles that were far more advanced. These were not just toys, but modeling kits that could really show older builders just how motors and steering actually worked.

Personally, I remember being fascinated by the go-cart (set 948, see Figure 1-3) with its rack-and-pinion steering function. There were other sets that had features like a forklift that could elevate its prongs, not to mention a crane with more advanced functions of any LEGO crane ever before. There was even a kit that you could purchase that would allow the user to motorize these creations.

Like all LEGO sets, new models were produced every year, and eventually, the name of Expert Builder got changed to Technic. Not only did it produce sets that specialized in a certain type of vehicle model, but there were a lot of great Universal Building sets that you could buy during that time in the late 1970s and early 1980s.

By 1985, the company was adding air pressure as their coolest feature. It's something that isn't really in modern sets. By 1988, Technic went new directions as it created creations that could transform. They also attempted these giant figurines that were made for the scale of the vehicles. These larger figures have since been discontinued.

Figure 1-4. *Advancements of LEGO Technic in the 1980s*

In 1989, LEGO brought back the Universal Building sets, as well as some models like large Auto Chassis (8865) and Prop Plane (8855). On a somewhat related note, LEGO was also attempting a new type of structure with the model team, which were a lot bigger models with more detail.

The year of 1990 is when Technic saw this programmable control center, which had two 9V motors for some very advanced motorized models like a robot, a crane, and a drawing machine. This type of functionality was the first attempt of making something that was essentially programmable in the LEGO world, with greater advancements in that technology advancing later.

In the early 1990s, new types of LEGO pieces came to the Technic set. These were pieces that didn't have studs on them. It was slowly evolving, and the Night Chopper (set 8825) There were pieces on this set that were flat and with holes, but somewhat different than the LEGO Technic pieces that had gone before it. Set 8207, the Dune Duster, is almost completely bereft of traditional LEGO brick.

There were all kinds of variations within Technic itself, which is characteristic of a lot of LEGO systems. For example, 1997 was the year of Bungee Blasters, as you pull them back and off they go. Technic had a set 8250 that was a sub with pneumatic, and it had these two interesting pieces with no studs on them. There was also a slight push for fiber optic lighting. Then, in 1998, LEGO introduced this series called Cyber Slam. Think of it as Rock 'em Sock 'em robots with these figures, because that Technic was still doing its "maxi-figs."

Also in 1998, something big yet little had happened. The old bricks were hardly being used. The traditional Technic bricks, which were essentially traditional LEGO bricks with holes in the sides, were replaced with beams, which had the holes, but not the studs.

In 1999, LEGO gave its Technic users throwbots, made under the Technic brand, that could throw discs. Newer models were under the "Tech Build" category.

In 2000, even *Star Wars* got into this. All models had virtually none of the old bricks, and there was some interesting detail work as far as these droids were concerned. For example, the Battle Droid (set 8001) was able to fold up and then rise to its feet at the touch of a button thanks to the help of some rubber bands and really nifty building techniques.

Figure 1-5. *Various LEGO Technic sets inspired by Star Wars*

So yes, Technic was slightly veering away from its vehicle sets to focus more on robotics. There were sets like Slizer and Robot Riders. Not to mention Speed Slammers.

It was also in 2000 that the unveiling of MINDSTORMS occurred. This was an intelligent brick playset. All of the models were built with the new versions of the bricks and could be programmed. There was even a *Star Wars* version of it. MINDSTORMS had a second version with the NXT and then had a third version known as the EV3 on 2013. The MINDSTORMS system has been recently discontinued and had its last Robot Inventor product in 2020. I won't be focusing much on MINDSTORMS in this particular book, but I have written a book on the EV3 if you are interested.

Figure 1-6. *LEGO MINDSTORMS series, with the first version, followed by NXT 2.0 and EV3*

In 2001, they revealed the Bionicle system, which was still under the Technic umbrella. These had various iterations in its decade-long run and even had a few direct-to-DVD movies. Technic pieces are used for the Bionicle series, but I won't be discussing any of the arms, legs, feet, or faces from that, as this series has also been discontinued.

Of course, Technic kept going with new models that just kept getting more and more advanced. In 2007, there was special edition known as Power Functions (not related to MINDSTORMS) where the motors could be remotely controlled. Of course, in an age where "there is an app for that," there is also an app for that known as LEGO Technic Control + as made for propelling a vehicle backwards and forwards and can even steer a vehicle as well.

LEGO Technic continues to thrive today, as the sports cars/race cars are always popular, along with motorcycles, not to mention airplanes and helicopters. There are even smaller scale kits, as well as big construction equipment like cranes, and small construction equipment available.

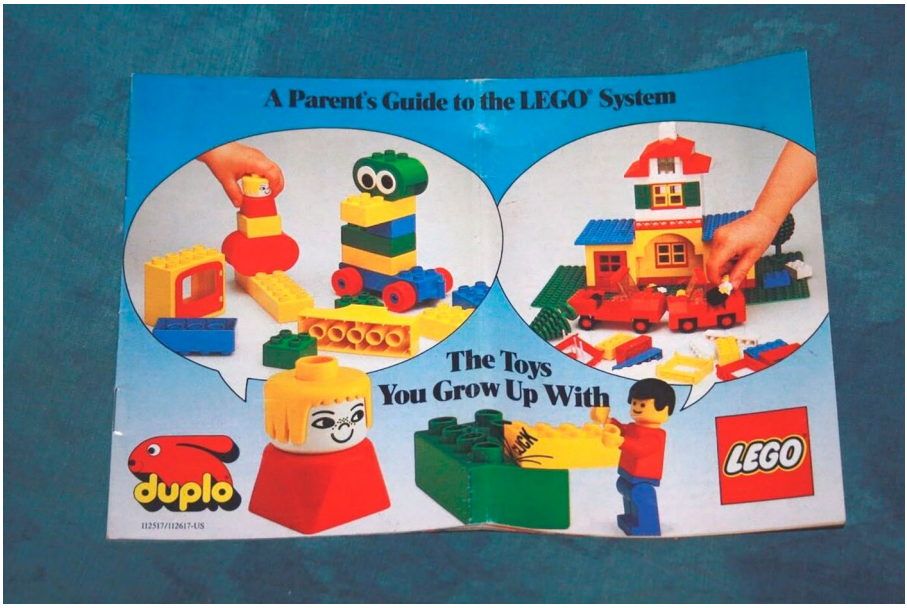

Figure 1-7. *Various LEGO kits throughout the years*

Difference Between Technic and Regular LEGO

I hope you had a lot of fun with that trip down LEGO Technic memory lane, as I know I have. I wanted to talk about why I consider LEGO Technic and regular LEGO as separate entities, but still all part of the same LEGO family.

Complexity

I think about Technic being different from traditional LEGO as a Duplo is different from LEGO. A kid of a certain age wouldn't be caught dead playing with Duplo because they are viewed as baby's toy. Not that a Duplo block won't fit with a traditional LEGO block, as they are made

to be a regular traditional LEGO brick with an exact double proportion. Most traditional LEGO is based on stacking bricks in what is hopefully the strongest manner possible to make something aesthetically pleasing.

And of course, building with Technic is also something that is aesthetically pleasing, but the principles to building strong are different. I will have to admit that vehicles and machines have their set of aesthetics that make them attractive in their own way. However, Technic is all about having your end model do something, even if you don't "play" with it. The point is realism, and you want it to be able to steer because your actual, real life-sized car can steer.

In order to do that, you will need to use axles, gears, and all kinds of parts that could be confusing if you don't understand simple machines, and most younger kids do not. Some adults can't really identify LEGO Technic as LEGO, honestly.

Scale

Most LEGO sets are designed with the same sort of scale. Once the minifig caught on, it set a size standard for LEGO. The fact that a minifig foot is about the size of a LEGO stud means that one foot equals one LEGO stud.

That is, if you were to create a house, car, castle, or spaceship, then you had better make certain that a minifig can fit in there, even if it is uncomfortable with the amount of space it has.

With Technic, the scale is much larger, and you would not want a minifig to try and drive a Technic vehicle. As I said before, LEGO used to make figures designed for Technic vehicles, but that has gone the way of dial-up Internet.

Part of building in Technic is about attention to detail, which can't be done on a minifig scale. Since the Technic vehicles are much larger in scale, details can be explored, which opens up the possibilities to what a Technic model can do.

Can LEGO Technic and Traditional LEGO work together?

The short answer would be yes, and there are several traditional LEGO sets that include some pieces that I consider Technic pieces. There are also LEGO Technic sets that have many traditional LEGO pieces included.

For example, some traditional LEGO sets that have wheels often use an axle and a wheel in their construction. There are also LEGO Technic sets that include a lot of traditional bricks with an emphasis on tiles (flat or plate pieces with no studs on top) to add realism to vehicle creations.

The thing about using traditional LEGO with LEGO Technic, and vice versa, is that the two styles of bricks often stick out in the creation. I think the best way to compare traditional LEGO and LEGO Technic is to use an analogy, comparing 2D animation with 3D animation. Animation started with 2D to make cartoons that eventually looked good with the help of great artists hand drawing every single frame. Then when 3D came around, artists were also needed to make works that were almost photo-realistic in nature, and there was less work on a frame-by-frame level as the computer did the motion rendering.

I bring this up to emphasize that 2D animation is still used, and 3D is not "better" than it. You can use whatever style to make a story that work. Again, I'm not trying to say that one is better than the other, and I'm not saying that LEGO Technic is better than traditional LEGO. The problem is when you start mixing these together.

Sometimes, it comes across well, as the 1986 film *The Great Mouse Detective* had massive clock gears that were rendered in CG. It was in the Disney Renaissance where the CG backgrounds began to look like they dwarfed the characters, like the ballroom scene from *Beauty and the Beast* and the cave scene in *Aladdin*. One of the worst examples is Twentieth-Century Fox's animated *Titan A.E.*, where the spaceships looked very pristine and incredibly shiny and metallic with these 2D characters.

However, there are examples where mixing 2D and 3D work so well, that I had to be told that a 3D element was added. If you ever watched *The Iron Giant*, it is a great 2D animated film with a 3D addition of the giant in it. The same applies to *Treasure Planet*, with silver's artificial arm. In both cases, the 3D kind creates an otherworldly charm, which would stand out no matter how you rendered it.

For me, I see regular LEGO as 2D animation, and I see LEGO Technic as 3D animation. If you watch enough animation, then you know that 2D and 3D often don't look good together. Granted, it is easy to make 3D environments and put in hand-drawn animation, but it might not mix well.

For the most part, Technic has steered away from traditional bricks, even the Technic bricks that it used to have. I recently constructed a spaceship using LEGO Technic beams as a frame and then put LEGO plates (flat traditional LEGO pieces) as the body of this, and it worked quite well.

You may find that it is possible to build with both, and I discuss many different building techniques in this book.

Places to Find LEGO Technic at a Low Price

Just to let you know, this book isn't the only one about LEGO that I intend to publish at this time, as I am also publishing a book about how to work with traditional LEGO as well.

In the other book about LEGO Worldbuilding and Architecture, I discussed where to obtain LEGO, focusing on eBay auctions to garage sales. I will have to say that the least expensive way to obtain LEGO is to get them from people giving them away, because nothing is cheaper than free.

I've had several people give them away and obtained some for myself. Most parents have kids that grow up with them, and then they kind of abandon them. They store them away, and the collection just sits in

storage like the Our-Mom-a-Geddon from *Lego Movie 2*. Usually thrown away are the boxes and possibly the instructions, so all that is left is a disorganized mass that gets put in some kind of storage.

If you are wanting to do that, you might find someone willing to give away leftover LEGO Technic, but that can be difficult. Technic is so different; many users keep it separate, so you could luck out. However, a lot of parents don't care about separating the LEGO Technic from the traditional LEGO, so these specialized pieces literally get lost in the shuffle.

For me, I had obtained many Technic sets throughout the years and would often purchase newer sets if I thought they could help me build bigger and more complex models. Yes, that will cost you. Speaking of costing me, there was a time where I found really an untrustworthy website selling cheap sets and bought a whole bunch. I remember waiting quite a while for the order, and when it came, it was a sham. I'd rather not talk about that, no matter how interested you might be in hearing that story.

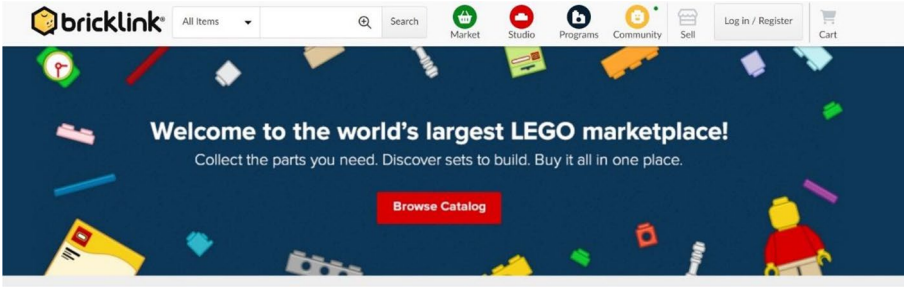

Figure 1-8. *The BrickLink homepage, a good place to purchase individual LEGO Technic pieces*

Let the buyer beware, and chances are you need to be looking for specific pieces that come with most Technic sets. Therefore, I recommend going to places like BrickLink and others in order to obtain what pieces that you will need. I talk more about other places to find bricks in my book, so I'm going to proceed like you have many.

Sorting Your LEGO Technic Pieces

When it comes to traditional LEGO, the pieces are so diverse, and I have a different method of doing that. Of course, I discuss that in my other book and the other video based on that chapter, but honestly, organizing LEGO Technic is a lot simpler as you can separate them into categories based on usage.

Since I work with a lot of LEGO Technic, it became necessary to just organize the pieces. After all, the point of this is to learn to plan as you build, and the last thing you want to do is sift through thousands of pieces just to find the one you need at one specific spot in your building.

As a kid, that works, I guess, but you really lose a lot of time sifting when you could be building. The best thing that you can do is separating different types of pieces in small drawers, like those found on tackleboxes. I purchased these at a retail store about a decade ago, and I devote certain sections to certain types of pieces. If you look at LEGO enthusiasts, they often have garages with drawers to house all their numerous pieces. So if they need a piece of a certain design with a specific color, bam, there it is.

When I talked about organizing pieces in my last video, I discussed phases. The first phase is organizing by size, then color, and then usage, and then actual piece. In case you don't know, every piece that LEGO creates has a specific designated number.

Personally, I don't have too many pieces of Technic, so I don't really consider color. I organize pretty much by shape, and the space that I put them in is so small; I can usually find the color that I need when I need it. I tend not to care too much about color when I build, because I'm not really going for aesthetics, but functionality. Not only that, some pieces only come in one color anyway.

Bricks

When Technic, or Expert sets, as they were called back then, were unveiled, they created a new type of brick that was still discernible from the old one. The idea was pretty simple, as instead of attaching one brick to the top with the studs, one could go to the sides. Of course, if they were studded on both sides, then they would not so easily fit together, but with certain other pieces, such as the connector pegs (which we'll discuss later), you could fit them together.

I must admit that these Technic bricks, which were the basic units of building in the old Technic kits, have phased out these bricks for the beams, which I will discuss right now. I did want to bring them up because they can be used, but there won't be much to talk about here. In fact, I actually incorporate Technic bricks in my other book about LEGO Worldbuilding, which should be available at the time you are reading this book.

You might note how the studs are hollowed out on top, but not certain why that is.

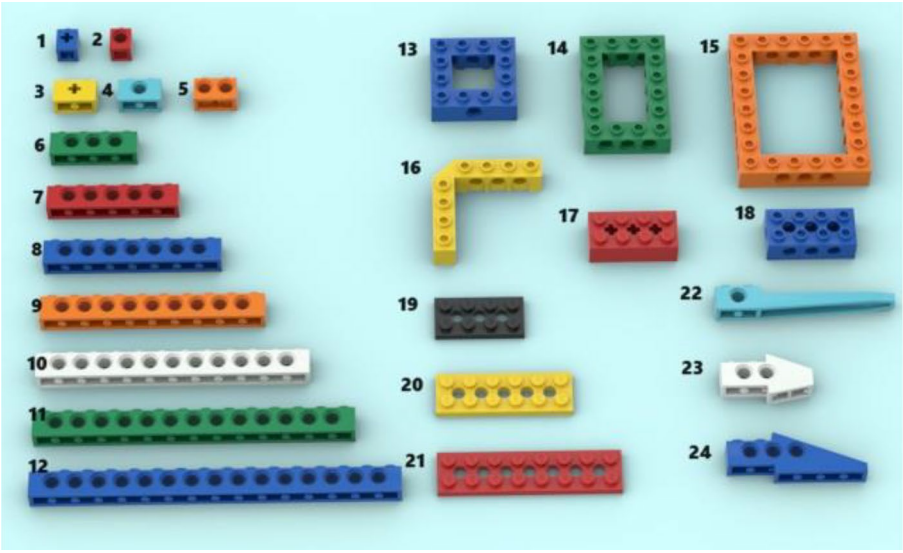

Figure 1-9. *Samples of LEGO Technic bricks*

1) Technic brick 1 × 1 with axle hole (73230): A typical 1 × 1 brick with an axle hole in the middle

2) Technic brick 1 × 1 with hole (6541): Another typical 1 × 1 brick with a Technic addition of a through hole. Generally, the number of through holes is equal to the number of studs, minus one, but this is one exception

3) Technic brick 1 × 2 with axle hole (32064): A 1 × 2 brick with an axle hole

4) Technic brick 1 × 2 with hole (3700): Typical round hole in a 1 × 2 typical brick

5) Technic brick 1 × 2 with holes (32000): Another exception to the number of through holes equal to the number of studs, minus one

6) Technic brick 1 × 4 with holes (3701): With one exception, LEGO Technic bricks generally have an even number of studs, and this is one of the smallest at a length of 4M with three round holes on the side. The rest of the Technic bricks increase by 2M or two studs, and the rule of the number of round holes on the side is equal to the number of studs, minus one
7) Technic brick 1 × 6 with holes (3894)
8) Technic brick 1 × 8 with holes (3702)
9) Technic brick 1 × 10 with holes (2730)
10) Technic brick 1 × 12 with holes (3895)
11) Technic brick 1 × 14 with holes (32018)
12) Technic brick 1 × 16 with holes (3703)
13) Technic brick 4 × 4 open center (32324): Of course, it is possible to create this piece with several other Technic brick pieces, but it is good to start a creation with a solid form such as this
14) Technic brick 4 × 6 open center (32531)
15) Technic brick 6 × 8 open center (32532)
16) Technic brick 5 × 5 right angle (32555): Like traditional LEGO bricks, LEGO Technic bricks come with corner pieces
17) Technic brick 2 × 4 with three axle holes (39789): This is a typical 2 × 4 brick with three axle holes in the middle

18) Technic brick 2 × 4 with holes on all sides (3709a): A typical 2 × 4 brick with through holes on the sides and top

19) Technic plate 2 × 4 with three holes (3709b): Like the brick, the LEGO plate also had through holes, equal to the number of pieces in the length, minus one

20) Technic plate 2 × 6 with five holes (32001)

21) Technic plate 2 × 8 with seven holes (3738)

22) Technic forklift fork (2823): This is essentially a 1 × 2 Technic brick with an odd extension that takes it to a length of 6M. I believe it is called a fork as it used to be used in LEGO sets with forklifts

23) Technic slope 4 × 1 × 2 1/3 (2743): LEGO Technic used to have sets with airplanes that had these types of LEGO bricks, before moving to beams

24) Technic slope 6 × 1 × 1 2/3 (2744)

Beams

While Y2K didn't cause all the problems that we thought it might, 2000 was quite a year as Technic bricks were essentially phased out, with these beams taking their place. These are now the basic units of building in Technic, and there are no studs on top, or the bottom. All there are these through holes.

It should be noted that until the bricks, which are usually even-numbered studs (with the three being still very common), the beams are usually odd-numbered. The exception being the two, which comes in this one with an axle hole in one and a through hole in another, or just two through holes. The longest beam is currently at 15.

In addition to the straight ones, there are two that come at right angles. This particular 2 × 4 has an axle hole, while the 3 × 5 has all through holes.

Then there are some beams which have this angle of 53.1 degrees on them. You might think it is a 45-degree angle, as that would be half of a right triangle, but these particular ones are at this angle for a reason. This reason is so you can make a triangular shape with this angle, but you will find the Pythagorean theorem doesn't really apply in a traditional sense.

Then there is this double angle beam, and this has two 45-degree angles to make this 90.

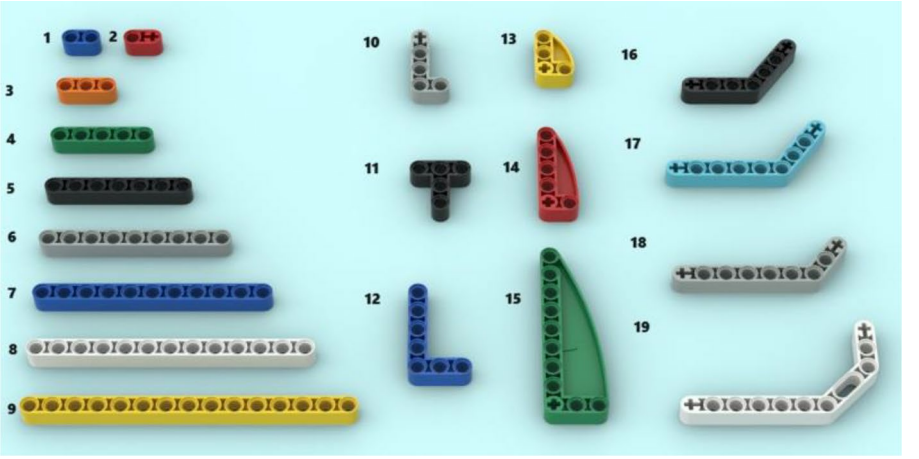

Figure 1-10. *Samples of LEGO Technic beams*

1) Technic 2M beam (43857): As stated earlier, most beams are odd-numbered in their measurement, which is equal to the number of holes, and this is the only even-numbered beam

2) Technic 1 × 2 beam with cross and hole (60483): This 2M beam is has an axle hole, as well as a through hole