



Building Genius™



Teacher's Primer

Second Edition



What's in this Primer?

Lux was designed to give people a means of better understanding their world through the activity of construction. Lux achieves this by using moving linkages to build things as we find them in our world. This unique characteristic offers natural springboards into a wide variety of subject matter and disciplines. This was the intention of the inventors - to stimulate curiosity, exploration and creativity, and to build connections to the world.

The primer is divided into four sections:

Getting Started: Not to be skipped! This section gives a brief practical guide to using Lux and describes some of its features.

Linkages: Lux is like learning a new language. It is the language of linkages or kinematics. This primer will not get too technical, but will help to point out the basic ideas when exploring how motions, structures and shapes can be described and discussed when using Lux. Lux is there to help start a larger conversation about the world, and we have provided some leaping off points.

Math: From basic counting manipulatives to making three dimensional objects and creating probability tools, the snapping connecting blocks can make math a stimulating, hands-on creative activity.

Three Dimensional Thinking: Three dimensional thinking can be taught. Building the geometric solids and learning structural principles and patterns with Lux is very fun and totally rewarding. Seeing and recognizing patterns is a way of thinking and understanding one's world.



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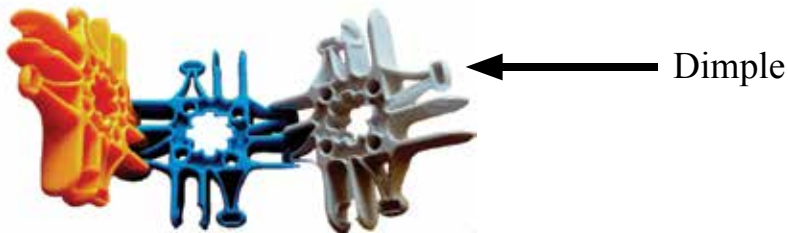


Getting Started With Lux™

There are a few things to know about Lux before getting started. For more ideas and “how-to” videos, please visit our website at www.luxblox.com.

Dimples

The dimples are the rectangle-shaped cavities on the egg-shaped connector. One thing to keep in mind when building with Lux is to be consistent with the direction the dimples are facing—either all ‘in’ or all ‘out’—so they will all connect to each other. Otherwise, you may need to go back and remake parts.



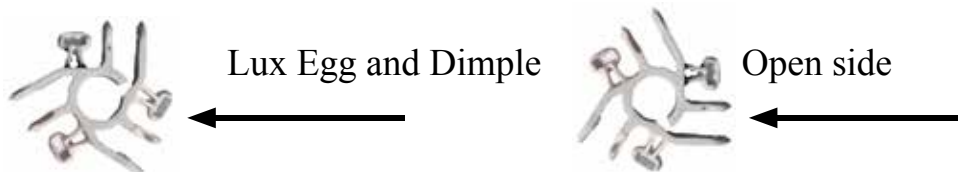
The Egg Goes in the Nest

When connecting Lux, simply push the connectors together so each egg-shaped part goes into each U-shaped “nest” and the Lux will snap into place. Once they snap, the blox become a strong hinge with 240 degrees of rotation.



Trigons

The trigons are left and right-handed depending on what face is showing. You can tell the difference by noticing the dimples on the egg of the Lux connector—only one side of the Lux egg has this dimple.



To get the best fit with trigons, make sure they are not connected to each other on the open sides.

Like this



Not like this



Go to www.luxblox.com to learn more and see what others are building with Lux™!



Unsticking Your Cube

If you make a Lux cube, you will discover it is not easy to take apart. This is easily solved by simply inserting a pencil or dowel rod into the hole of a Lux and prying open your cube.



What is the Hole in the Middle for?

Lux was made to be a tool for creativity and invention. The star-shaped hole was designed to fit two craft sticks side by side so you can expand your Lux creations with the addition of these inexpensive items. Craft sticks are also the ideal tool when building with Lux because you can use them to hold the Lux in place as you snap on other parts and not crush what you have already made. The hole will also allow a pencil to rotate freely, which makes a great axle in machines and vehicles. A 1/4 inch diameter wooden dowel rod, which you can find in craft and home improvement stores, also makes an axle and 5/16 inch diameter rods will make great struts for adding structure to your creations. The smaller four holes are for wires, toothpicks, or other similar-sized objects.



Living in a Structured Universe of Linkages



Lux was named after the Latin word for light, because Lux sheds light on the principles of construction and design underlying all of nature.

Lux will help teachers introduce students to this amazing structural world they were born into. Much of what we experience is structures and machines. Lux is all about making hands-on creative connections to the natural and human-made world of structures and machines.

Why So Few Types of Parts with Lux?

The reason, and why Lux parts have connections that allow for bending, is this is how nature puts itself together: with a limited inventory of linking shapes. This limited inventory of shape parts has the awesome effect of allowing for an explosion of diversity when parts are combined.

This is known as the Min/Max Theory - or the Minimum Inventory/Maximum Diversity Theory. A minimum inventory of the right pieces can create a maximum diversity of potential outcomes. In good design, we try always to do more with less. In nature, we see awesome examples of doing the most with the least. The triangle and square shaped Lux pieces are the two most basic polygons, and therefore can be used to build a universe of complex shapes and structures that model the natural world. This is the miracle of natural design—from very few parts arises a world of possibilities!

So, What is a Structure?

The word structure is from the Latin word *structura*, which means “a fitting together, or construction.”

A structure is something that is put together with parts, and tends to hold its shape. It is a patterned stabilization, meaning the stability or rigidity comes from connecting the parts into the right patterns.

Buildings, vehicles, and even living things are all structures. They are put together with parts and tend to hold their shapes. For example, a building like your school is a structure that holds the shape of the classrooms, hallways, cafeteria,



A building that has collapsed under the heavy load of many feet of snow. This building could not maintain its shape under the weight of this much snowfall, therefore the structure failed.



offices, closets and other rooms. Your school will hold its shape under many conditions, including severe storms, ground tremors, rain and snow.

When there is a blizzard that produces many feet of snow, one place you would avoid is a building with a very large roof. This is because such a building may not have been built to support the weight of so much snow. Under the great weight of the snow, the building may not be able to hold its shape and may cave in or collapse.



In 1908, San Francisco, California, experienced a very strong earthquake. The quake revealed that the buildings with internal steel structures held their shape and did not collapse. Brick buildings, on the other hand, were shaken apart.

In an earthquake, buildings can be violently shaken up and down and side to side. Many buildings were built out of materials that can crumble in earthquakes. This is why it is advisable to hide under a table or in a doorway during an earthquake, as these are often stronger structures than the building itself and they may hold their shape when the building will not.

Airplanes are strongly built structures that can do much of what a building can do and can also fly! Airplanes are so strong that they can be shaken by an earthquake or blown by a hurricane and still not be damaged. This is because airplanes were built to hold their shape while flying around for many years and landing thousands of times in their lifetime.

Trees and plants also have very strong structures and can often survive extreme weather better than our buildings.

We are always trying to improve structures so that we can do fun and exciting things. Thinking about and improving structures helps us travel to space, make faster and more fuel-efficient vehicles, build taller buildings, make homes safer to live in, and make artificial limbs and organs and medical devices.

Corrugated Structures: Why Things Hold Their Shapes



When you make a flat sheet of Lux either out of trigons, squares, or a combination of both, you are making what can be referred to as a membrane. This bendable membrane can form into many shapes and will seem to have little structure of its own. It is more like a fabric, but notice that by simply bending the membrane along one or more of its creases, it will begin to stiffen and make a rigid structure. Stiffening, or making a rigid structure by bending and holding a shape, is called corrugation.

Membranes are found in the film on water and the lipid structures in cells. Structures such as bubbles and cell walls are formed when these membranes are corrugated. The way rockets and airplanes and automobiles are made also involves bending lightweight, thin sheets of materials, like steel and aluminum, to form strong and light-weight structures.

Linkages: The Natural Bridge Between Structures and Machines

Connecting a chain of three square Lux end-to-end will make a pliable and small membrane. By attaching each end, you will make a triangular prism. There is no shape-changing with a triangular prism—it is an amazingly stable structure! A chain of four Lux squares is a different story, however.



Lux membranes folded into triangular prisms are remarkably strong structures which hold their shape.

When four Lux squares are made into a chain and then connected on each end, they will make what is called a four-bar linkage. The linkage is the hinged corner connecting each square. Notice that this linkage will move a little and transform from being in the shape of a rhombus (or diamond) to a square and back to a rhombus again. While stable and non-moving structures that hold their shapes can be made from linkages, linkages like this four-bar linkage are in a state of instability and are more akin to mechanisms. To stabilize and limit the motion of the four-bar linkage, you can add an adjacent square to lock the linkage into place. The additional square will lock it into a cube configuration and make a stable structure. Many simple machines use four-bar linkages.



Four bar linkage made of a chain of four Lux squares.

Most of our tools and machines are linkage systems. In fact, all of life is literally made of linkage systems, from cell walls transforming from membranes into rigid walls and microscopic architecture, to the joints in our bones. The more we see the world as structures and mechanisms, the more we can marvel at its wonder and elegance. Allowing your students to explore this amazing structural, mechanical world with Lux will enable them to connect to this world at a very personal and intellectual level.



When we ride a bike, we are participating in being a part of a four-bar linkage. The bars are the shaft from the pedal sprocket to the seat, the upper leg, and the pedal shaft. The linkages are the joints in our legs and the bike.





This is an example of using a four-bar linkage (red) with stable three-square Lux prisms (purple) to make a gimbal. The red squares are free to bend into diamond and square shapes while the triangular prisms cannot bend at all. Together they make an interesting object!



Example of an artificial human knee, a four-bar linkage. We have the same kind of linkages that are in our machines!

Examples of Corrugation in our World

Optimization is making the best or most effective use of a situation or resource. Corrugation is a form of optimization by which a material is folded or bent in order to enhance its strength without adding to its weight or mass.

Metal, wood, plastic and paper are all materials which are often corrugated.



The World War II German JU 52 was a cargo plane made out of corrugate aluminum. The ripple patterns in the sheet metal gave it great rigidity and allowed the plane to be a much lighter weight.

Cardboard is a great example of how we make paper into an amazing structure by using corrugation. By layering paper with ripples, sandwiched



The reason we are able to make this incredibly strong and lightweight Quonset Hut out of thin sheet metal is because it is corrugated. The ripples in the metal give it rigidity and make it suitable for structures such as these and on many roofs around the world.

between layers of flat paper, we create rigid (or stiff) boards that can then be used to make strong lightweight boxes.

These corrugated cardboard boxes are used for packaging goods that are manufactured in all parts of the world.

These boxes are loaded into lightweight, but very strong, shipping containers made of corrugated sheet metal. Yes - the corrugated paper boxes are loaded into corrugated metal boxes!





The container ship takes thousands of corrugated metal containers, each filled with perhaps thousands of corrugated paper boxes full of goods, all over the world. The containers will then be put on trains, airplanes, and trucks and shipped to customers.

The corrugated metal containers are then put onto large moving boxes (known as boats, trucks, and trains) which are also made of corrugated metal. These vehicles will transport the box containers thousands of miles around the globe.

These items often end up in large supermarkets which are sometimes called “Big Box Stores”. The stores themselves are giant corrugated boxes made of hollow concrete blocks and corrugated sheet metal, and often have corrugated metal roofs just like the boxes and containers that make them possible.



The corrugated metal roof inside a “Big Box” store. This corrugation allows for the very large roof to have the structure to hold up under conditions like wind, rain, and heavy snowfall.

Corrugated Structures in Nature

Nature also uses corrugation to give animals and plants a safe place to live and the ability to get more sunlight when needed.

Living creatures use linking parts to create rigid structures like shells and bones. Flexible linkages are used in membranes, joints between bones, muscles and other appendages like antennae.



These microscopic Diatoms created a very stable triangular prism structure for their skeletons.

The “Creature Creativity” section of this primer offers opportunities to discuss the various ways creatures use linking systems to adapt to their environments.



Linkages

Understanding linkages enables us to understand connections between machines and structures. Since so much of our world is either a machine, a structure, or a combination of the two, understanding this helps teachers bring the world to their students in a more cohesive and exciting way.

Lux are hinge elements that make linkages. Structures and machines can be thought of as assemblages of linkages. A mechanical linkage is an assembly of bodies which are connected to manage forces and movement. Linkages may be constructed from open chains, closed chains, or a combination of both. Each link in a chain is connected by a joint to one or more other links. Mechanical linkages are usually designed to transform a given input force and movement into a desired output force and movement. The ratio of the output force to the input force is known as the mechanical advantage of the linkage, while the ratio of the input speed to the output speed is known as the speed ratio. A chain in which one link is fixed or stationary is called a mechanism. A linkage designed to be stationary is called a structure. Structures are those linkages in which we have limited their degrees of freedom and stopped them from moving on themselves.

The Centrifugon

The Centrifugon demonstrates centrifugal force. As you twist the spindle (pencil) between your fingers, the flex arms are free to twirl around. As they do, they go up until they have risen 90 degrees from the spindle (pencil).

Can your students think of other examples of centrifugal force?

Can the students demonstrate it with their bodies? Sure! The arms at the shoulder have a ball and socket joint which allows them to freely move in the same direction as the Centrifugon. Have your students stand and spin around, allowing their arms to rise up. You can ask the students how fast they have to spin to get their arms to rise. How do you measure this? By using a clock or stopwatch, you can introduce the measure of revolutions per minute (RPM).



Lux Flux

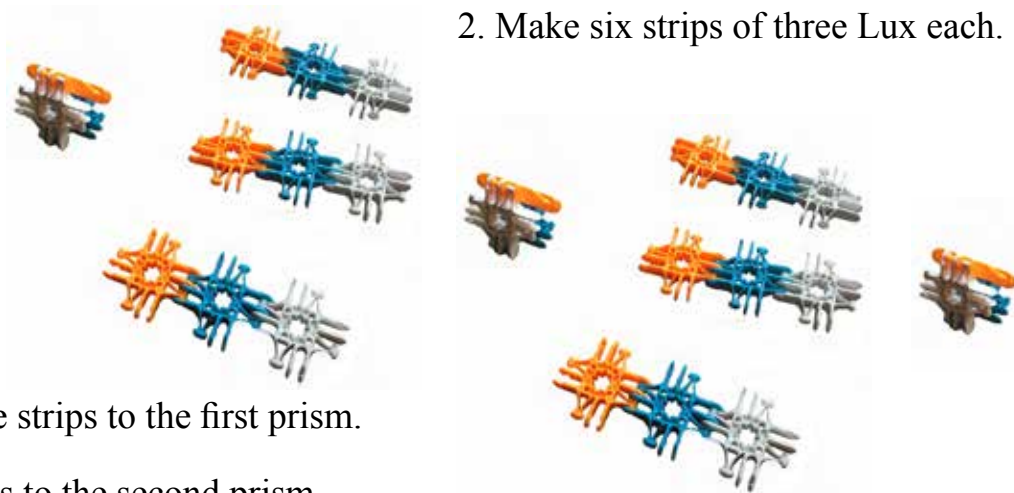
27 pieces



dimple

1. Make three triangular prisms, making sure that all the Lux have the dimples facing to the inside of their prisms.

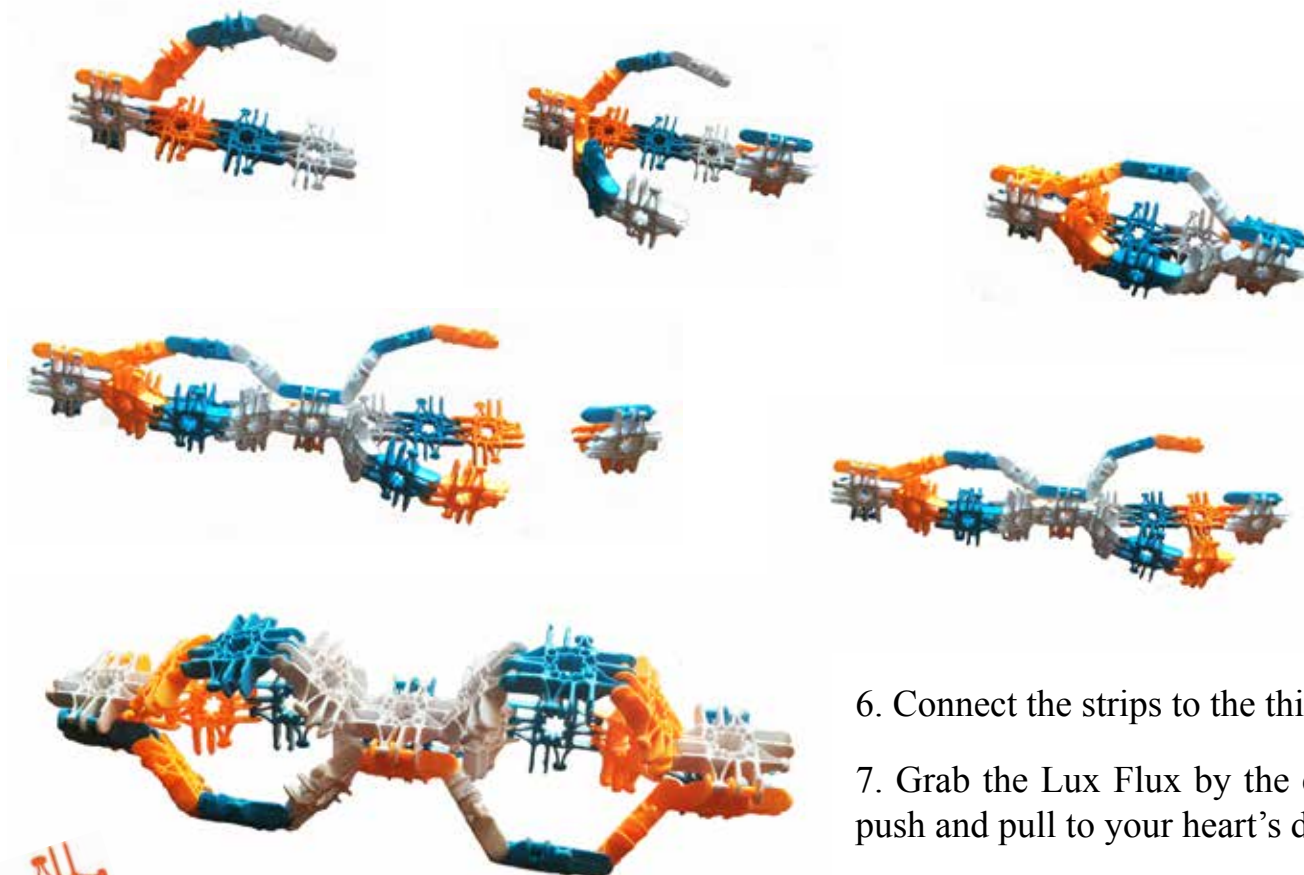
2. Make six strips of three Lux each.



3. Connect the three strips to the first prism.

4. Connect the strips to the second prism.

5. Repeat by connecting the remaining three strips to the second prism.



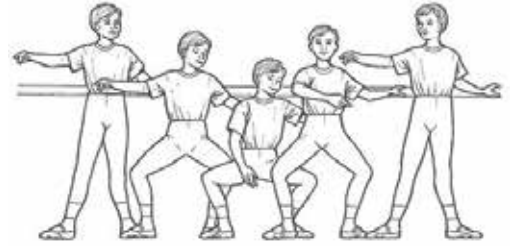
6. Connect the strips to the third prism.

7. Grab the Lux Flux by the ends then push and pull to your heart's delight.



The Flux is a Sarrus linkage which converts linear motion into circular motion. The triangular Flux uses triangular prisms positioned in the same direction. The prisms attach to one another with chains of three Lux. The linear back and forth motion of the prisms causes a circular arc motion.

The Flux is a very common motion in nature. It shows the transfer of force from a straight direction into a circular motion. This transfer of mechanical forces happens in nature all the time, virtually everywhere we look. Even in our own bodies, we exhibit this linkage motion.



The students can demonstrate this motion with their own bodies! Starting with their fingers showing a tripod grasping motion, they can replicate this linkage.



In ballet, there is a type of squat called the Plié. It is performed by pointing your toes outward, then bending your knees. Plié is a French word which means ‘to bend’. If the kids squat all the way down until their heels come off the floor, they are doing a ‘Grand Plié’. If their heels remain on the floor and they only partially squat down, they are performing a ‘Demi Plié’. This also demonstrates the linkage motion.

You can expand the Flux by making bridges between the linkages.



The Lux Flex-Cube (30 pieces)

To make the Flex-Cube, simply make six “plus signs” out of five Lux each and arrange them in the cross configuration as shown below. Snap the six plus signs into a cube shape. The structure will be squishy! The students can mimic this motion by putting their hands together with only the finger tips touching, then manipulating their hands, keeping their finger tips always touching the other hand’s tips.

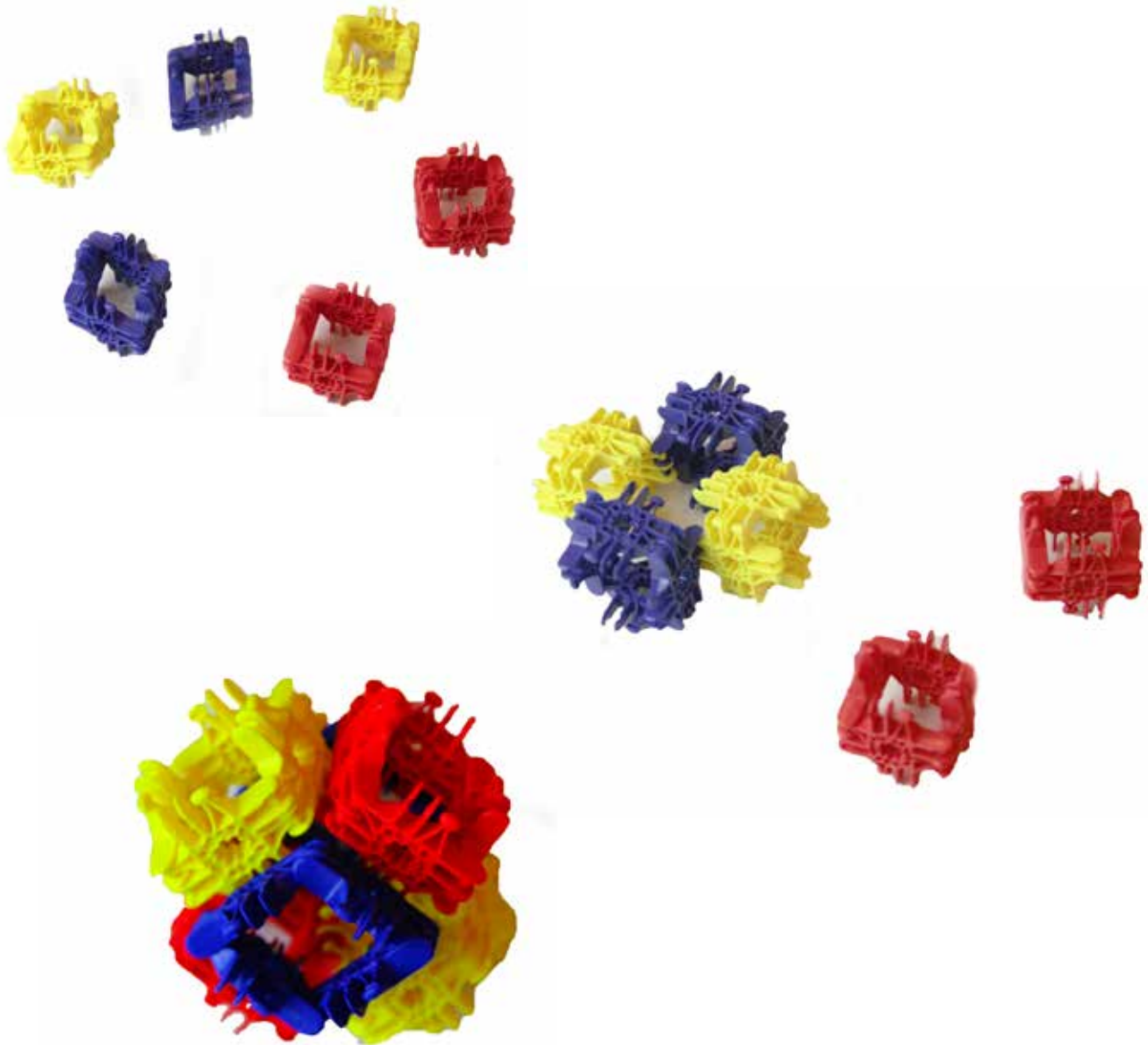


The Gimbalgus

The Gimbalgus is a very amusing Lux creation composed of “four bar linkages”. When you snap together four Lux, you see that, unlike the triangular prism that locks into one shape, the square prism wants to move from diamond to square to diamond. This motion can be harnessed to do many amazing things.

Begin by making eight square prisms. Make certain the dimples are all facing inward to connect properly together in this model.

Next, begin to connect the prisms together. First make a ring of four prisms, as seen below with the blue and yellow prisms. Then add the top and bottom prisms (shown in red) to complete the Gimbalgus.



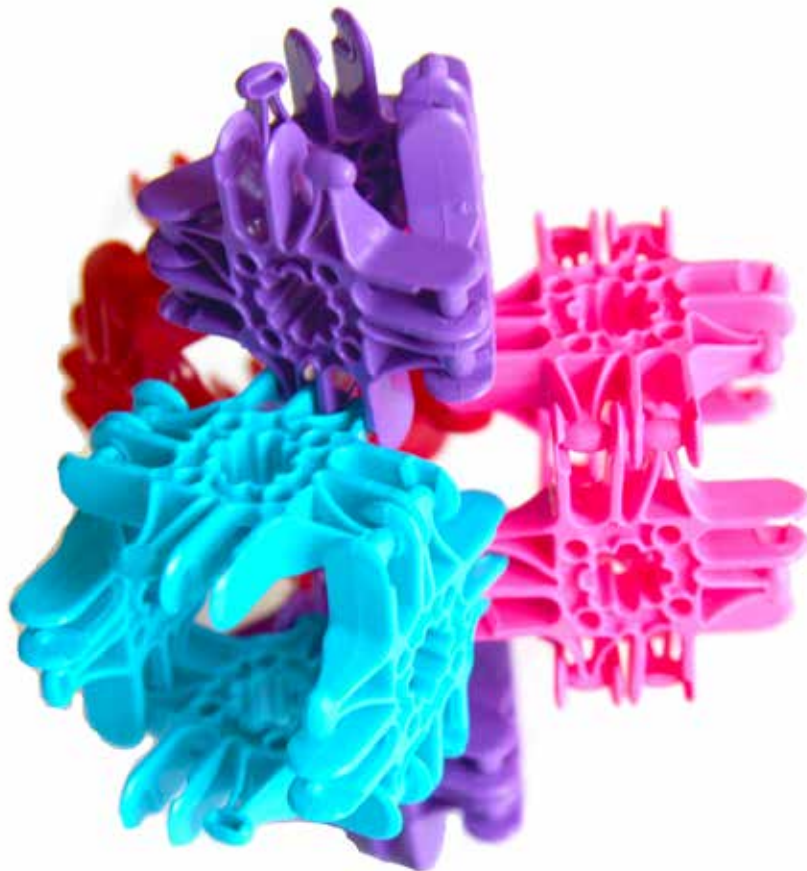
So What is Happening in the Gimbalgus?

Notice the Gimbalgus faces are free to move between a rhombus or diamond shape to a square, and back to a rhombus at right angles to the original rhombus. Since there are six of these movable shapes linked to together, they are free to move, but only within the restraints of the system in which they are joined. Isn't that an interesting idea? Isn't that how freedom is in our own society? We are free within the system we all agree upon based on laws, a government or elected officials, and rules we agree to follow.

A pile of Lux that are not connected to each other have the most freedom but are they interesting when they are not connected to each other? Can they accomplish much when they are not connected to other Lux?

Hmmm! One of those educational moments!

Try making a triangular Gimbalgus also! Just make three square prisms and two triangular prisms. First make a ring of the three square prisms, then connect a triangular prism to the top and bottom triangular openings. This Gimbulgus also makes a swiveling motion. It has less freedom than its square cousin, but it is also a very useful motion. This is the type of Gimbalgus used to make the spine in Gimbalgams.



Arthropodion (68 pieces)

To make segmented animals like the Arthropodion, simply make a Lux Octoball (see page 26) for the body and add the segmented legs made of triangular prisms.



An arthropod (from Greek arthron, “joint” and pous, “foot”) is an invertebrate animal having an exoskeleton (external skeleton), a segmented body, and jointed appendages (paired appendages).

Arthropods are from the phylum Arthropoda, and include insects, spiders, and crustaceans (crabs, lobsters, crayfish, shrimp, krill, woodlice, and barnacles). Arthropods are characterized by their jointed limbs and rigid cuticle. The arthropod body plans consists of segments, each with a pair of appendages. Their versatility has enabled them to become the most successful species in most ecosystems. They have over a million species, making up more than 80% of all living animal species, some of which, unlike most animals, are very successful in dry environments.

The advantages of having a hard outer shell are obvious. But what about when those shells can be hinged to each other? What are the advantages then?

Have the students make an Arthropodion, then have them make variations on the design to see if they can make their creature have other advantages.



Creature Creativity

Have the students consider what attributes they might want their creature to possess and then have them work at designing the creature using Lux.

Their creature could have a combination of hard shells and moving structures that can serve to move the creature on land or through the water (or air). Their creature can have features that trap food, defend against attack, allow it to move quickly or in different directions. The students can defend their design and the group can discuss what creatures might succeed most in various environments. This is a natural bridge to a discussion about ecology and the food chain as well as a nice launching point to take a hike outside and collect specimens to analyze back in the classroom. Can the students mimic the creatures they discover in the wild with their Lux back in the classroom?



Math

The first thing you make with Lux are chains or strips. These are excellent for use as a basic manipulative since each block can serve as a quantity of one. Here we will explore counting, sorting, shape language, perimeter, surface area, and the geometric solids.

Lux make a nice loud snapping sound when snapped together. This can be very pleasing and requires a small amount of effort for a small person, especially if the Lux are placed on a flat surface and pushed together.

A great job to give the student who is just starting counting is to task them with creating strips containing specific amounts of Lux. After they have made dozens of such strips, the idea of the quantity will be more hardwired from the mechanical activity of building these.

How many different kinds of quadrangles can we make with sixteen Lux?

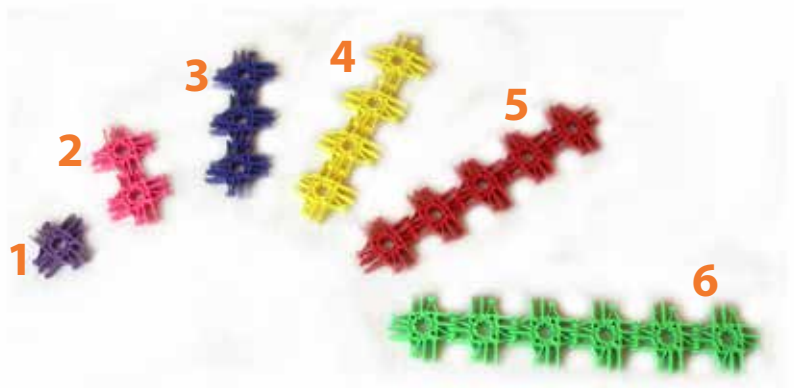
Let's see. We can make a sixteen by one (16×1) quadrangle. We can make a two by eight (2×8) quadrangle. We can make a four by four (4×4) quadrangle. How many is that? Three?

This is a great question way to get students thinking about number families. Many craftspeople use “width by height” when measuring. So, for instance, you can say, “please make a two by seven strip of Lux”. Soon you can introduce the notion that “by” can be substituted for “times” or “multiplied by”.

You can introduce reversibility as well, and ask them how long would a strip have to be if it were 2 wide and had 8 Lux. The object is for the student to internalize the process and build fluency with numbers. This also prepares them for the concept of surface area.



Counting & Grouping Using Lux



Speed Strips

One way to make counting and number families fluent is through repetition and speed. Not allowing time for mechanical counting helps to hardwire the number patterns in the brain. The goal is to make the relationships of numbers effortless. This is what we call fluency.

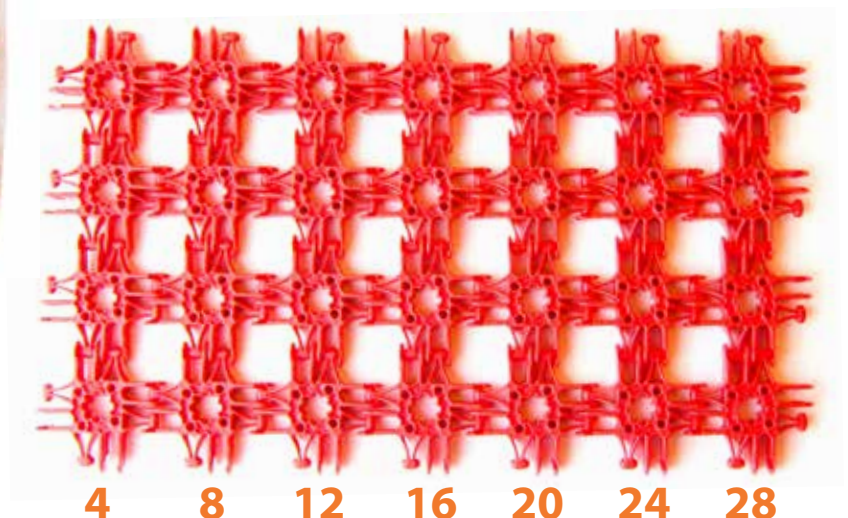
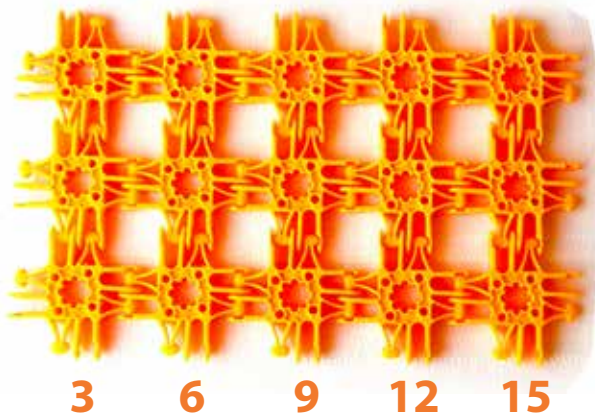
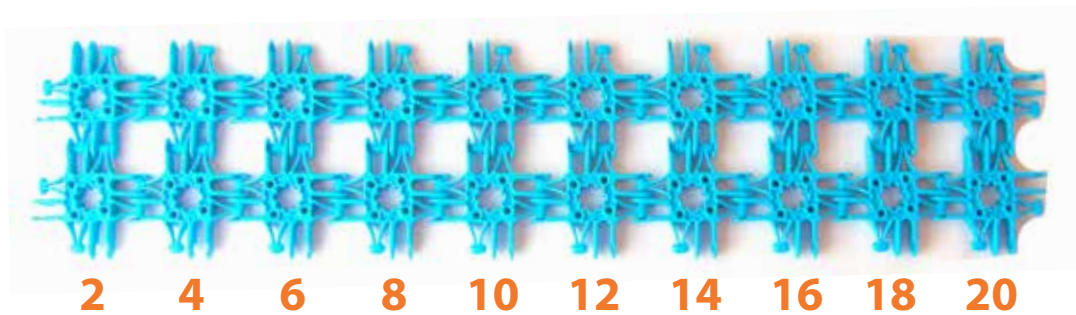
The strips can be identified as “width by height” and total blocks (or surface area). So the teal blue strip would be 2 by 10, 20 Lux. Orange is 3 by 5, 15 Lux. The red, 4 by 7, 28 Lux.

Students can make their own strips and games can be made in which teams challenge each other.

Number families can be concentrated on using speed strips as well.

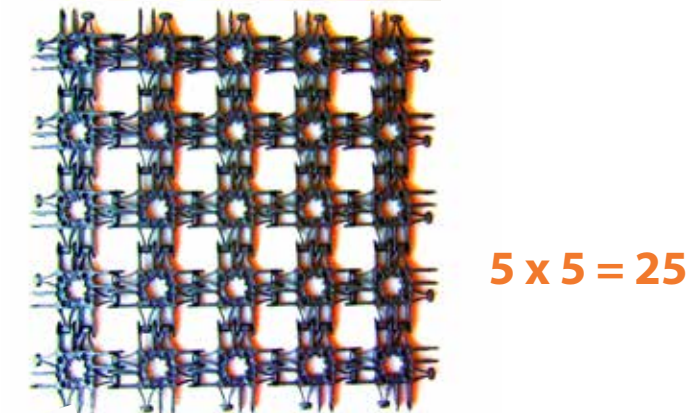
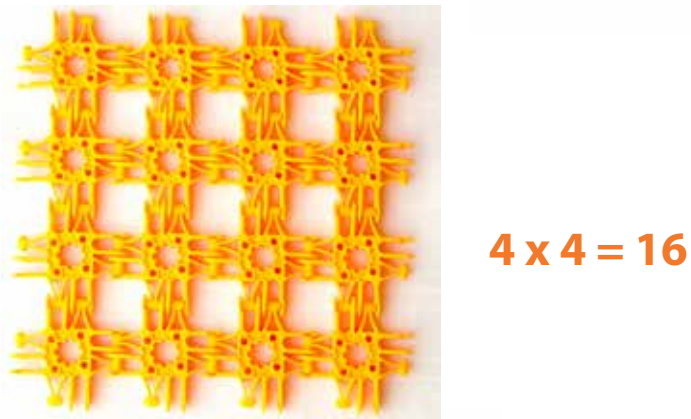
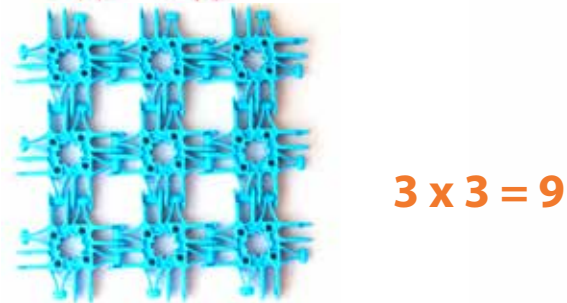
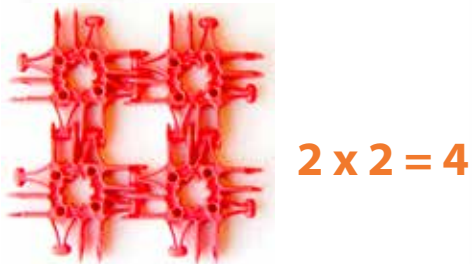
Lux can be used as a currency and for tallying.

The students can create systems in which a color can represent a value of another color of Lux. For instance, an orange Lux can be worth ten teal blue Lux, ten teal blue make one neon green, ten neon green make one red, ten red make one purple, etc.



Square Numbers

You can have the students construct a type of Lux flash card to help them reinforce learning square numbers. Using the Lux squares, they can see that the blue configuration has an edge length of three and is a square. It is “three squared”.



Perimeter

This is an excellent opportunity to introduce perimeter and area problems using Lux as fencing on a farm, for instance. The Lux would stand upright, and the students can design their corral according to specifications such as, “Lonny has 24 lengths of fence, what is the narrowest her corral can be? What is the longest it can be?”

Maybe the students need to make a corral for horses who are famous for jumping very high and escaping, so they need to build a corral that is two Lux tall. If they have to enclose an area of 36 square Lux, how many Lux will they need to construct this fence?



Polygons

A polygon is a plane (flat) figure that is bounded by a finite chain of straight line segments closing in a loop to form a closed polygonal chain or circuit. The Lux on edge can represent our line segment viewed from above looking down.

Where the Lux segments meet are the polygon’s vertices (singular: vertex) or corners. The interior of the polygon is sometimes called its body. An n-gon is a polygon with n sides; for example, a triangle is a 3-gon. A polygon is a 2-dimensional example of the more general polytope in any number of dimensions.

Let’s use Lux chains to make polygons defined by their edges. As we build our n-gons, starting with three, (the minimum n-gon), we begin to see that the more sides we add, the “smoother” the n-gon becomes, and we see that it is approaching a circle.



Row 1: 3-gon Triangle, 4-gon Square, 5-gon Pentagon,
6-gon Hexagon, 7-gon Heptagon

Row 2: 8-gon Octagon, 9-gon Nonagon, 10-gon Decagon

Row 3: 11-gon Hendecagon 12-gon Dodecagon

Surface Area

The simple act of building boxes is a beautiful opportunity to explore many mathematical ideas and to reinforce useful foundational skills.

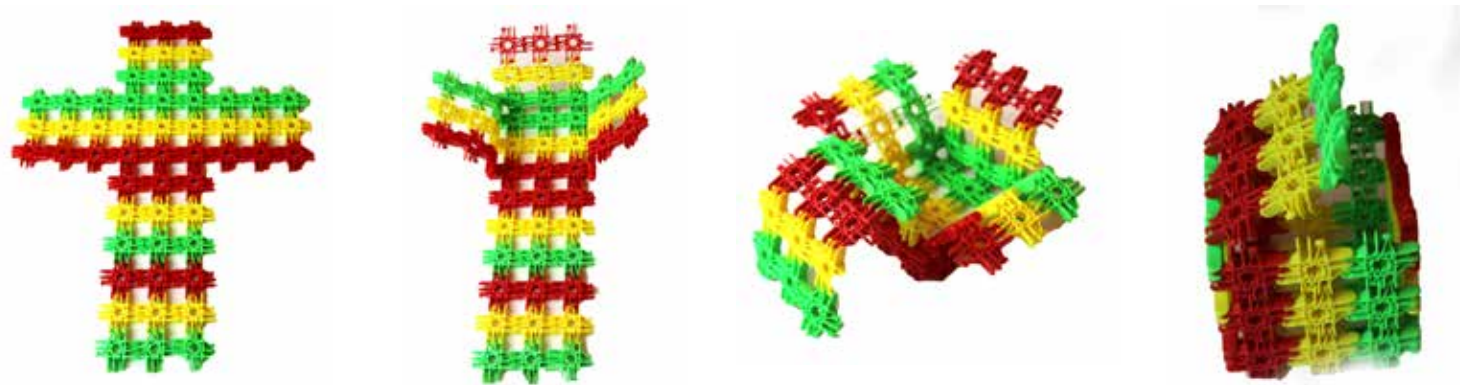
Starting with the cube, have your students identify that the cube (or hexahedron) must have six square sides. Once they have identified the “sixness” of the cube, they will quickly begin to use that helpful shortcut when estimating how many Lux they will need to make a cube with a given edge length.

How many Lux are needed to make a cube of a given an edge length of E?

$E \times E \times 6 =$ total Lux needed. Or E “squared” times six equals total Area.

If the cube must be 3 Lux high, how many Lux will I need to build it?

Answer $E = 3$, so $3 \times 3 \times 6 = 54$ Lux total.



Activity

Have the students create boxes or baskets and other items for use in the classroom. They can be a specific dimension, or be able to hold a specific amount of items (like four apples). It could be a challenge!



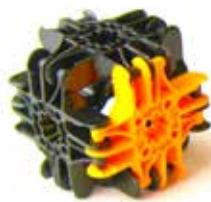
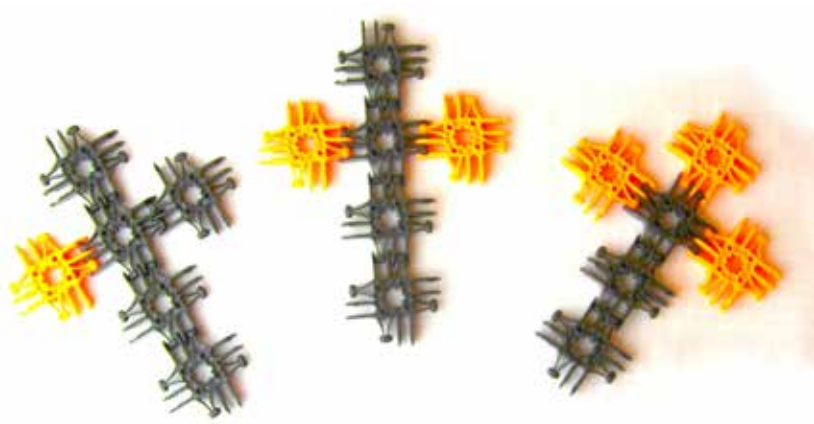
Probability

Probability is a wonderful way to teach a wide range of concepts and skills. Since there are so many games of chance, we can integrate creative play in the math class.

We are going to cover three constructions that can give your students a number of games to play in the course of their study.

Dice

To make Lux dice, simply make a cross of six Lux and fold them in to form a cube. Shown below are three different dice that each have different probabilities when thrown. What are the odds of rolling neon orange or black with a single dice? How about when multiple dice are thrown? Care to place a bet?



Orange 1:6



1:3



1:2

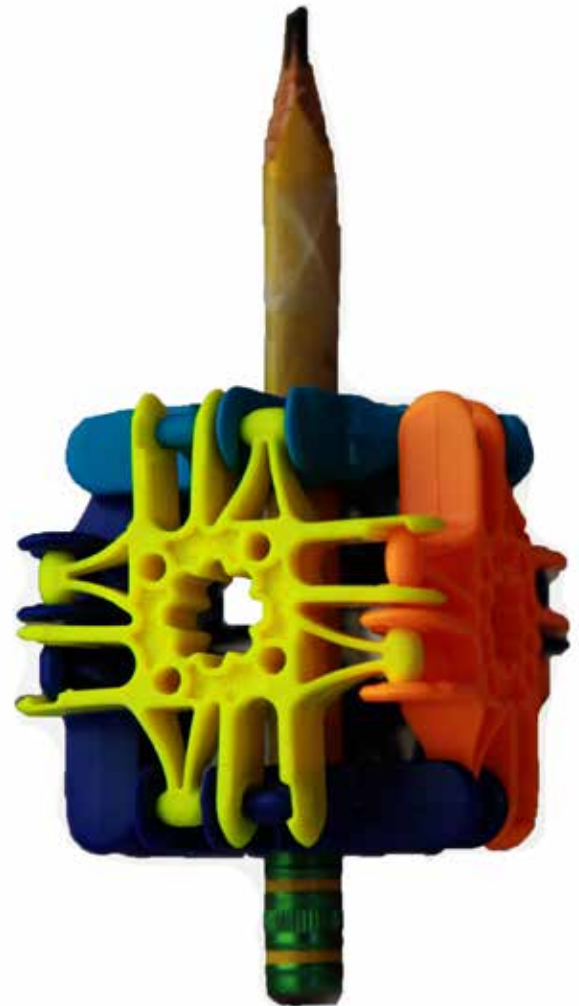
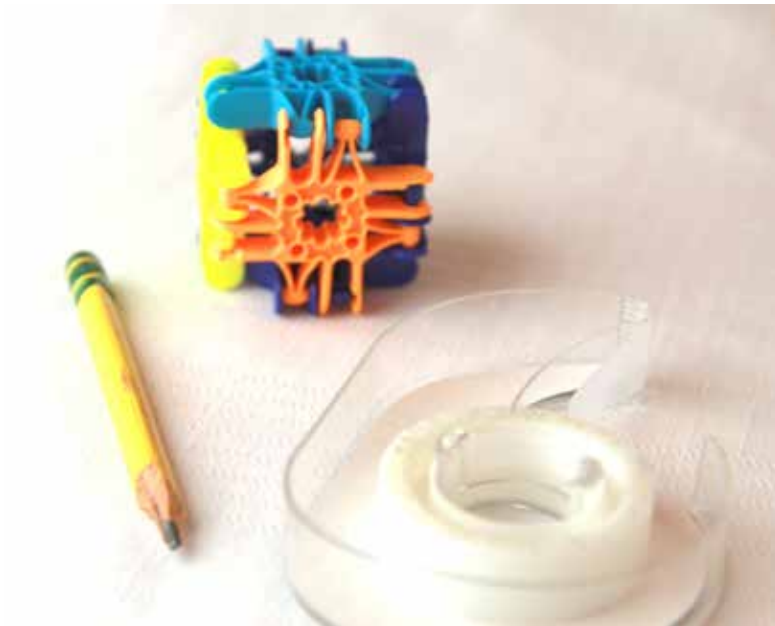


Teetotum

A teetotum (or T-totum) is a spinning top used in a game of chance that is known across Europe from Roman times. It has a polygonal body, originally four-sided, marked with letters or numbers which indicate the result of each spin. The name originates from Latin Totum meaning 'all' which was marked by a T on one of the four sides and indicated that the winning player could take all the played tokens.

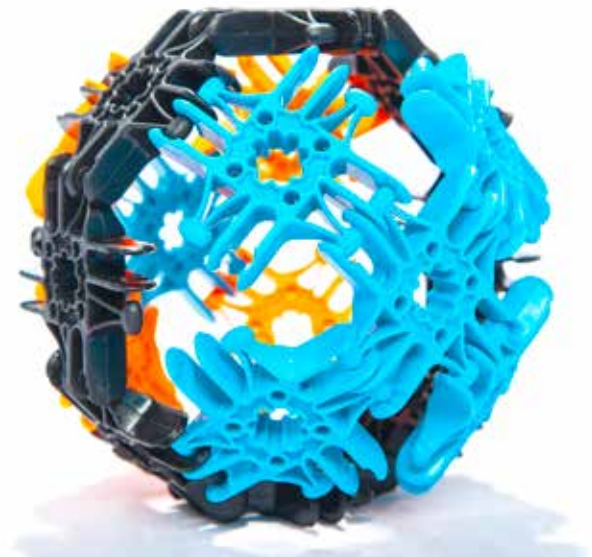
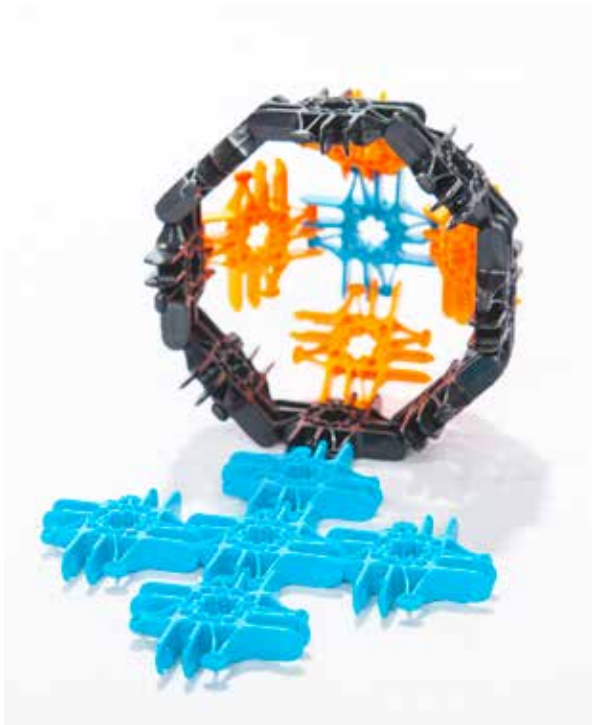
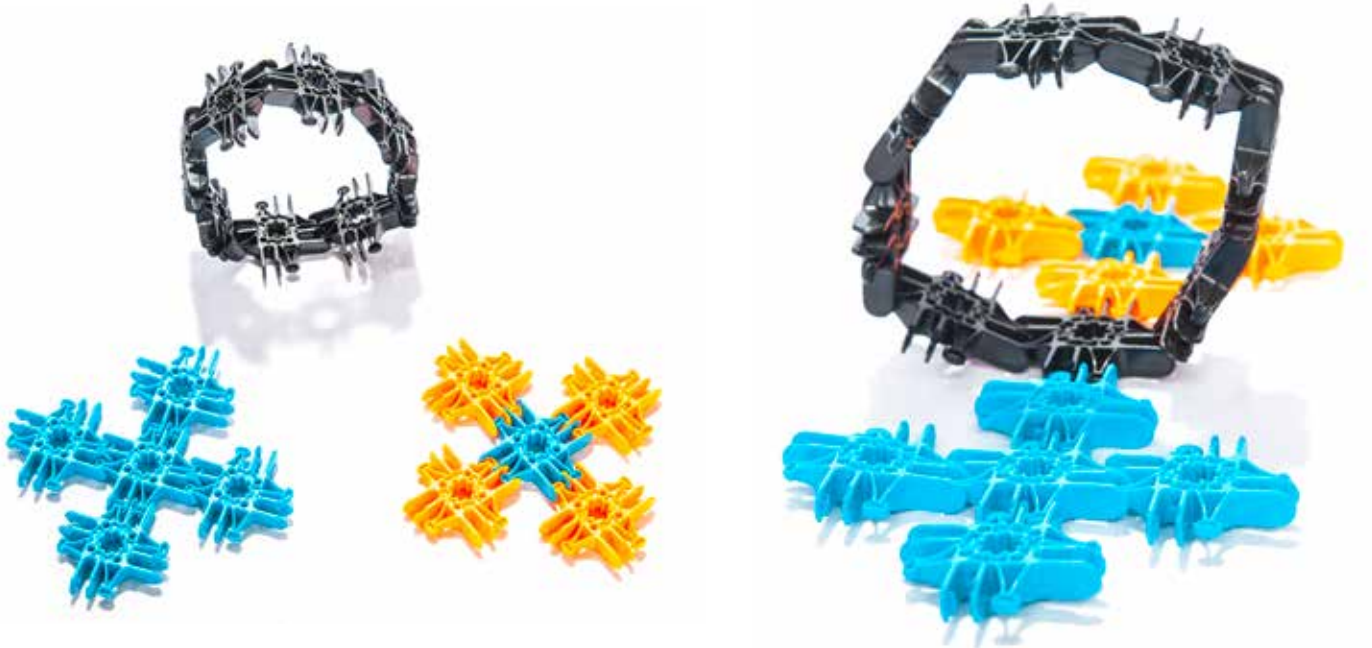
The teetotum is known today as a dreidel used in a children's game traditionally played on the Jewish festival of Hanukkah, and as the Perinola in many Latin American countries. Some modern teetotums have six or eight sides, and are used in commercial board games in place of dice.

The odds with a cube teetotum are based on four possible outcomes because there are four sides it can land on.



Making the Octoball

The Octoball is made of 18 Lux. Octoballs can be rolled and used in probability exercises. To make an Octoball, make two plus signs with five Lux each. Next make an octagon with eight Lux. Connect the plus signs to each side of the chain of eight.



What are the Odds?

Shown here are six combinations that can be created. It would be interesting to have the students create these balls and then roll them a number of times and write down each roll. After 20 or 40 rolls, do the outcomes match the given probability?



1 Yellow, 1 Neon Pink,
16 Teal Blue



2 Yellow, 8 Black, 8 Teal Blue



8 Black, 10 Red



6 Royal Blue, 8 Neon Pink,
4 Neon Orange



6 Red, 12 Neon Green



8 Yellow, 2 Purple,
2 Neon Green, 6 Black



Three Dimensional Thinking

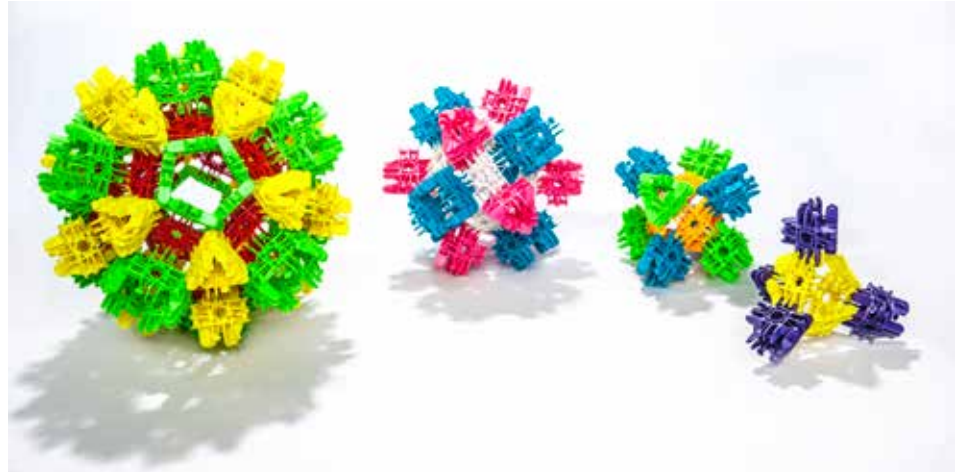
Polyhedra

A regular polyhedron is highly symmetrical, and all its faces are congruent regular polygons which are assembled in the same way around each vertex.

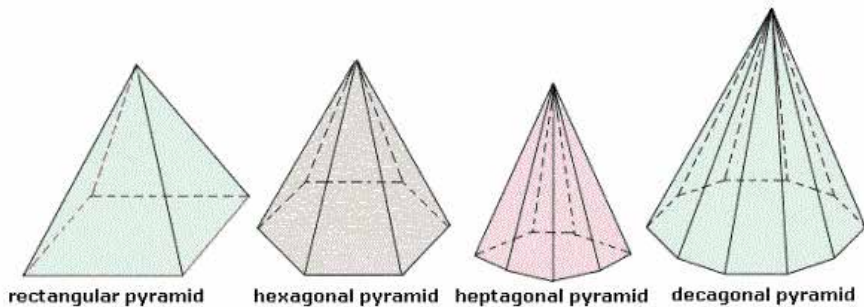
There are five finite convex regular polyhedra, known as the Platonic solids. These are the tetrahedron, cube, octahedron, dodecahedron, and icosahedron.

These can be made by connecting strips of two Lux wide strips together.

They can also be made by connecting prisms together.



Pyramids



rectangular pyramid

hexagonal pyramid

heptagonal pyramid

decagonal pyramid



Making Linkages into Prisms

Prisms are very common both in nature and in the human made world around us. A prism is a solid geometric figure whose two end faces are similar, equal, and parallel rectilinear figures, and whose sides are parallelograms.

Prisms are very easy to make with Lux. You can make them solid, as is shown in Figure A. You can also make them with open faces using bent corrugated edges of two Lux wide as shown in Figure B. You will notice that the prisms made in the fashion of Figure B will be flexible. Figure B shows prisms that have warped into oblique prisms. They are actually large Gimbalguses!

Figure A

Figure A. Shown from left to right are an octagonal prism, a heptagonal prism, a hexagonal prism, a pentagonal prism, a square prism, and a triangular prism.

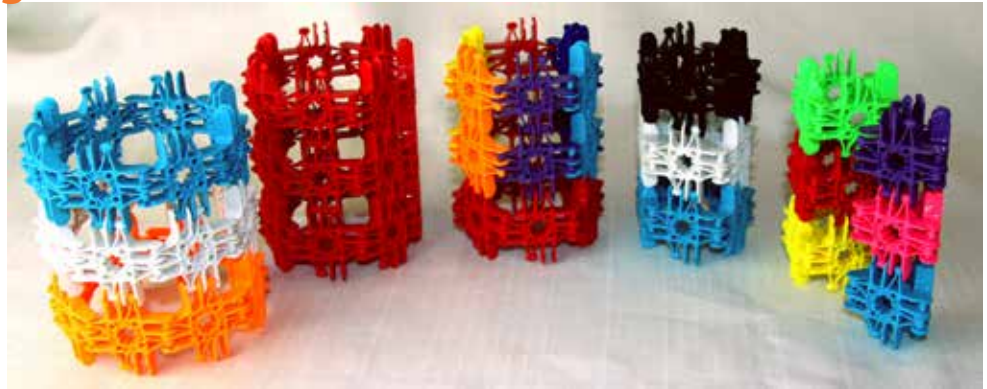


Figure B. Shown from left to right are a hexagonal oblique prism, a pentagonal oblique prism, a square oblique prism, and a triangular oblique prism.

Figure B



Figure C. Shown left is a square prism as a cube. Notice that the Lux edge strips are convex and not concave. The corners are joined with three Lux, making pyramids that lock the cube into shape and stop it from moving like it does when it is an unlocked linkage as in a Gimbalgus.

Figure C



Figure D. Shown far right is a quadrangle oblique prism. Like its small cousin the Gimbalgus, this oblique prism is free to move about as each of its openings can change from rhombus (diamond) shape to square shape.

Figure D



Diamonds and Ice

If you ever thought that diamonds and ice seem similar, you might not be surprised to learn that they share the same structure at the molecular level. The bonds of oxygen in water and the bonds of carbon in diamonds both organize their crystal structure in the same type of lattice!

We make this molecule by making two kinds of nodes, the tetrahedron, Figure 1, and the compound tetrahedron, Figure 2.

Make certain when you construct your prisms that all of the dimples are facing in.

Figure 1

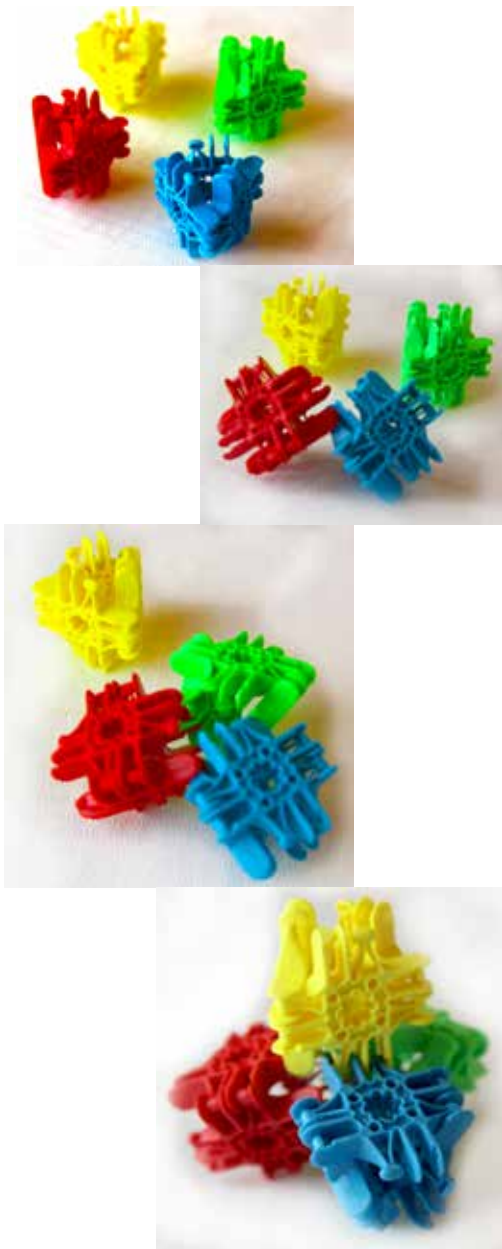


Figure 2



Making the Diamond and Water Molecule

First construct seven compound tetrahedra, Figure 1 and four tetrahedra, Figure 2.

Connect each of the four vertices of the tetrahedron to a compound tetrahedra. See Figure 3.

Next, connect six tetrahedra between all of the compound tetrahedra, as in Figure 4 and 5.

Have the students explore other molecular configurations and see what else they can make by combining the two nodes in different ways.



Figure 1



Figure 2



Figure 3

Figure 4

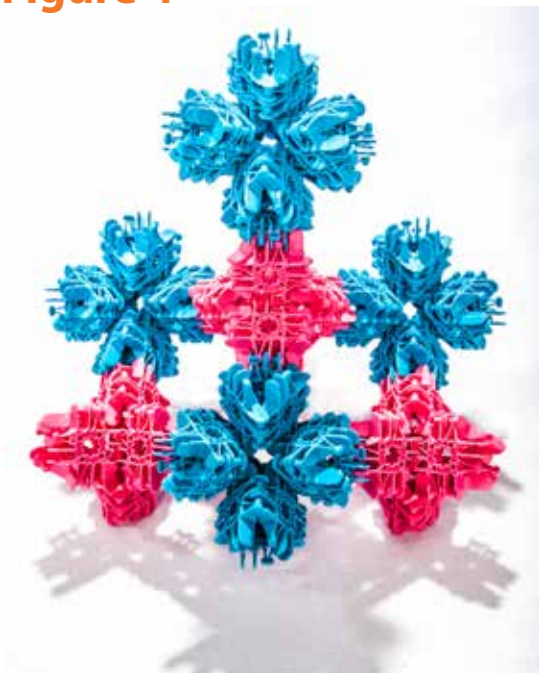


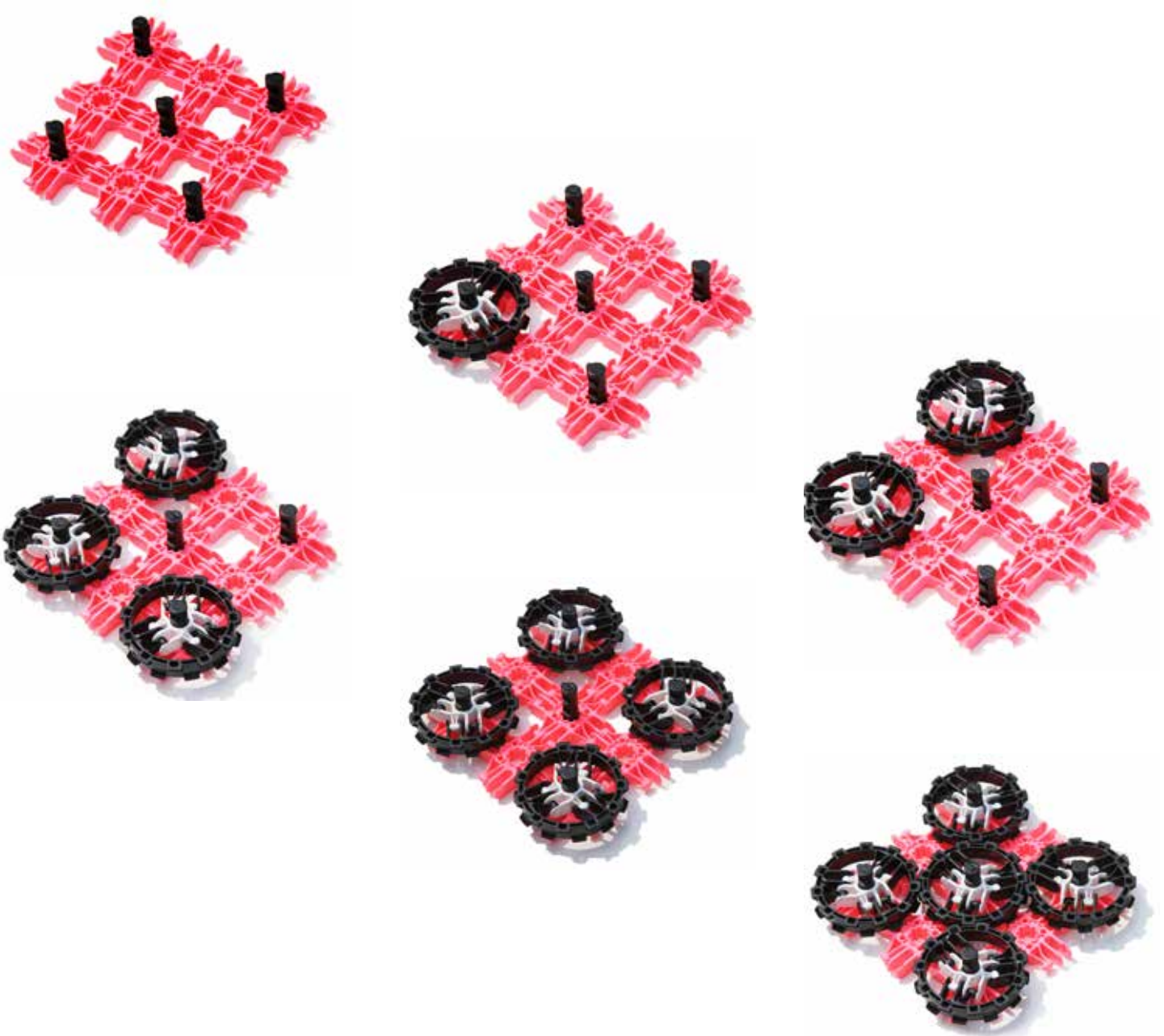
Figure 5



Simple Machines

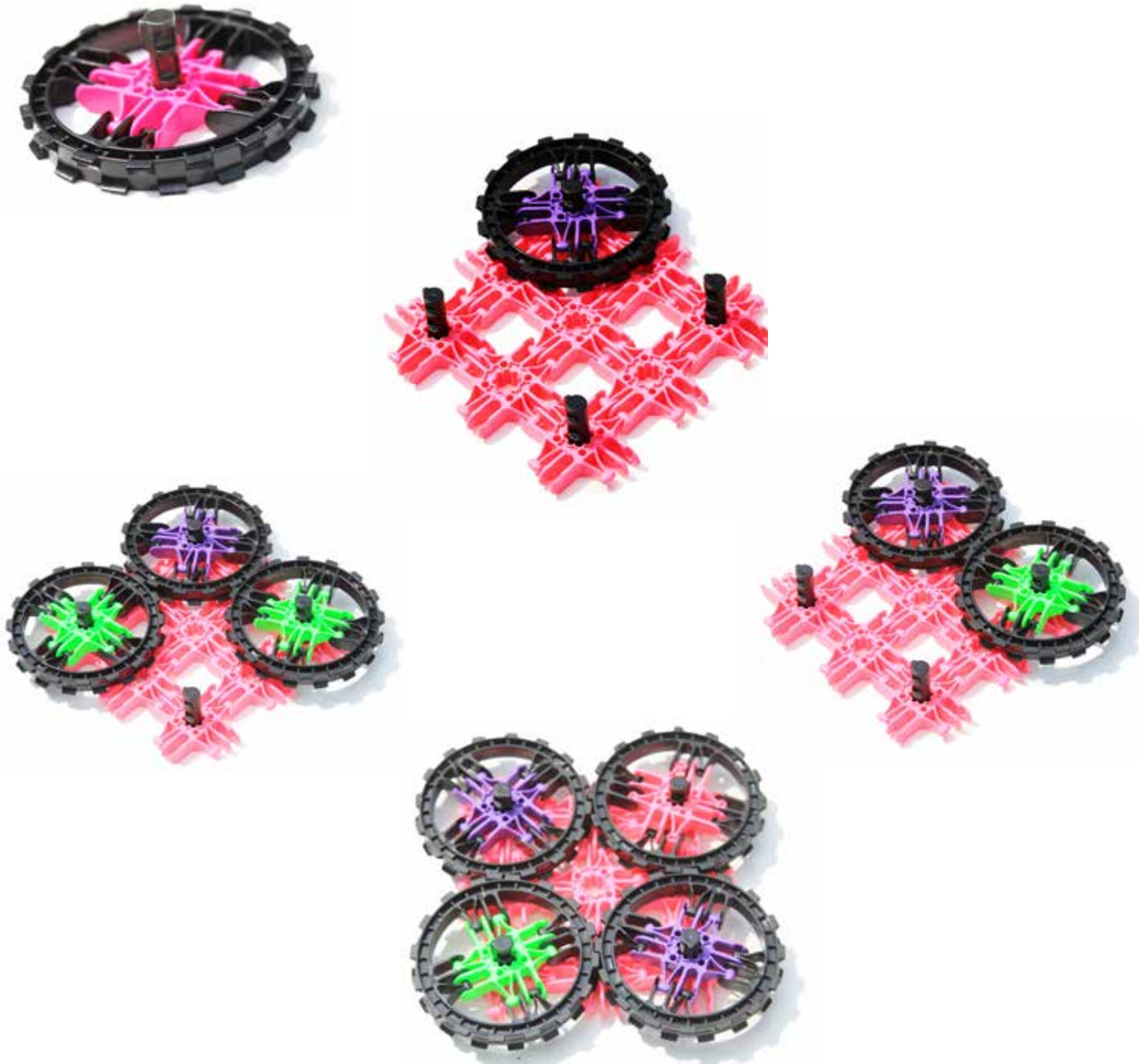
Trigon Multi-Wheel Gears

The trigon gears will mesh together on a square grid at 45 degrees. To make these five wheels all work together make a grid of 3 x 3 squares on a flat tabletop. Next, push five axles into the holes as shown until they are against the table surface. Line up the trigon wheel so the gap in the center wheel lines up with the key on the axle. Slide the trigon onto the axle all the way until it is resting on the nine-square surface. Do this again for the other four wheels. You may have to wiggle the wheels that the gear teeth properly mesh.



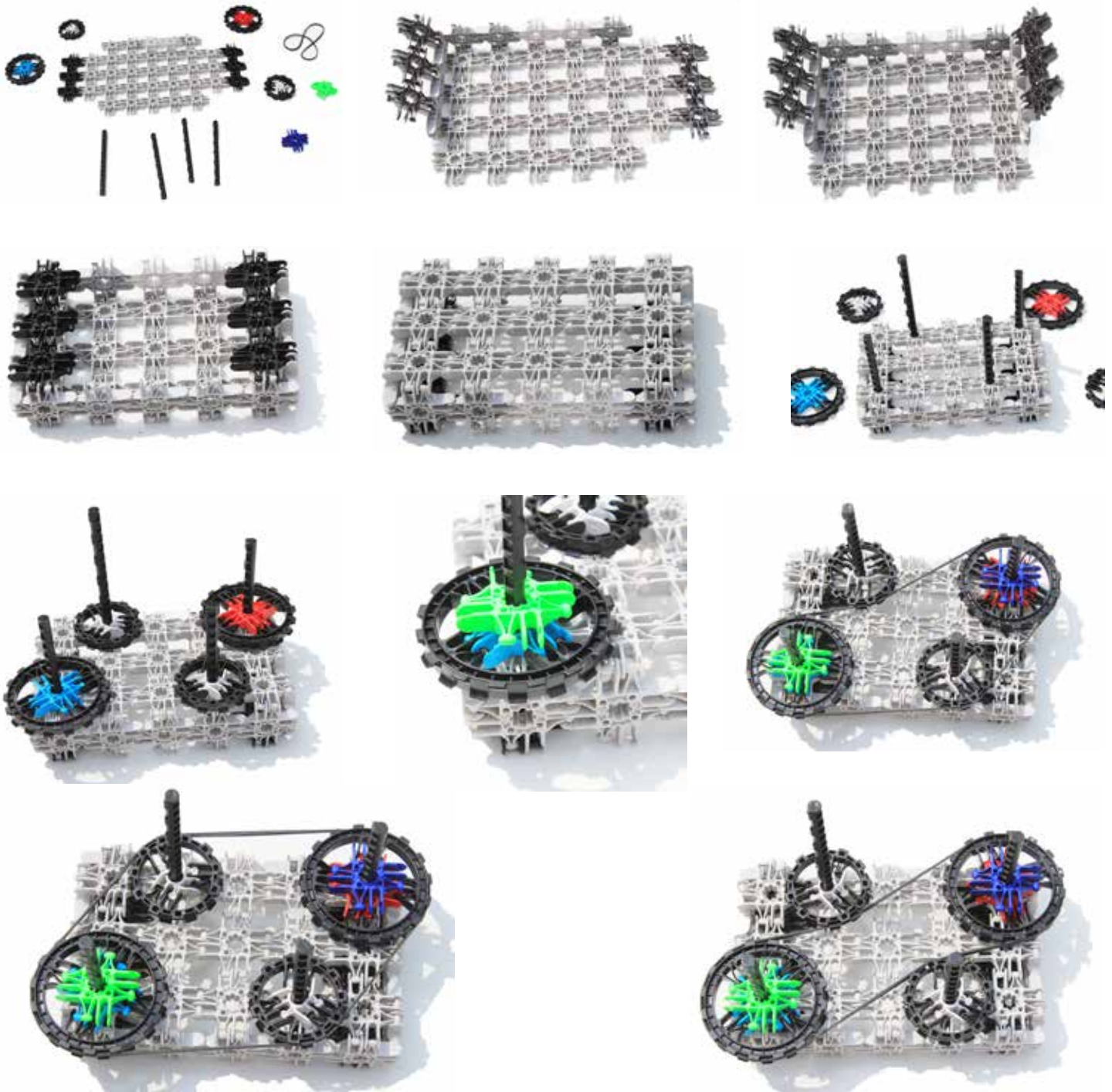
Square Multi-Wheel Gears

The square multi-wheel gears will mesh together on a square grid at 90 degrees from each other. To make these four wheels all work together make a grid of 3 by 3 squares on a flat tabletop. Next, push four axles into the holes as shown until they are against the table surface. Slide the square wheels onto the axles all the way until they are resting on the nine square surface. Do this again for the other three wheels. You may have to wiggle the wheels that the gear teeth properly mesh.



Gear and Pulley Box

Create the box. Line up a fabric of squares as shown in first image. Next, snap together the box and flip it over. Put four axles all the way in until they touch the table surface. Place two square wheels and two trigon wheels until they lay flat on the surface of the box. To make the square wheel rotate straighter, you can put another square on the axle so equal pressure is pushing on the square multi-wheel. Try different configurations of the rubber band to observe how the pulleys move. See if students can predict patterns of clockwise and counter-clockwise rotation ahead of time by looking at the picture first.

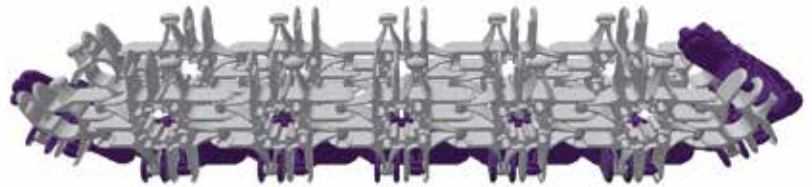


How to Make a Lux Roadster

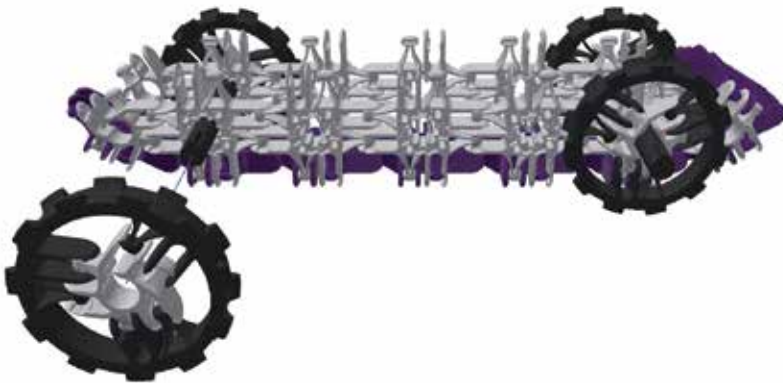
Step 1



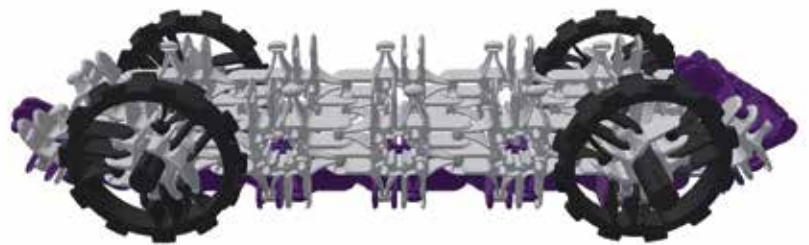
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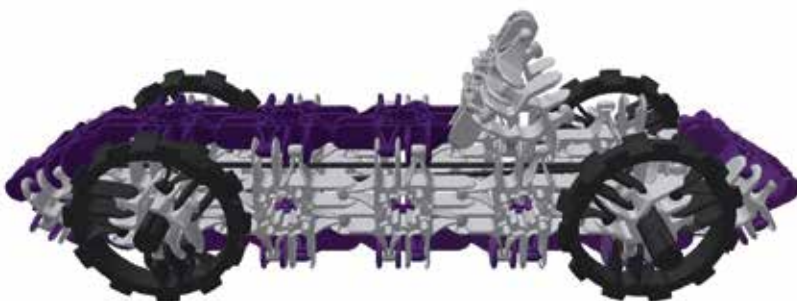
Step 3



Step 4



Step 5



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US Patent US9643101B2

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