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description: The history of Rubik's Cube hardware innovations, such as magnets, stickerless cubes, smart cubes, and more.

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# Hardware Evolution

Rubik’s Cube has undergone a large amount of evolution. Starting from Ernő Rubik’s wooden prototype, to the final patent, to Rubik production design updates, and to the various innovations by Chinese manufacturers, numerous milestones have been achieved in producing high performing cubes.

## Prototypes and Patent

The original Rubik’s Cube prototype of 1974 used rubber bands and paper clips to hold the pieces together, with a magnet-based prototype also having been tested [1]. Both of these designs proved undesirable due to the tendency for pieces to fall apart. Rubik wanted a product that didn’t have a built-in rule that the player must only turn the layers of the puzzle and to never separate the pieces. Eventually the idea of interlocking pieces dawned on Rubik, solving the problem. The new design can be seen in a wooden prototype, holding the common features that are seen in most modern 3x3x3 puzzles. These features include a core, attached and rotating centers, and individual corner and edge pieces with interlocking shapes that hold the puzzle together while allowing for layer turning.

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Images from [Liberty Science Center](<https://lsc.org/news-and-social/news/beyond-rubiks-cube-day-30-prototype-rubiks-cube>) and [Polityka](https://www.polityka.pl/tygodnikpolityka/nauka/1791468,1,kariera-kostki-rubika.read)

![](img/HardwareEvolution/Patent1.webp)

## First Production

The mass produced Rubik’s Cube made its debut in 1977 [2]. Produced by Politechnika (renamed to Politoys in 1980), the hardware closely follows the design laid out by Rubik’s patent. This first batch of the cube was both larger and heavier than subsequent releases, at around 143 grams. This batch also contained a design flaw with the mold causing the edge stickers to be raised higher than the corner stickers. The cubes of this first batch also contained pieces that were solid [3].

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Both images from TwistyPuzzles.com

## Hollow Pieces

Later in 1977 Politechnika produced a second batch that corrected the sticker height issue as well as reduced the piece size and weight to around 117 grams [4]. From this batch also came the introduction of hollow pieces.

![](img/HardwareEvolution/HollowPieces.webp)

Image from TwistyPuzzles.com

## Printed Colors

In 1979, Politechnika produced a small experimental batch of cubes with the colors printed on the faces, rather than using stickers [5]. A reaction between the paint of the orange side and the underlying black plastic caused the orange side to change to purple.

![](img/HardwareEvolution/PrintedColors.webp)

Image from TwistyPuzzles.com

## Arched Centers

In 1980, Ideal Toy Corporation released the Rubik’s Cube Deluxe Edition. This version of Rubik’s Cube altered the shape of the bottoms of the center pieces to be arched, allowing for smoother turning. This cube also had variants that used tiles instead of stickers [6]. This version of the cube wasn’t produced in large numbers and the normal edition of Rubik’s Cube continued to use flat centers.

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Both images from TwistyPuzzles.com

In the early 2000s arched centers were brought to the primary version of Rubik’s Cube that was sold in stores. In March 2004, Paul Kobayashi posted comparison photographs showing the difference between two modern cubes [7]. Both cubes came in the same packaging, but one was more recent and had arched center pieces.

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## DIY Kit

### Zauber Puzzle (1981)

In 1981, Politoys produced the first official 3x3x3 DIY kit, called the “Working Puzzler” [8]. It included the use of arched centers and screws. However, this DIY kit was produced only in a limited run.

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Both images from TwistyPuzzles.com

### Hessport DIY (2001)

2001 saw the return of the DIY concept. In that year Hessport.com started selling an official Rubik’s brand DIY kit [9, 10]. The kit came with a blank cube, two sets of stickers, and lube.

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### Studio Cube (2003)

Starting in 2003, a speedsolving oriented 3x3x3 DIY kit was produced, this time by Rubik’s Studio Hungary [11, 12]. The kit was called the Rubik’s Studio and was only available for purchase by the online puzzle community, specifically from Ton Dennenbroek’s website [13].

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### Assembly Cube (2004)

In the middle of 2004, the production controller at Seven Towns released a statement announcing the intent to offer a DIY cube for purchase on the Rubik’s website. This statement was shared with the community by David Hedley Jones, senior vice president of the Rubik’s Brand at Seven Towns, as well as with Wayne Johnson [14, 15].

> We will also soon be introducing to rubiks.com a cube builder kit. Which is essentially and complete set of cube parts un-assembled. This way speedcubers can assemble the spring pressure to their own liking.

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In August and September 2004 Jones announced that the Rubik’s DIY cube, called the “Rubik’s 3x3 Assembly Cube”, was available on rubiks.com [16, 17]. The DIY kits were purchasable in various configurations [18, 19]. The design of the cube contained a choice of rivets or screws, arched centers, as well as had caps on the inner corners similar to the 1982 Zauber Puzzle DIY.

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Image from rubiks.com, [Jon “nascarjon2001” Morris](<https://web.archive.org/web/20050213025824/http://www.geocities.com/nascarjon2001/dyi.htm>), [Gary Fixler](<https://www.flickr.com/photos/garyfixler/117173834/in/photostream/>), and Conrad Rider

## Tracks

### Guojia

In May 2006, Guojia released the Type A DIY 3x3x3 [20]. This cube helped make affordable and quality cubes available to the worldwide market. Thanks to the success of the Type A, Guojia was able to invest into design improvements. In May 2008, the Type A II was released. The major feature of this cube was the addition of tracks on the inner sides of the corners and edges. The primary purpose of the tracks was friction reduction.

![](img/HardwareEvolution/Tracks.webp)

Image from [Baidu](<https://baike.baidu.com/item/%E5%9B%BD%E7%94%B2%E9%AD%94%E6%96%B9/8552780>)

### GAN

In 2018, puzzle manufacturer GAN optimized the tracks idea into a honeycomb design [21]. This feature was first introduced in the GAN Air SM, and was advertised as assisting with friction reduction and even lube distribution.

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## Tabs

In September 2008, Guojia released the third model of the Type A 3x3x3 series [20]. The primary difference compared to Type A II is that the edges of the Type A III have tabs attached to the edges to prevent pops.

![](img/HardwareEvolution/Tabs.webp)

Image from lt-219 on [bbs.mf8-china.com](<http://bbs.mf8-china.com/forum.php?mod=viewthread&tid=14644>)

## Stickerless Pieces

The 1979 batch of experimental official Rubik’s Cubes with printed colors was previously described in the Printed Colors section. This process can also be found in some later 3x3x3 models, such as the Diansheng Type E 333 from 2009 [22]. However, within the modern meaning of “stickerless”, the plastic itself is a solid color and the pieces have the capability of splitting into sections. This innovation first came from DaYan with the release of the GuHong V1 [23].

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Pictures from [Witeden](https://web.archive.org/web/20130614072021/http://www.witeden.com/goods.php?id=140).

## Torpedoes

In March 2011 DaYan released their fourth cube series, the LunHui [24]. The ends of each edge contained a horizontal extension called a torpedo by the English-speaking community. The purpose of the torpedoes was to reduce pops.

![](img/HardwareEvolution/LunHui.webp)

Image from [Baidu](https://baike.baidu.com/item/%E5%A4%A7%E9%9B%81%E9%AD%94%E6%96%B9/7236070)

## Magnets

### Original Use

#### Larry Nichols

The idea of magnets in a twisty puzzle can be traced back to even before Rubik’s Cube was produced. In March 1970, Larry Nichols submitted a patent for his “Pattern forming puzzle and method with pieces rotatable in groups” [25]. The primary design within this patent was what is now known as a 2x2x2 twisty puzzle. Nichols’ method for holding the individual pieces together into a cube shape was the use of embedded bar magnets.

![](img/HardwareEvolution/NicholsPatent.webp)

#### Ernő Rubik

Although not part of the final design, Ernő Rubik considered magnets as the mechanism of Rubik’s Cube. In \_Rubik’s Cubic Compendium\_, the design process was described, with magnets stated as one of the original ideas [1].

> The basic question was: what would keep the small cubes together? I had to find a means of keeping them together which would allow them to leave one section of the cube and join another, rotating in a different direction, during the performance of the different turns. Many alternative solutions presented themselves. The use of magnets seemed to be the most obvious one. I made the inside face of each piece concave, in such a way that they would fit round a steel ball in the centre. Then I fitted magnets into the concave face of each piece. They clung to the steel ball, and could be moved about with the desired effect, but this was not the real solution. Magnetic force decreases as the distance of the surfaces clinging to one another is increased; the closer the two surfaces are, the larger the force, but even a small increase in distance results in a relatively great decrease in the magnetic attraction, and the cube will then fall apart. Further, this method of construction would produce a toy that would come apart and this was not the sort of real solution that I was looking for.

#### Magneto Cube

In 1981 a German manufacturer released magnetic versions of the 2x2x2 and 3x3x3 [26, 27]. It is unknown if the internal magnetic arrangement was similar to Nichols’ patent or if a single pole is featured on each side of each inner piece.

<ImageCollage

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Images from [Jaap Scherphuis](<https://www.jaapsch.net/puzzles/images/collection/big/2x2x2%20magnet%20cube.jpg>) and [Ton Dennenbroek](https://www.speedcubing.com/ton/collection/Other%20Puzzles/pages/Magneto.htm)

#### WorldWide Tech Solutions Asia

In 2003, WorldWide Tech Solutions Asia produced a 3x3x3 puzzle held together by internal magnets [28]. This product is similar to the Magneto puzzles, except that the magnet arrangement is visible. It can be seen that the arrangement was different from Nichols’ 2x2x2 patent in that a single magnetic pole faces outward on each inner side.

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#### Gary Fixler

In April 2006, Gary Fixler independently arrived at the same idea [29, 30]. Fixler attached magnets to clear acrylic cubes to create a working 3x3x3 puzzle. He later discovered the previous creations by Nichols and WorldWide Tech Solutions Asia [30]. A guide for creating your own version is provided by Fixler on instructables.com [31], or download <a href="/archive/Documents/MagneticAcrylicRubik'sCube.pdf">here</a>.

Some interesting statements by Fixler about the design process are provided. Interestingly, Fixler once referred to it as the “magnetocube”, likely not knowing of the existence of the previously described “Magneto Cube” [32].

> The end result is a little tricky to get the hang of, and you could never speed cube with it, but it remains fun, and everyone to whom I showed it at work really loved it. Also, every single person gave it back to me with pieces oriented wrong. The labels will help with that. The cry came back from all that it needs LEDs, and that speaks of another idea I've got in the works. Hopefully much more on that project in the days to come, but that one is all kinds of way harder than this one was.

>

> The final tally:

>

> - 27 acrylic cubes from 3 sets of 10 from Tap Plastics

> - 108 D32 magnets 1/ea sets of 100 and 25 from K&J Magnetics

> - Duco Cement from the hardware store

> - 3 hours of drilling and gluing - an hour each over 3 days with shipment times, about 2.5 weeks from conception to final model

>

> Of course, two days before I finished, my friend found this. $5 from China, and you can have a perfect, machine-made version. My prototype here, with all the parts and shipping, probably ran about $80. Alas, it was just one of many cube ideas I've had lately, and I had fun designing and building it, so the project is a success in my view. I searched for magnetic rubik's cube and got nothing. He searched for magnetic rubix cube. If only I had misspelled it, too, I would have known it existed. Actually, magnetic rubik cube finds it, too, but that didn't occur to me as a search term. I'm glad I didn't find it, because it felt good to just make something again. I'm bringing it along to the Maker Faire next weekend.

>

>The magnet pair magnetic axle between this front face and the cube's central piece is strong enough to support the weight of this face, but only just. Next time - bigger axle mags.

>

> To add the final bit of insult to injury, though my Google searches turned up nothing, a friend managed to find my exact idea for sale in China for a mere $5 US :) I must've spent about $80 on the parts and supplies for this, but it was fun, and I like the crystalline nature of what I made.

>

> Check it out, you can mix them up the same way. My magnetocube prototype has passed its final test. Time to go release it into the wild and hope for the best.

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Images from [Gary Fixler](https://www.flickr.com/photos/garyfixler/albums/72057594105668430/)

### Magnetic Assistance

#### Idea

Nichols is the first known to have made use of magnets within a twisty puzzle. However, the purpose was different from how magnets are now implemented. The use of magnets as an addition to the interlocking piece structure to provide alignment assist is an idea that came much later. One early suggestion can be seen in 2003 from user “anti\_stickers” in the Speed Solving Rubik’s Cube Yahoo! group [33]. In the message, the user suggests the idea of placing magnetic materials inside the pieces. It is even suggested that the major benefit would be automatic layer alignment.

![](img/HardwareEvolution/anti\_stickers.webp)

In 2009, Martin Smith responded to a thread where a user was selling a replica of Fixler’s magnetic cube [34]. Smith stated that he was considering adding magnets to a 2x2x2 or 4x4x4 to create automatic layer alignment.

![](img/HardwareEvolution/Smith.webp)

#### Implementation

In 2013 Michael Fuentes-Vasques-Wilson posted a thread to SpeedSolving.com stating the intent to modify a Zhanchi 3x3x3 by adding internal magnets [35]. The idea was to add 48 neodymium magnets inside of each piece with the hope that it would lead to more accurate turning.

![](img/HardwareEvolution/Wilson1.webp)

Before adding the magnets, Wilson shared additional ideas and thoughts within the thread. Notably, Wilson found Fixler’s magnet-based acrylic 3x3x3 and stated the intent to use the magnet polarity configuration from that puzzle as a guide when modifying the Zhanchi [36]. On January 30 2013, Wilson announced the completion of the modification and provided additional details regarding the magnet placement [37]:

> in case anyone is wondering about the polarity's what i did was all the center pieces have a magnet with N pointing outwards and all of the edge pieces have a magnet with S pointing inwards, this way the pieces will always attract to each other, even if turned around.

This also means that inside each edge piece the magnets repel each other, not strong enough to push the edge piece apart but enough to stop them pulling to each other and possible breaking the glue over time.

On February 1 2013, Wilson uploaded a video that shows the magnet configuration and the automatic alignment when turning the layers of the 3x3x3 [38, 39]. This is the first known physical implementation of turning assist magnets within a 3x3x3.

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Screen captures from the video, showing the magnet placement.

In one reply to the thread, user “speedpicker” submitted the idea of not only arranging the magnets to attract, but also to repel [40]. The desired effect is to create a frictionless cube.

![](img/HardwareEvolution/speedpicker.webp)

In February 2016, Julien Adam posted the idea of a repel only 3x3x3 on SpeedSolving.com [41]. This post received replies from various users, with the reception being primarily negative. Users questioned the turning ability of the layers, the possibility of the magnets attracting at certain points, and the cost increase [42, 43].

![](img/HardwareEvolution/Adam.webp)

On August 19 2016, Chris Tran posted a video to YouTube showing that he had modified a ShengShou FangYuan 3x3x3 to add internal magnets [44]. The arrangement was the same as Wilson’s Zhanchi modification, with four magnets inside of each center cap and two magnets inside of each edge.

<YouTube embedId="bBEkEapVLIU" />

<br />

![](img/HardwareEvolution/Tran1.webp)

Screen capture showing the four center cap internal magnets.

#### Production

MoYu led the charge with implementing magnets into commercially available puzzles. The first mass produced magnetic puzzle was the MoYu Magnetic Pyraminx, released in August 2016 [45]. The magnetic Pyraminx was announced in May 2016, with a pre-release version being used by Drew Brads in July 2016 to break the Pyraminx average world record with a time of 2.14 seconds [46, 47]. In an interesting coincidence, just one day after MoYu's announcement, QiYi announced a magnetic Pyraminx [48].

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On July 21 2016, MoYu had also announced the production plan for a SenHuan Magnetic Magic Clock [49]. Based on the announcement including the statement of "using magnets in the products is our new idea", it was clear that MoYu intended to implement magnets into as many puzzles as possible.

![](img/HardwareEvolution/MoYuClockAnnouncement.webp)

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Images from [MoYu](https://www.facebook.com/moyumagiccube/posts/pfbid0QJVx9zyCcRQNSLUPXBHnAXrCog4LX1NrbCVMd2dbVpfgKEnpcwrECxLyuAfuBBknl?\_\_cft\_\_[0]=AZXIty3nO6RtNyBdFhk1HA33sJBz2fj52w0x616BrLZXe8OBUQ2Wh3OyeKVB0Syj7V8oy0Y0kSjDK9SgC6R0V90vatYxmNd6HYsKDHQQGBxcZdeUvuGrNrSv\_3bI-fcep\_e8huk37LjglZAVRkZ50zvqmSB6p-\_1bhhQVplIchRCYA&\_\_tn\_\_=%2CO%2CP-R)

On the same day, just one hour after MoYu announced their magnetic Clock, QiYi announced the magnetic QiYi Clock [50]. The time difference isn't seen in the Facebook announcements, but in the original threads on a Chinese message board, and MoYu was careful to point this out in their announcement to avoid confusion.

![](img/HardwareEvolution/QiYiClockAnnouncement.webp)

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Images from [QiYi]([https://www.facebook.com/mofanggecube/posts/pfbid02Gh57PbRzi72FKacZRDQsXazswVmoi81fvn9V5UCXqUpSjTZp86rbnaUwuovSzhFol?\_\_cft\_\_[0]=AZUme9zwYeduYS3KdrNJTpRUNiuP\_ongVU2SFS-Xva71huBRA2bgpKIjTdtjhSVW4h7iE\_b0T7TXFb4GQfMG0iMrOHQUOfiPFLtJbD0UOun8UKq6tlMjMOS1WmCaczcLsFyphAbrr-B5dyeVn0\_hitJxeGy-5nuTB8rW\_HAcwIdnXUk08BlsaIpjZsAyMFX0Z6BFqVJCGJJattbxfF6vLrtK&\_\_tn\_\_=%2CO%2CP-R](https://www.facebook.com/mofanggecube/posts/pfbid02Gh57PbRzi72FKacZRDQsXazswVmoi81fvn9V5UCXqUpSjTZp86rbnaUwuovSzhFol?__cft__%5b0%5d=AZUme9zwYeduYS3KdrNJTpRUNiuP_ongVU2SFS-Xva71huBRA2bgpKIjTdtjhSVW4h7iE_b0T7TXFb4GQfMG0iMrOHQUOfiPFLtJbD0UOun8UKq6tlMjMOS1WmCaczcLsFyphAbrr-B5dyeVn0_hitJxeGy-5nuTB8rW_HAcwIdnXUk08BlsaIpjZsAyMFX0Z6BFqVJCGJJattbxfF6vLrtK&__tn__=%2CO%2CP-R))

On September 22 2016, Tran posted a video to YouTube demonstrating magnets applied to a GAN 3x3x3 as part of Cubicle Labs [51]. The same day, Tran posted a thread to SpeedSolving.com announcing the first commercially available magnetic 3x3x3 – the MoYu Weilong GTS M [52].

![](img/HardwareEvolution/Tran2.webp)

<YouTube embedId="o7aTjVGa1d0" />

<br />

Making it clear that they weren't done with applying magnets to puzzles, on October 29 2016, MoYu announced the MoYu Magnetic Skewb [53].

![](img/HardwareEvolution/MoYuMagneticSkewb.webp)

#### Community Opinion

Upon release of the MoYu Weilong GTS M, reactions from the community were mixed. The primary question was whether the cube should be competition legal. Some believed that there wasn't any problem in allowing it, while some others believed that magnets introduce an advantage that strays too far from the standard 3x3x3. One major opposing argument was that magnets automatically align layers, removing the necessity for the solver to put forth effort to avoid a +2 second penalty.

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#### User Modifications

Despite the mixed opinions, many in the community liked the concept. However, due to the expense of having to buy a new cube to have the magnetic experience, some began modifying their existing cubes and other puzzles to add internal magnets. Puzzle manufacturer GAN even began selling magnets on their website, to aid users in modifying their GAN puzzles and possibly signaling that magnetic GAN puzzles were in development [54].

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Some even produced tutorials for modifying puzzles to include magnets. The first known written guide was published by Karl Zhao on September 27 2016, just five days after the release of the GTS M [55]. The first video guide was published by David Miller on October 5 2016 [56]. The goal behind the tutorials was to offer a cheaper alternative to buying a new cube or to show people how to modify cubes that they already owned and enjoyed using [55, 57]. These tutorials likely assisted many in modifying their own cubes before the inevitable release of numerous other magnetic cubes.

![](img/HardwareEvolution/Zhao.webp)

YouTube embedId="mouftEig8Gk" />

<br />

![](img/HardwareEvolution/Miller.webp)

#### Concerns Addressed by Phil Yu

On September 25 2016, after seeing the community price concerns and custom modifications, Phil Yu put out a statement in the Cyoubx's Friends Facebook group [58]. Yu stated that he respects the community modification efforts, but wanted to emphasize that the goal behind releasing the GTS M was to make easily available to everyone a premium magnetic cube. He also felt that the price was fair considering the time, effort, and research and development costs.

> Our goal was to produce a polished product that would be available for speedcubers who might find the cube/concept useful or interesting. We also wanted to get the ball rolling on a technology that might become a mainstream thing for speedcubing in the future. I’ve seen posts about prior existing magnetic 3x3s (one ZhanChi and the dice cube), suggesting that we were not the first to produce them. That is certainly true, and we were definitely not the first to produce magnetic 3x3s. We never claimed ownership of the concept, nor did we claim to make the first magnetic cube. But, from what I know, we were the first to commercially offer competition-viable magnetic speedcubes. These cubes have speedcubing utility, and have the potential to perform well in competitive speedcubing environments. Cubes outfitted with magnets in the past were interesting. Our cube is interesting and useful. I personally think this is an important distinction.

>

> I’ve also noticed that some handy people are trying to reverse engineer our product. That’s cool, and I respect that. But, I feel it is inappropriate to do so in attempt to imply or “demonstrate” that the product is priced unfairly. A lot of this reverse engineering was started after information about the cube was made available to the public. I can firmly remember people relying on this information to produce their own magnetic cubes. Given information and a picture showing the magnets, I would be surprised if a resourceful person couldn’t put forward a strong attempt at reverse engineering. I believe a resourceful person’s ability to reverse engineer with guidance at different costs is not indicative that the product is priced unfairly -- it’s more indicative of that person’s ingenuity. We spent meaningful time and resources exercising our own ingenuity without as much guidance, and we’ve also completely ruined many cubes in the process. The pricing of this product comes from considering the costs associated with developing and regularly producing the product, as well as our subjective valuation of our labor (mine included).

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### Adjustable Magnets

In September 2018, GAN released a teaser video for the first production 3x3x3 with an adjustable magnet strength [59]. The magnets within each edge are directly across from each other on opposite sides and connected through a rod. The packaging comes with sets of additional magnet rods of varying strength that the user can push through and replace the currently inserted rods. The cube was released under the name “356X” in October 2018 [60].

<YouTube embedId="9QomqgRQR9o" />

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![](img/HardwareEvolution/GAN.webp)

### Maglev Tension

<https://www.youtube.com/watch?v=Nh5zvUe83bE>

October 17 2016 at 1:31 PM

<https://www.speedsolving.com/threads/cubicle-labs-premium-cubes.62448/post-1200198>

9 minutes later Chris shared the video with SSF.

<https://www.youtube.com/watch?v=OZCnmZ3yZxY>

October 17 2016 at 4:17 PM

<https://www.youtube.com/watch?v=ZPCOFptwNIw>

October 26 2016

## Smart Cubes

### Idea

It has been a commonly proposed idea to embed electronics within a 3x3x3. The big idea is to allow the cube to recognize its own state, for the purpose of self timing or self solving. Several example mentions can be found in the Cube Lovers mailing list starting in 1980 and in the Speed Solving Rubik’s Cube Yahoo! group.

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### Production

In early 2015 Chinese company Giiker started investing into research on a smart cube, with a prototype first completed in late 2015 [61]. After spending two years refining the technology behind the smart cube, Giiker settled on a final product in late 2017. In March 2018, Giiker launched a campaign on Xiaomi crowdfunding to assist with bringing the product to market. After exceeding the crowdfunding goals, thanks to over 15,000 backers and over $200,000 contributed, the Giiker Cube was launched on June 4 2018 [62]. This makes the Giiker Cube the first production smart cube.

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    style={{position: 'absolute', top: 0, left: 0}}>

  </iframe>

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## Credit

Thanks to Draco Tong for providing the idea behind this page. Within a thread in the Cyoubx’s Friends Facebook group in September 2024, Tong suggested that there should be a page that describes the history of hardware innovations [63].

![](img/HardwareEvolution/Tong.webp)

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