



Smart Magnets for Smart Product Design

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Correlated Magnetism Research creates specially engineered “smart” magnets that are superior to conventional magnets for use in product design.

There are several problems associated with conventional magnets. For example, they may not be as strong as expected, they tend to slam together from a distance, pick up stray objects, damage credit cards and interfere with sensitive electronic devices. Furthermore, conventional magnets don't provide much shear force resistance or align very well.

CMR's software-controlled magnetization process enables control over magnetic fields and produces new magnets called “Polymagnets”. The result is that these unique magnets provide the holding force needed from magnets in product design while eliminating the issues related to conventional magnets. Polymagnets open up entirely new opportunities for using magnets in product design.

	Conventional Magnets	Polymagnets
Reach	Uncontrolled	Controlled
Shear Force	Weak	Strong
Sensitive Electronics	Interference	Safe
Credit Cards	Damage	Safe
Engineering Data	Limited, unrealistic reference data	Practical Design Data
Alignment	Imprecise	Precision

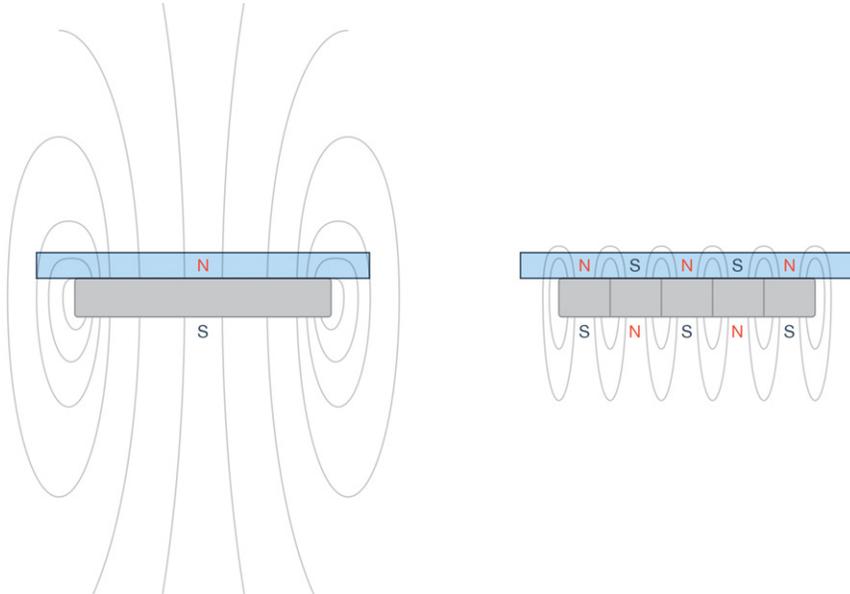
Product Designer Wish List

When a product designer creates a product with magnets, the design may require one or more of the following:

- Stronger magnet in a limited volume
- More secure, controlled feel as the system comes together, as opposed to slamming together
- More force yet limited magnetic field to maintain compatibility with credit cards and compasses
- Improved shear strength
- Improve how the pieces come together and self-align into the right position

Stronger magnet in a limited volume

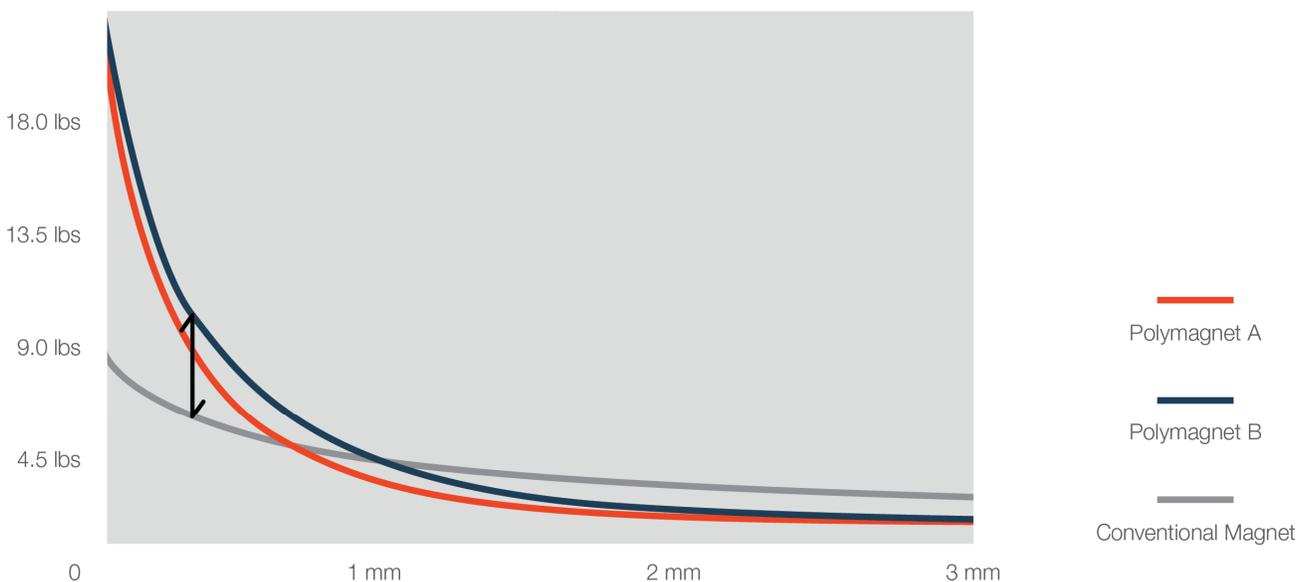
There is a lot of energy in a conventional magnet that is wasted in product design. The picture below at left showing the magnetic field lines of a conventional magnet illustrates that much of the energy is lost through the thin steel target. The picture on the right illustrates how Polymagnets are different.



Instead of long field lines wrapping around from a magnetic north pole on one face to a south pole on the other as with a conventional magnet, a Polymagnet has a network of north and south poles on its face. As a result, the Polymagnet offers a much more compact, tightly controlled, efficient magnetic circuit.

The force curve in the graphic below compares the force of a Polymagnet to that of a conventional magnet. The black arrow shows the difference in the force at a particular design gap – or distance between the magnet and the target. The Polymagnet provides superior force.

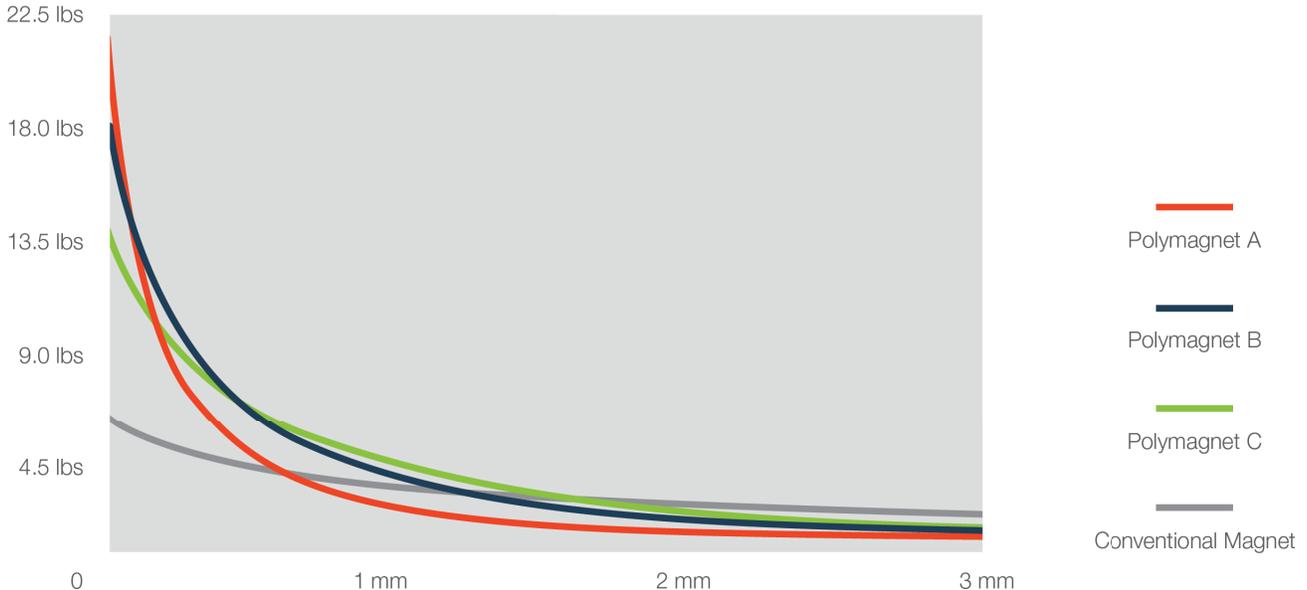
Two Different Polymagnets vs. Conventional



More secure, controlled feel

The force of the pull between conventional magnets may cause them to accelerate toward one another from a distance. Using a tablet stand as an example, a more gentle engagement might be preferred. The force curve in the graph below shows why product designers can use Polymagnets to make a significant difference in how such a system feels in a product.

Polymagnet vs. Conventional (0.010" steel)



The graph illustrates the difference between a Polymagnet's force and that of a conventional magnet. With a very far reach, a conventional magnet creates a force that is going to pull the table case to the stand hard and slam together. But with Polymagnets, this field is "tuned" to be more gradual such that the force is focused where it is desired. The product comes together and holds securely without snapping together abruptly.

Note that there are three Polymagnet curves on the graph. With Polymagnets, engagement range is tunable, based on a number of factors, to provide the desired user experience. A steeper force curve gives a shorter engagement distance while providing very strong attachment. A more gradual force curve can be used to help pull the system together from a longer distance but in a controlled way.

More force yet limited magnetic field

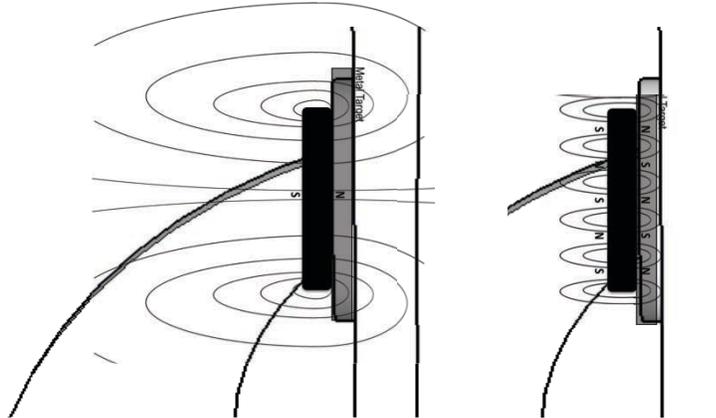
It is clear that Polymagnets provide more force, a more efficient circuit and a better "feel" than conventional magnets. But what if product requirements include the need for even more force as well as compatibility with credit cards?

CMR's test results show that magnets with a field over 2,000 gauss can corrupt the magnetic strip on a credit card. As such, the magnetic force needs to be kept low yet still provide increased holding power, something that would seem impossible.

There are a number of options for increasing the holding force. One way is to increase the grade of the magnet, but this increases the magnetic field flux and raises the potential for damaging a credit card. Another option is to increase the thickness, but this also increases the magnetic field flux and may not be very efficient for product design.

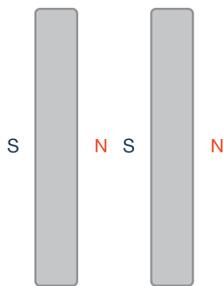
CMR can control the magnetic field by increasing the surface area while keeping the grade and thickness the same. This is the best way to increase the force to the level desired while maintaining compatibility with credit cards.

Shear Resistance

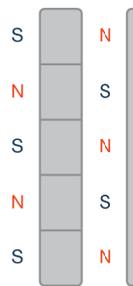


With the example of a tablet stand, the case must stay in place and not slide down on the stand. Consider three approaches to magnetic attachment shown in the picture below:

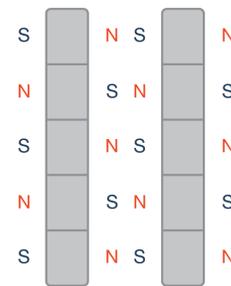
- Conventional magnet to conventional magnet (left example; Poor System)
- Polymagnet against steel (middle example; Good System)
- Polymagnet-to-Polymagnet (right example; Best System)



Poor System
Magnet-to-magnet



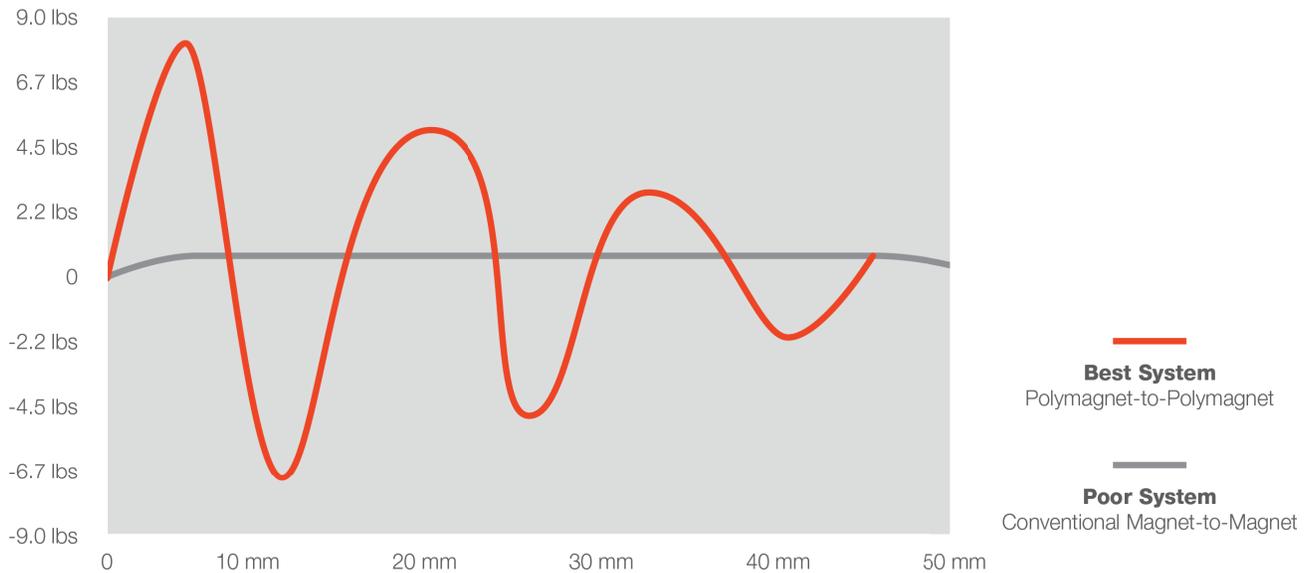
Good System
Polymagnet-to-Steel



Best System
Polymagnet-to-Polymagnet

The grey line in the graph on the next page shows that pairing two conventional magnets does provide a shear force component, though it is relatively small. As the magnets are displaced, there is a fairly constant force that tries to pull them back to equilibrium.

Shear Force w.r.t. Lateral Displacement (1mm separation)



In the second example, a Polymagnet provides good holding force to a steel target. However the shear resistance, which comes from the holding force of the magnet against the target and the coefficient of friction between the two surfaces, is still limited.

For the tablet stand example, a Polymagnet-to-Polymagnet system is best. In this system, there are many alternating poles facing each other. The attraction and repulsion between the alternating poles creates good shear resistance. The curve in the red line on the graph shows that when there is lateral displacement between the magnets, there is a fairly high shear force back toward the equilibrium point. This option provides much better shear resistance than the other two systems.

Thus far in the example of the tablet stand, a product has been created that comes together, feels good when it comes together, and holds securely. But there's still something missing. What if a charging feature or some other connection feature is desired, or what if the components just need to come together in the same manner every time?

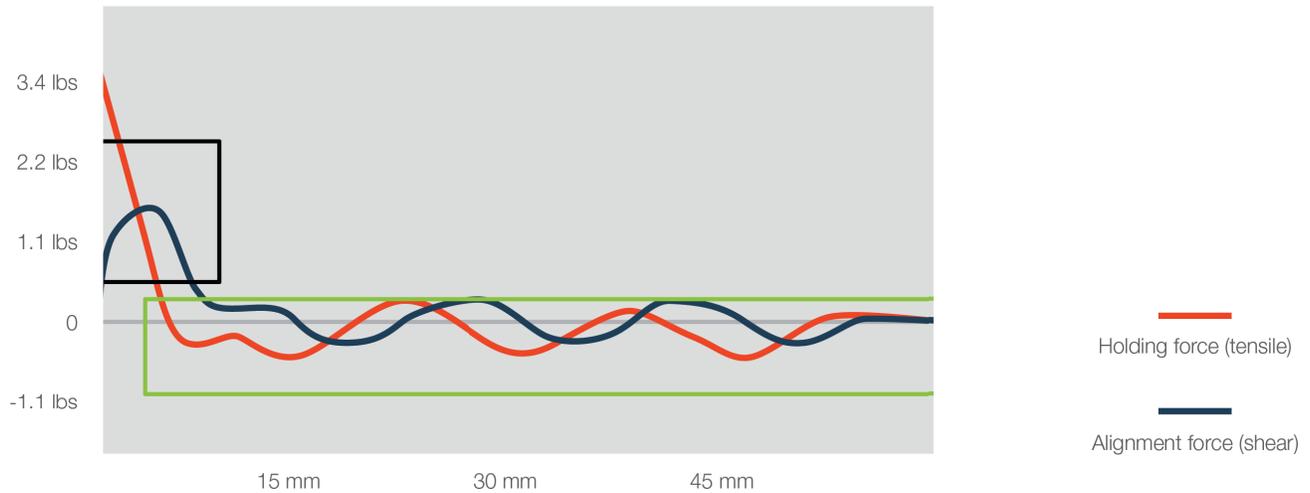
Alignment Features

There is a family of Polymagnets that answers this design requirement as well. CMR offers self-aligning magnets that reject misalignment so that they only go together one way.

In the graph below, the blue line indicates the holding force between a pair of Polymagnets, and the red line is the shear - or alignment - force. Both of these are a function of lateral displacement. The black box shows the area of positive alignment force. As you move away from center and alignment, there is a pull or a force back toward alignment.

The force curve between the magnets shows that if there is a small amount of displacement between the magnets, you go from a positive force that holds them together to a negative force that repels. The green box on the graph shows that there is actually a large area where the magnets are mostly repelling each other. This will make your tablet stand and case, or components of any other system you are designing, seem to float apart from each other until they are aligned and they satisfyingly click into place.

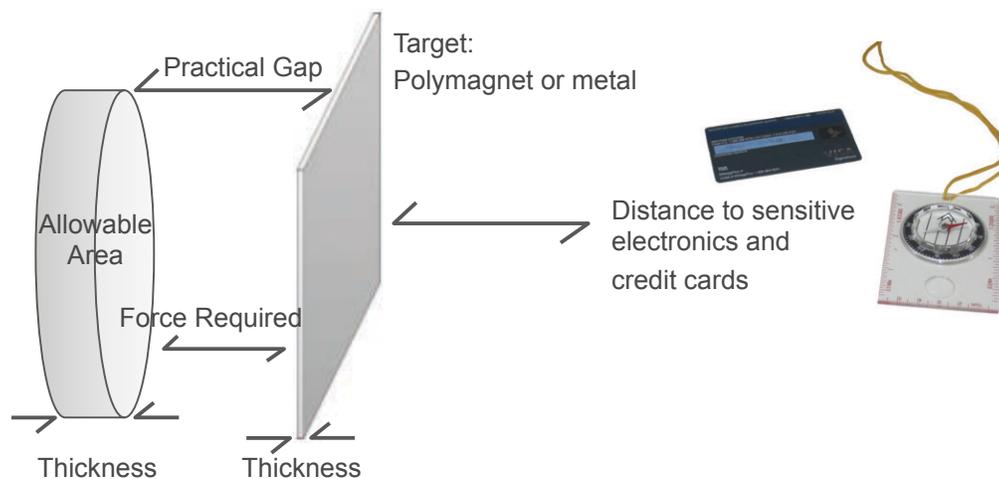
Pair of Polymagnets Repel When Not Aligned



Requirements and Functions to Consider

The discussion above illustrates that, when considering magnets for product design, these questions should be considered:

- What force is needed?
- What surface area is available for the face of the magnet?
- Is there a limit needed to the magnetic field? At what distance?
- Is compatibility with credit cards required?
- How far is the magnet from the target (either magnet or metal)?
- How should the system feel as the magnets engage?
- What functions (alignment, shear, release behavior) are required?



Polymagnet Catalog

Product designers can consult CMR's Polymagnet Catalog to get the right feel and function for their product. CMR has Polymagnets that are tailored for certain applications, such as tablet products, mobile phones and accessories.

The catalog also offers standard Polymagnets with a range of functions in a range of sizes. Polymagnets come in a variety of versions, each offering a different 'feel' for a particular function. In addition, specialty Polymagnets are available with novel functions not available in standard magnets.



A product designer can choose which Polymagnet to use to 'tune' the overall experience desired for their customers. You can buy Polymagnets from prototype quantities all the way up to high volumes from CMR's manufacturing facility in China.

Custom Polymagnets

Custom Polymagnets are also available. CMR can combine Polymagnet functions in a wide variety of ways to meet the needs of a specific product if the magnets offered in the Polymagnet Catalog are not the perfect fit.

Next Steps In Designing a Polymagnet system

Polymagnets are available in the Polymagnet Catalog in a variety of shapes and sizes, with a variety of functions, giving product designers a new tool for designing products. The catalog provides an excellent starting point for most products. Visit www.polymagnet.com for further information. To discuss a custom design project, please contact a CMR sales representative listed in the contact section of CMR's website: www.polymagnet.com/contact

Polymagnets are an incredible design tool that provide new capability above and beyond the limitations of conventional magnets.