Geometric systems including 2-D building elements configured to connect together for building 3-D structures, the of 2-D building elements each have a body that is at least: a central main body, tabs extended away from the central main body, and notches, one of the notches being disposed between each of the tabs and the central main body are described. The notches are oriented to form an underlying polygon of the central main body, and a width of each of the tabs is no greater than one half a length of one side of the underlying polygon. In some examples, where each of the tabs is comprised of a substantially rigid material, the width of the tab is no greater than one third the length of one side of the underlying polygon. In other examples, where each of the tabs is comprised of a substantially flexible material, the width of the tab is no less than one third the length of one side of the underlying polygon.
GEOMETRIC SYSTEMS FOR BUILDING 3-D STRUCTURES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and is a continuation-in-part of copending U.S. patent application Ser. No. 13/758,926, filed on Feb. 4, 2013, which is hereby incorporated by reference for all purposes.

BACKGROUND

[0002] The present disclosure relates generally to geometric systems. In particular, geometric systems with interfitting building elements for building 3-D structures are described.

[0003] The construction of 3-D structures from 2-D building elements is an effective means for studying various geometric shapes, including, but not limited to, Platonic, Archimedean, and Johnson solids as well as prisms, anti-prisms, and various non-convex structures with regular faces. This area of study also lends itself well to the understanding of mathematical concepts associated with these geometric shapes and may aid in the development of the user’s creative appetite. Indeed, geometric building systems are an excellent means for constructing desired geometric shapes while exposing users to an activity that intersects the world of art with the world of mathematics to make wonderful and colorful creations.

[0004] Known geometric systems are not entirely satisfactory for the range of applications in which they are employed. For example, existing geometric systems do not easily allow for the interfitting or interconnection of individual building elements to construct a 3-D structure. In particular, it is difficult increasingly difficult to attach additional pieces as a 3-D structure nears completion, and therefore can be most difficult to attach final piece in the 3-D structure. Further, existing geometric systems do not easily allow for the disassembly or disconnection of individual building elements to deconstruct a 3-D structure. In particular, it is difficult to detach the first piece of a 3-D structure.

[0005] In another example, existing geometric systems do not easily allow for the interfitting or interconnection of incongruent building elements and/or building elements comprised of materials of differing degrees of flexibility (e.g., rigid materials, semi-flexible materials, flexible materials, etc.) to construct a 3-D structure. Additionally, because of their failure to allow the interconnection of incongruent elements and/or building elements comprised of materials of differing degrees of flexibility, conventional geometric systems are limited to a very small subset of 3-D structures that can actually be constructed.

[0006] Thus, there exists a need for geometric systems that improve upon and advance the design of known geometric systems. Examples of new and useful geometric systems for building 3-D structures relevant to the needs existing in the field are discussed below.

[0007] Disclosure addressing one or more of the identified existing needs is provided in the detailed description below. Examples of references relevant to geometric systems for building 3-D structures include U.S. Pat. Nos. 7,469,898; 5,593,337; 5,489,230; and U.S. Patent Application Publication: 20120164912. The complete disclosures of the above patents and patent applications are herein incorporated by reference for all purposes.

SUMMARY

[0008] The present disclosure is directed to geometric systems for building 3-D structures. The geometric systems include 2-D building elements configured to connect together for building 3-D structures, the of 2-D building elements each have a body that is at least: a central main body, tabs extended away from the central main body, and notches, one of the notches being disposed between each of the tabs and the central main body. The building elements are configured to fit together at respective notches to form a 3-D structure. Each of the notches is oriented relative to adjacent notches to form an underlying polygon of the central main body. A width of each of the tabs is no greater than one half a length of one side of the underlying polygon. In some examples, where each of the tabs is comprised of a substantially rigid material, the width of the tab is no greater than one third the length of one side of the underlying polygon. In other examples, where each of the tabs is comprised of a substantially flexible material, the width of the tab is no less than one third the length of one side of the underlying polygon. In some further examples, a length of each of the notches is no greater than one half the width of each of the tabs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of a first example of a geometric system including a first example building element and a second example building element depicting the two incongruent building elements interconnecting.

[0010] FIG. 2 is a perspective view of the first example geometric system shown in FIG. 1 depicting two congruent building elements interconnecting (i.e., two of the second example building element).

[0011] FIG. 3 is a perspective view of the geometric system illustrating four incongruent building elements interconnecting (i.e., one of the first example building element, one of the second example building element, one of the fifth example building element, and one of the sixth example building element).

[0012] FIG. 4 is a top plan view of a second example of a geometric system including a third building element at the top of the figure having non-rectilinear notches and a fourth building element at the bottom of the figure having rectilinear notches.

[0013] FIG. 5 depicts the third building element and the fourth building element shown in FIG. 4 with the third building element interconnecting with the fourth building element by joining together the non-rectilinear notch of the third building element and the rectilinear notch of the fourth building element.

[0014] FIG. 6 is a top plan view of a fifth example building element.

[0015] FIG. 7 is a top plan view of a sixth example building element.

[0016] FIG. 8 is a top plan view of a seventh example building element.

[0017] FIG. 9 is a top plan view of an eighth example building element.

[0018] FIG. 10 is a top plan view of a ninth example building element.

[0019] FIG. 11 is a top plan view of a tenth example building element.
FIG. 12 is a top plan view of a 3-D structure constructed from a plurality of building elements to form an octahedron structure.

FIG. 13 is a top plan view of a 3-D structure constructed from a plurality of building elements to form a cubic-octahedron structure.

FIG. 14 is a top plan view of a 3-D structure constructed from a plurality of building elements to form a truncated icosahedron structure.

FIG. 15 is a top plan view of an eleventh example building element.

FIG. 16 is a top plan view of a 3-D structure constructed from a plurality of congruent building elements to form an icosahedron structure.

FIG. 17 is a bottom plan view of a 3-D structure constructed from a plurality of congruent building elements, the final piece in an orientation to be attached to the 3-D structure.

DETAILED DESCRIPTION

The disclosed geometric systems will become better understood through review of the following detailed description in conjunction with the figures. The detailed description and figures provide merely examples of the various inventions described herein. Those skilled in the art will understand that the disclosed examples may be varied, modified, and altered without departing from the scope of the inventions described herein. Many variations are contemplated for different applications and design considerations; however, for the sake of brevity, each and every contemplated variation is not individually described in the following detailed description.

Throughout the following detailed description, examples of various geometric systems are provided. Related features in the examples may be identical, similar, or dissimilar in different examples. For the sake of brevity, related features will not be redundantly explained in each example. Instead, the use of related feature names will cue the reader that the feature with a related feature name may be similar to the related feature in an example explained previously. Features specific to a given example will be described in that particular example. The reader should understand that a given feature need not be the same or similar to the specific portrayal of a related feature in any given figure or example.

With reference to FIGS. 1-17, geometric systems 18 and 118 for building 3-D structures will now be described. Geometric system 18 includes a first building element 20 and a second building element 30. The reader should understand that geometric systems described herein may include a plurality of building elements, such as 2, 3, 5, 10, 50, or 100 or more building elements and that the plurality of building elements can be congruent (i.e., of the same shape) or incongruent (i.e., of a different shape) building elements.

In use, as shown in FIGS. 1-3, 5, 12-14, 16 and 17, two or more building elements are interconnected together to form a three-dimensional (3-D) structure. In some examples, the geometric system forms a 3-D structure in the form of a polyhedron whereas in other examples, the system forms an irregular 3-D structure. The user's imagination and skill will lead to a variety of 3-D shapes, which adds to the enjoyment and learning possible with the geometric systems described herein.

For example, the geometric systems described herein may form Platonic solids, Archimedean solids, and Johnson solids by interconnecting building elements together. Alternatively, a user may interconnect building elements to each other to form a variety of 3-D polyhedrons or other 3-D structures. Of course, substantially planar structures may be created with geometric systems described herein as well, which might be considered two-dimensional given the relative dimensions of the resulting structure.

In many examples, the building elements are made from a lightweight, inexpensive material, such as paper, foam, flexible plastic, and/or other flexible materials that can be used to construct 3-D structures that are light weight and easily assembled, but can be less structurally sound. However, in some examples, the building elements are made from structurally significant materials, such as wood, hard plastic, metal, and/or other rigid materials, and may be used to construct 3-D structures with a greater degree structural integrity. For instance, geometric systems including structural building elements may form enhanced 3-D structures such as lamps, toys, or even more permanent structures as part of an arts and crafts kit.

The plurality of building elements in a geometric system and/or a 3-D structure may be of the same shape and/or configuration, as shown in FIG. 2, or may include one or more different shapes and/or configurations, as shown in FIGS. 1, 3, 5, 13, and 14. In some examples, the building elements are each a different shape and/or configuration from the other building elements within the plurality of building elements. In other examples, the plurality of building elements includes a mix of building elements that are congruent to other building elements and incongruent to other building elements in the plurality or set of building elements making up the geometric system.

FIGS. 4 and 5 demonstrate one example of building elements of differing configurations. The building elements in FIGS. 4 and 5 are the same shape when viewed in profile, but are configured differently with regard to the shape of their notches. In FIG. 4, building element 120 is shown at the top of the figure in the shape of a triangle with edges 124 and non-rectilienar notches 126 (i.e., notches having at least one curvilinear longitudinal edge/side of the notch). Building element 130 is shown at the bottom of FIG. 4 and is in the shape of a triangle with edges 134 and rectilinear notches 136.

Each of the building elements shown in FIGS. 1-17 has a central main body that includes a tab portion that is at least partially continuous with and extended away from a body of the building piece. The notches are disposed between the tab and the central main body. The notches are aligned relative to other notches of the building piece to define an underlying polygon for the building element.

In order for the building elements to be easily assembled and disassembled with other congruent or incongruent building pieces, it is desirable for the tab to be wide enough to provide an easily gripped and manipulable portion of the building element, while minimizing interference to other building elements being added to a 3-D structure. Thus, according to the present invention, the width of each of the tabs has designated ratios relative to the length of the notch and/or the length of one side of the underlying polygon. Further, a length of each of the tabs is sufficiently long enough to be easily gripped by a user.

Specifically, for each of the building elements, a width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of substantially rigid material,
the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. If the building element is comprised of a substantially flexible material, the width of the tab can be greater than one third the length of one side of the underlying polygon (e.g., less than or equal to one half the length of one side of the underlying polygon). Further, the length of each notch is no greater than one half the width of each of the tabs so that the notches can be easily engaged and disengaged while providing sufficient holding power to retain the assembled 3-D structure.

The specified dimensions and ratios of dimensions of the building elements allow for the size of the tab (i.e., width) to be maximized and easily manipulated by a user, while allowing sufficient space and/or open area for the notches of the pieces to be joined when building a 3-D structure without interference from tabs of other building elements in the 3-D structure. In general, the larger the tab, the more easily it can be gripped and manipulated by a user, so tabs should be as large as permissible. For rigid materials, the width of the tab being one third the length of one side of the underlying polygon is the preferred ratio. Flexible materials allow for the tab to be wider (i.e., a width up to one half the length of one side of the underlying polygon), since the tabs can be bent and/or slightly deformed out of the way during assembly and disassembly of a 3-D structure. Further, the specified dimensions and ratios limit interference by the tabs of other building elements during connecting and/or disconnecting of a building element.

In some of the example building elements, a plurality of elongate projections are continuous with and extended away from the central main body (e.g., building elements 320, 420, 520, 620, 1220 shown in Figs. 6, 7, 10, 11, and 15, respectively). In these examples, each of the tabs is a portion of one of the elongate projections that is extended beyond the notch and is at least partially continuous with the projection. The elongate projections define a negative space and/or indentation in the periphery of the overall shape of the building element. In other words, corners of the underlying polygon lie outside of the body of the building element within the negative space and/or indentation between the elongate projections. The negative space and/or indentations have the advantage that they allow for easier mating and unmating of notches during assembly and disassembly of 3-D structures by limiting interference from the bodies of other building elements in the 3-D structure.

In other example building elements, the tab is partially continuous with the central main body and is extended away from the central main body (e.g., building elements 120, 130, 720, and 820 shown in Figs. 4, 8 and 9, respectively). In the examples shown in Fig. 4, the central main body of the building element is offset relative to the underlying polygon and the tabs are located on corners of the central main body. Accordingly, corners of the underlying polygon lie outside of the body of the building element. In the examples shown in Figs. 8 and 9, the central main body of the building element is coextensive with the underlying polygon and the tabs are centrally located on sides of the central main body. Accordingly, corners of the underlying polygon are within the body of the building element (i.e., corners of the underlying polygon are coextensive and/or congruent with the corners of the body of the building element).

The presently described building elements and geometric systems address many of the limitations and issues of known geometric systems. For example, because of the specific ratios of the width of the tabs relative to the length of the sides of the underlying polygon, the tabs are easily manipulatable (i.e., gripped and/or slightly deformed by a user during assembly and disassembly of a 3-D structure), and the tabs are sufficiently spaced apart so that notches of a building element can easily be mated to notches of a other building elements without the tabs of the other building elements in the 3-D structure interfering with assembly and disassembly. In another example, because of the specific ratios of the width of the tabs relative to the length of the notches, the notches can be easily mated and unmated, while still providing sufficient holding power to retain the shape of a 3-D structure.

Because the building elements are easily assembled and disassembled, the geometric system can include building elements of various shapes and materials. For example, the presently described building system can include any of the building elements shown in Figs. 1-17. In other words, any combination of the presently described and shown building elements can be used in combination to create a desired 3-D structure. In another example, the geometric system can include building elements comprised of flexible materials and/or rigid materials. Further, the geometric system can include a combination of building elements comprised of flexible materials and building elements comprised of rigid materials.

Turning attention now to Fig. 1, building element 20 defines a first geometric shape 22, a 3-pointed star, defined by outer edges 24 (i.e., defined by a perimeter of the building element). While building element 20 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

In the example shown in Fig. 1, building element 20 includes a main body 21 with tabs 23 extended away from the main body (i.e., extended outwardly from the main body). Building element 20 also includes three notches 26. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure.

Notches 26 are oriented relative to adjacent notches to form an underlying polygon 29 (i.e., a triangle) of main body 21. In other words, notches 26 are aligned on the periphery of main body 21 along underlying polygon 29. In certain examples, the building element includes less than three notches, such as one or two notches. In still further examples, the building element includes more than three notches, such as four, five, or six or more notches. In the example shown in Figs. 1 and 2, notches 26 are disposed proximal to the periphery of the main body.

Notches 26 are substantially rectilinear in shape as compared to notches 126 shown in Fig. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

A center of main body 21 further includes a centrally positioned aperture 28 having the shape of a circle. In some examples the main body does not include an aperture in the shape of a circle, but instead includes an aperture of another shape, such as a triangle, square, another regular
polygon, or an irregular polygon. Aperture 28 may assist users to hold and manipulate building element 20 while constructing 3-D structures. In other examples, the building element does not have an aperture and instead has a continuous or solid center portion.

[0047] In the example shown in FIGS. 1 and 2, building element 20 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 20. The building elements having the same shape as building element 20 may be larger and smaller than building element 20.

[0048] Although building element 20 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 1, each side of underlying polygon 29 has a length a, each of tabs 23 has a width b and a length d, and each of notches 26 has a length c.

[0049] As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

[0050] Accordingly, if building element 20 is comprised of a substantially flexible material, the length c is no greater than one half the width b and the width b is no greater than one half the length a. If building element 20 is comprised of a substantially rigid material the length c is no greater than one half the width b and the width b is no greater than one third the length a. In both examples, the length d is a sufficient length for the tab to be easily gripped by a user.

[0051] In one specific example for building element 20 comprised of a substantially rigid material, the length a is 1.75 in, the width b is 0.5 in, the length c is 0.25 in, and the length d is 0.375 in. In another example for building element 20 comprised of a substantially flexible material, the width b can be larger than 0.5 in (i.e., up to 0.875 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

[0052] Building element 20 can be manufactured from a substantially flexible material such as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building element 20 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

[0053] Continuing with FIG. 1, a second building element, building element 30, will now be described. Building element 30 in FIG. 1 and the other building elements described herein, such as those shown in FIGS. 3-17, are similar in some respects to building element 20 and different in other respects. Accordingly, the distinctions between the building elements will be highlighted and the reader should understand that the features and contemplated variations of building element 20 described above may apply to the other building elements described herein.

[0054] As shown in FIG. 1, building element 30 defines a second geometric shape 32, a 5-pointed star, defined by outer edges 34 (i.e., defined by a perimeter of the building element). While building element 30 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component. In the present example, building element 30 is larger than building element 20.

[0055] As depicted in FIG. 1, building element 30 includes a main body 31 with tabs 33 extended away from the main body (i.e., extended outwardly from the main body). Building element 30 also includes five notches 36. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure. Because of the specific shape of building element 30 (i.e., a 5-pointed star), tabs 33 are located in elongate projections 35, which are extended away from main body 31. Elongate projections 35 define indentations 37 (i.e., negative spaces in the body of the building element) between each of the elongate projections.

[0056] Notches 36 are oriented relative to adjacent notches to form an underlying polygon 39 (i.e., a pentagon) of main body 31. In the example shown in FIGS. 1 and 2, notches 36 are disposed proximal to the periphery of the main body. In other words, notches 36 are aligned on the periphery of main body 31 along underlying polygon 39. In certain examples, the building element includes less than five notches, such as one or two notches. In still further examples, the building element includes more than five notches, such as six or more notches.

[0057] Notches 36 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

[0058] Building element 30 includes a centrally positioned aperture 38 having the shape of a circle. In some examples the main body does not include an aperture in the shape of a circle, but instead includes an aperture of another shape, such as a triangle, square, another regular polygon, or an irregular polygon. Aperture 38 may assist users to hold and manipulate building element 30 while constructing 3-D structures. In other examples, the building element does not have an aperture and instead has a continuous or solid center portion.

[0059] In the example shown in FIGS. 1 and 2, building element 30 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 30. The building elements having the same shape as building element 30 may be larger and smaller than building element 30.

[0060] Although building element 30 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon
are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 1, each side of underlying polygon 39 has a length e, each of tabs 33 has a width f and a length b, and each of notches 36 has a length g.

**0061** As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the width of the other side of the underlying polygon and is preferably no less than one third the length of the other side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the length of each of the tabs.

**0062** Accordingly, if building element 30 is comprised of a substantially flexible material, the length g is no greater than one half the width f and the width f is no greater than one half the length e. If building element 30 is comprised of a substantially rigid material, the length g is no greater than one half the width f and the width f is no greater than one third the length e. In both examples, the length h is a sufficient length for the tab to be easily gripped by a user.

**0063** In one specific example for building element 30 comprised of a substantially rigid material, the length e is 1.75 in, the width f is 0.5 in, the length g is 0.25 in, and the length h is 1.375 in. In another example for building element 20 comprised of a substantially flexible material, the width f can be larger than 0.5 in (i.e., up to 0.875 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

**0064** Building element 30 can be manufactured from a substantially flexible material such as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building element 30 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

**0065** As depicted in FIG. 1, building element 30 is incongruent to building element 20. However, building elements 20 and 30 can be interconnected through their respective notches 26 and 36 to form a 3-D structure. Alternatively, in other examples, such as shown in FIG. 2, building elements (i.e., two of building elements 20) that are congruent may also be interconnected via their respective notches. As further shown in FIGS. 3, 12-14, 16, and 17 geometric systems described herein may include a variety of interconnected building elements, some congruent and some incongruent, to form desired 3-D structures.

**0066** Interconnecting incongruent building elements, such as building element 20 and building element 30, may be facilitated by forming notches 26 and 36 to be of equal length. Further, placing notches 26 and 36 proximate the periphery of the building elements helps enable a user to construct 3-D structures having regular faces (i.e., faces that are equiangular and equilateral). Having a plurality of building elements, each with notches oriented proximate the periphery of the main bodies enables a user to interconnect a large number of building elements, whether the building elements are congruent or incongruent to one another and/or whether the building elements are comprised of the same or different materials.

**0067** For example, the building elements shown in FIGS. 1 and 3 are incongruent and interconnected. Further, the building elements shown in FIGS. 1 and 3 can be comprised of the same material or differing materials (e.g., a rigid material and a flexible material). Different building elements defining different shapes, different numbers of notches, and different degrees of flexibility (i.e., being comprised of different materials) with respect to other building elements in the geometric system allows a user to construct a wide variety of 3-D structures.

**0068** Turning attention to FIG. 4, a second example of a geometric system 118 will now be described. Geometric system 118 includes many similar or identical features to geometric system 118 and can be used in combination with geometric system 118. Thus, for the sake of brevity, each feature of geometric system 118 will not be redundantly explained. Rather, key distinctions between geometric system 118 and geometric system 118 will be described in detail and the reader should reference the discussion above for features substantially similar between the two geometric systems.

**0069** As can be seen in FIG. 4, geometric system 118 includes a third building element 120 and a fourth building element 130. Here, geometric system 118 differs from geometric system 118 in that building elements 120 and 130 define a substantially similar shape (i.e., shapes 122 and 132, respectively) when viewed in profile, namely, a triangle; however, the building elements are configured differently. In particular, building element 120 defines a plurality of non-rectilinear notches 126 (i.e., notches including at least one curvilinear longitudinal edge) whereas building element 130 defines rectilinear notches 136 (i.e., notches including two opposing linear longitudinal edges).

**0070** In the example shown in FIG. 4, building element 120 includes a main body 121 with tabs 123 extended away from the main body (i.e., extended outwardly from the main body). Building element 120 also includes three notches 126. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure.

**0071** Notches 126 are oriented relative to adjacent notches to form an underlying polygon 129 (i.e., a triangle) of main body 121. In the example shown in FIGS. 4 and 5, notches 126 are disposed proximal to the periphery of the main body. In other words, notches 126 are aligned on the periphery of main body 121 along underlying polygon 129. In certain examples, the building element includes less than three notches, such as one or two notches. In still further examples, the building element includes more than three notches, such as four, five, or six or more notches.

**0072** Notches 126 are substantially non-rectilinear in shape. More specifically, notches 126 include one curvilinear longitudinal edge and an opposing linear longitudinal edge. In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

**0073** Also shown in the example of FIG. 4, building element 130 includes a main body 131 with tabs 133 extended away from the main body (i.e., extended outwardly from the
Building element 130 also includes three notches 136. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure.

Notches 136 are oriented relative to adjacent notches to form an underlying polygon 139 of main body 131 (i.e., a triangle). In the example shown in FIGS. 4 and 5, notches 136 are disposed proximal to the periphery of the main body. In other words, notches 136 are aligned on the periphery of main body 131 along underlying polygon 139. In certain examples, the building element includes less than three notches, such as one or two notches. In still further examples, the building element includes more than three notches, such as four, five, or six or more notches.

Notches 136 are substantially rectilinear in shape. More specifically, notches 136 include opposing linear longitudinal edges. In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches. FIG. 5 illustrates that notches 126 are non-rectilinear, but still configured to be interconnected with rectilinear notches 136 of building element 130.

In the example shown in FIGS. 4 and 5, building elements 120 and 130 have specific sizes. In some examples, the geometric system may include building elements with the same shape, but a different size than building elements 120 and 130. The building elements having the same shape as building elements 120 and 130 may be larger and smaller than building elements 120 and 130.

Although building elements 120 and 130 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 4, each side of underlying polygon 129 has a length i, each of tabs 123 has a width j and a length l, and each of notches 126 has a length k. Further, each side of underlying polygon 139 has a length m, each of tabs 133 has a width n and a length p, and each of notches 136 has a length o.

As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

Accordingly, if building element 120 is comprised of a substantially flexible material, the length k is no greater than one half the width j and the width j is no greater than one half the length i. If building element 120 is comprised of a substantially rigid material, the length k is no greater than one half the width j and the width j is no greater than one third the length i. In both examples, the length l is a sufficient length for the tab to be easily gripped by a user.

In one specific example for building element 130 comprised of a substantially rigid material, the length i is 1.75 in, the width j is 0.5625 in, the length k is 0.28125 in, and the length l is 0.5 in. In another example for building element 20 comprised of a substantially flexible material, the width j can be slightly larger than 0.5625 in (i.e., up to 0.875 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

Further, if building element 130 is comprised of a substantially rigid material, the length o is no greater than one half the width n and the width n is no greater than one half the length r. If building element 130 is comprised of a substantially rigid material, the length o is no greater than one half the width n and the width n is no greater than one third the length m.

In both examples, the length p is a sufficient length for the tab to be easily gripped by a user.

In one specific example for building element 130 comprised of a substantially flexible material, the length m is 1.75 in, the width n is 0.5625 in, the length o is 0.28125 in, and the length p is 0.5 in. In another example for building element 130 comprised of a substantially flexible material, the width n can be larger than 0.5625 in (i.e., up to 0.875 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

Building elements 120 and 130 can be manufactured from a substantially flexible material such as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building elements 120 and 130 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sial. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

Turning attention to FIG. 6, additional building elements that can be used with either or both of geometric system 18 and geometric system 118 will now be described. The additional building elements include many similar or identical features to the building elements included in geometric system 18 and geometric system 118. Thus, for the sake of brevity, each feature the additional building elements will not be redundantly explained. Rather, key distinctions between these additional building elements and the building elements from geometric system 18 and geometric system 118 will be described in detail and the reader should reference the discussion above for features substantially similar between the additional building elements and the building elements of geometric systems 18 and 118.

As can be seen in FIGS. 3 and 6, a fifth building element 320 defines a fifth geometric shape 322, a 4-pointed star, defined by outer edges 324 (i.e., defined by a perimeter of the building element). While building element 320 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

In the example shown in FIG. 6, building element 320 includes a main body 321 with tabs 323 extended away from the main body (i.e., extended outwardly from the main
body). Building element 320 also includes four notches 326. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure. Because of the specific shape of building element 320, tabs 323 are located in elongate projections 325, which are extended away from main body 621. Elongate projections 325 define indentations 327 (i.e., negative spaces in the body of the building element) between each of the elongate projections.

[0087] Notches 326 are oriented relative to adjacent notches to form an underlying polygon 329 (i.e., a square) of main body 321. In the example shown in FIGS. 3 and 6, notches 326 are disposed proximal to the periphery of the main body. In other words, notches 326 are aligned on the periphery of main body 321 along underlying polygon 329. In certain examples, the building element includes less than four notches, such as one, two, or three notches. In still further examples, the building element includes more than four notches, such as five or more notches.

[0088] Notches 326 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

[0089] A center of main body 321 further includes a centrally positioned aperture 328 in the shape of a circle. In some examples the main body does not include an aperture in the shape of a circle, but instead includes an aperture of another shape, such as a triangle, square, another regular polygon, or an irregular polygon. Aperture 328 may assist users to hold and manipulate building element 320 while constructing 3-D structures. In other examples, the building element does not have an aperture and instead has a continuous and/or solid center portion.

[0090] In the example shown in FIGS. 3 and 6, building element 320 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 320. The building elements having the same shape as building element 320 may be larger and smaller than building element 320.

[0091] Although building element 320 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 6, each side of underlying polygon 329 has a length q, each of tabs 323 has a width r and a length l, and each of notches 326 has a length r.

[0092] As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

[0093] Accordingly, if building element 320 is comprised of a substantially flexible material, the length s is no greater than one half the width r and the width t is no greater than one half the length q. If building element 320 is comprised of a substantially rigid material, the length s is no greater than one half the width r and the width t is no greater than one third the length q. In both examples, the length t is a sufficient length for the tab to be easily gripped by a user.

[0094] In one specific example for building element 320 comprised of a substantially flexible material, the length q is 1.25 in, the width r is 0.55 in, the length s is 0.275 in, and the length t is 0.4 in. In another example for building element 320 comprised of a substantially rigid material, the width r can be less than 0.55 in (i.e., no greater than 0.4 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

[0095] Building element 320 can be manufactured from a substantially flexible material such as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building element 320 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

[0096] Turning attention to FIG. 7, a sixth building element 420 defines a sixth geometric shape 422, a 6-pointed star, defined by outer edges 424 (i.e., defined by a perimeter of the building element). While building element 420 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

[0097] In the example shown in FIG. 7, building element 420 includes a main body 421 with tabs 423 extended away from the main body (i.e., extended outwardly from the main body). Building element 420 also includes six notches 426. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure. Because of the specific shape of building element 420, tabs 423 are located in elongate projections 425, which are extended away from main body 421. Elongate projections 425 define indentations 427 (i.e., negative spaces in the body of the building element) between each of the elongate projections.

[0098] Notches 426 are oriented relative to adjacent notches to form an underlying polygon 429 (i.e., a hexagon) of main body 421. In the example shown in FIG. 7, notches 26 are disposed proximal to the periphery of the main body. In other words, notches 426 are aligned on the periphery of main body 421 along underlying polygon 429. In certain examples, the building element includes less than six notches, such as one or two notches. In still further examples, the building element includes more than six notches, such as seven or more notches.
Notches 426 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

A center of main body 421 further includes a centrally positioned aperture 428 in the shape of a circle. In some examples the main body does not include an aperture in the shape of a circle, but instead includes an aperture of another shape, such as a triangle, square, another regular polygon, or an irregular polygon. Aperture 428 may assist users to hold and manipulate building element 420 while constructing 3-D structures. In other examples, the building element does not have an aperture and instead has a continuous and/or solid center portion.

In the example shown in FIGS. 3 and 7, building element 420 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 420. The building elements having the same shape as building element 420 may be larger and smaller than building element 420.

Although building element 420 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 7, each side of underlying polygon 429 has a length u, each of tabs 323 has a width w and a length x, and each of notches 426 has a length y.

As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

Accordingly, if building element 420 is comprised of a substantially flexible material, the width w is no greater than one half the width r and the width v is no greater than one half the length u. If building element 20 is comprised of a substantially rigid material, the length a is no greater than one half the width v and the width v is no greater than one third the length u. In both examples, the length x is a sufficient length for the tab to be easily gripped by a user.

In one specific example for building element 20 comprised of a substantially flexible material, the length a is 1.25 in, the width r is 0.55 in, the length w is 0.275 in, and the length x is 0.4 in. In another example for building element 20 comprised of a substantially rigid material, the width v can be less than 0.55 in (i.e., no greater than 0.417 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

Building element 420 can be manufactured from a substantially flexible material such materials as foam, ethyl-vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building element 420 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

Turning attention to FIG. 8, a seventh building element 720 defines a seventh geometric shape 722, a triangle, defined by outer edges 724 (i.e., defined by a perimeter of the building element). While building element 720 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

Building element 720 includes a plurality of edge tabs 723 and a plurality of notches 726. Differences between building element 20 and building element 720 include their respective shapes and the addition of edge tabs 723 in building element 720. Building element 20 defines a 3-pointed star while building element 720 defines a fifth geometric shape, which is a triangle. As shown in FIG. 8, tabs 723 are semicircular-shaped tabs that are at least partially continuous with (i.e., integrally formed with) edge 724. Tabs 723 are positioned with a semicircular portion 727 extending away from edge 724. A flat edge 728 of tabs 723 cooperates with edge 724 to form three rectilinear notches 726.

Notches 726 are oriented relative to adjacent notches to form an underlying polygon 729 of main body 721 (i.e., a triangle). In the example shown in FIG. 8, notches 726 are disposed proximal to the periphery of the main body. In other words, notches 726 are aligned on the periphery of main body 721 along underlying polygon 729. In the present example, the underlying polygon is coextensive with the outer edges of the main body of the building piece. In certain examples, the building element includes less than three notches, such as one or two notches. In still further examples, the building element includes more than three notches, such as four, five, or six or more notches.

Notches 726 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

In the example shown in FIG. 8, building element 720 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 720. The building elements having the same shape as building element 720 may be larger and smaller than building element 720.

Although building element 720 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 8, each side of underlying polygon 729 has a length a, each of tabs 723 has a width b, and a length d, and each of notches 726 has a length c.
As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

Accordingly, if building element 720 is comprised of a substantially flexible material, the length cc is no greater than one half the width bb and the width bb is no greater than one half the length aa. If building element 720 is comprised of a substantially rigid material, the length cc is no greater than one half the width bb and the width bb is no greater than one third the length aa. In both examples, the length dd is a sufficient length for the tab to be easily gripped by a user.

In one specific example for building element 720 comprised of a substantially rigid material, the length cc is 1.75 in, the width bb is 0.5625 in, the length cc is 0.28125 in, and the length dd is 0.3 in. In another example for building element 20 comprised of a substantially flexible material, the width bb can be greater than 0.5625 in (i.e., no greater than 0.875 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

Building element 720 can be manufactured from a substantially flexible material such as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Alternatively, if building element 720 includes non-rectilinear notches, it can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sasal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

Turning now to FIG. 9, an eighth building element 820 defines an eighth geometric shape 822, a square, defined by outer edges 824. While building element 720 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

Building element 820 includes a plurality of tabs 823 and a plurality of notches 826. The primary difference between building element 720 and building element 820 is their respective shapes. Building element 720 defines a triangle and building element 820 defines a square. As shown in FIG. 9, tabs 823 are semicircular-shaped tabs that are at least partially continuous with (i.e., integrally formed with) edge 824. Tabs 823 are positioned with a semicircular portion 827 extending away from edge 824. A flat edge 828 of tabs 823 cooperates with edge 824 to form four rectilinear notches 826.

Notches 826 are oriented relative to adjacent notches to form an underlying polygon 829 of main body 821 (i.e., a square). In the example shown in FIG. 9, notches 826 are disposed proximal to the periphery of the main body. In other words, notches 826 are aligned on the periphery of main body 821 along underlying polygon 829. In the present example, the underlying polygon is coextensive with the outer edges of the main body of the building piece. In certain examples, the building element includes less than four notches, such as one or two notches. In still further examples, the building element includes more than four notches, such five or more notches.

Notches 826 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

In the example shown in FIG. 9, building element 820 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 820. The building elements having the same shape as building element 820 may be larger and smaller than building element 820.

Although building element 820 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building elements can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 9, each side of underlying polygon 839 has a length ee, each of tabs 823 has a width ff and a length hh, and each of notches 826 has a length gg.

As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

Accordingly, if building element 820 is comprised of a substantially flexible material, the length g is no greater than one half the width ff and the width ff is no greater than one half the length ee. If building element 830 is comprised of a substantially rigid material, the length g is no greater than one half the width ff and the width ff is no greater than one third the length ee. In both examples, the length hh is a sufficient length for the tab to be easily gripped by a user.

In one specific example for building element 820 comprised of a substantially rigid material, the length ee is 1.75 in, the width ff is 0.5625 in, the length gg is 0.28125 in, and the length hh is 0.3 in. In another example for building element 20 comprised of a substantially flexible material, the width ff can be larger than 0.5625 in (i.e., no greater than 0.875 in). It will be appreciated that the specific dimensions
above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

[0126] Building element 820 can be manufactured from a substantially flexible material such as materials as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Alternatively, if the building element 820 includes non-recticular notches, it can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

[0127] FIGS. 10 and 11 detail two more variations of the nearly unlimited shapes that can be used with the presently described geometric systems to construct 3-D polyhedrons. Specifically, FIG. 10 illustrates a ninth building element 520 that defines a ninth shape 522 that resembles a variation of a 4-pointed star (i.e., a 4-pointed star with longer tabs than shape 322), defined by outer edges 524. While building element 520 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

[0128] As depicted in FIG. 10, building element 520 includes a main body 521 with tabs 523 extended away from the main body (i.e., extended outwardly from the main body). Building element 520 also includes four notches 526. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure. Because of the specific shape of building element 520 (i.e., a 4-pointed star), tabs 523 are located in elongate projections 525, which are extended away from main body 521. Elongate projections 525 define indentations 527 (i.e., negative spaces in the body of the building element) between each of the elongate projections.

[0129] Notches 526 are oriented relative to adjacent notches to form an underlying polygon 529 (i.e., a square) of main body 521. In the example shown in FIG. 10, notches 526 are aligned on the periphery of the main body 521. In other words, notches 526 are aligned on the periphery of main body 521 along underlying polygon 529. In certain examples, the building element includes less than four notches, such as one or two notches. In still further examples, the building element includes more than four notches, such as five or more notches.

[0130] Notches 526 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

[0131] In the example shown in FIG. 10, building element 520 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 520. The building elements having the same shape as building element 520 may be larger and smaller than building element 520.

[0132] Although building element 520 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 10, each side of underlying polygon 529 has a length II, each of tabs 523 has a width jj and a length ll, and each of notches 526 has a length kk.

[0133] As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the length of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

[0134] Accordingly, if building element 520 is comprised of a substantially flexible material, the length kk is no greater than one half the width jj and the width jj is no greater than one half the length ll. If building element 120 is comprised of a substantially rigid material, the length kk is no greater than one half the width jj and the width jj is no greater than one third the length ll. In both examples, the length ll is a sufficient length for the tab to be easily gripped by a user.

[0135] In one specific example for building element 520 comprised of a substantially flexible material, the length ll is 1.75 in, the width jj is 0.625 in, the length kk is 0.3125 in, and the length ll is 0.75 in. In another example for building element 20 comprised of a substantially rigid material, the width jj can be less than 0.625 in (i.e., no greater than 0.583 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

[0136] Building element 520 can be manufactured from a substantially flexible material such as materials as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Alternatively or alternatively, building element 520 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

[0137] FIG. 11 illustrates a tenth building element 620 that defines a tenth shape 622, a shape resembling a 5-pointed leaf, defined by outer edge 624. While building element 620 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D)) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

[0138] As depicted in FIG. 11, building element 620 includes a main body 621 with tabs 623 extended away from the main body (i.e., extended outwardly from the main body). Building element 620 also includes five notches 626. Generally, the tabs are portions of the building element that extends
beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure. Because of the specific shape of building element 620, tabs 623 are located in elongate projections 625, which are extended away from main body 621. Elongate projections 625 define indentations 627 (i.e., negative spaces in the body of the building element) between each of the elongate projections.

Notches 626 are oriented relative to adjacent notches to form an underlying polygon 629 (i.e., a pentagon) of main body 621. In the example shown in FIG. 11, notches 626 are disposed proximal to the periphery of the main body. In other words, notches 526 are aligned on the periphery of main body 621 along underlying polygon 629. In certain examples, the building element includes less than four notches, such as one or two notches. In still further examples, the building element includes more than four notches, such as five or more notches.

Notches 626 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

In the example shown in FIG. 11, building element 620 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 620. The building elements having the same shape as building element 620 may be larger and smaller than building element 620.

Although building element 620 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 11, each side of underlying polygon 629 has a length mm, each of tabs 623 has a width nn and a length pp, and each of notches 626 has a length oo.

As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

Accordingly, if building element 620 is comprised of a substantially flexible material, the length oo is no greater than one half the width nn and the width nn is no greater than one half the length mm. If building element 620 is comprised of a substantially rigid material, the length oo is no greater than one half the width nn and the width nn is no greater than one third the length mm. In both examples, the length pp is a sufficient length for the tab to be easily gripped by a user.

In one specific example for building element 620 comprised of a substantially flexible material, the length mm is 1.0 in, the width nn is 0.5 in, the length oo is 0.25 in, and the length pp is 0.4375 in. In another example for building element 620 comprised of a substantially rigid material, the width nn can be less than 0.5 in (i.e., no greater than 0.333 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

Building element 620 can be manufactured from a substantially flexible material such materials as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building element 620 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

FIGS. 12-14 illustrate three of the virtually unlimited possible structures that can be constructed with the geometric systems described herein. FIG. 12 illustrates an octahedron 900 constructed from eight building elements 20, which define 3-pointed stars. FIG. 13 illustrates a cuboctahedron 1000 constructed from eight building elements 20, which define 3-pointed stars, and six building elements 320, which define 4-pointed stars. FIG. 14 illustrates a truncated icosahedron 1100 constructed from twelve building elements 30, which define 5-sided stars and twenty building elements 420, which define 6-sided stars.

FIGS. 15 and 16 illustrate an eleven building element 1220 that defines an eleven shape 1222 that generally resembles a 3-armed pin wheel, defined by outer edges 1224. While building element 1220 is technically three-dimensional in that it has a length, a width, and a thickness, it may be referred to as substantially two-dimensional (2-D) given that its thickness is significantly smaller than its length and width. In other examples, the building element may have a thickness that is larger and in those instances the building element may be considered a three-dimensional (3-D) component.

In the example shown in FIG. 15, building element 1220 includes a main body 1221 with tabs 1223 extended away from the main body (i.e., extended outwardly from the main body). Building element 1220 also includes three notches 1226. Generally, the tabs are portions of the building element that extends beyond the notches. During use, the tabs can be manipulated by a user for assembly and disassembly of a 3-D structure. Because of the specific shape of building element 1220, tabs 1223 are located in elongate projections 1225, which are extended away from main body 621. Elongate projections 1225 define indentations 1227 (i.e., negative spaces in the body of the building element) between each of the elongate projections.

Notches 1226 are oriented relative to adjacent notches to form an underlying polygon 1229 (i.e., a triangle) of main body 1221. In the example shown in FIG. 15, notches 326 are disposed proximal to the periphery of the main body. In other words, notches 1226 are aligned on the periphery of main body 1221 along underlying polygon 1229. In certain examples, the building element includes less than three notches, such as one or two notches. In still further examples, the building element includes more than three notches, such as four or more notches.

Notches 1226 are substantially rectilinear in shape as compared to notches 126 shown in FIG. 4, which are
non-rectilinear in shape (i.e., including at least one curvilinear longitudinal edge). In various examples, the building element may define rectilinear notches, non-rectilinear notches, or a combination of rectilinear and non-rectilinear notches.

In the example shown in FIGS. 15 and 16, building element 1220 has a specific size. In some examples, the geometric system may include building elements with the same shape, but a different size than building element 1220. The building elements having the same shape as building element 1220 may be larger and smaller than building element 1220.

Although building element 1220 can be constructed in any desired size, ratios of the width of the tab to the length of the notches and the length of a side of the underlying polygon are preserved so that the building element can be easily assembled and disassembled with one or more other building elements. Specifically, as shown in FIG. 15, each side of underlying polygon 1229 has a length sq, each of tabs 1223 has a width rr and a length tt, and each of notches 1226 has a length ss.

As described above, a length of each of the tabs is sufficiently long enough to be gripped by a user, a length of each of the notches is no greater than one half a width of each of the tabs, and the width of each of the tabs is no greater than one half a length of one side of the underlying polygon. More specifically, if the building element is comprised of a substantially flexible material, the width of the tab can be less than or equal to one half the length of one side of the underlying polygon and is preferably no less than one third the length of one side of the underlying polygon. If the building element is comprised of substantially rigid material, the width of the tab can be less than or equal to one third the length of one side of the underlying polygon. Further, the length of each notch is no greater than one half the width of each of the tabs.

Accordingly, if building element 1220 is comprised of a substantially flexible material, the length ss is no greater than one half width rr and the width rr is no greater than one half the length sq. If building element 1220 is comprised of a substantially rigid material, the length ss is no greater than one half the width rr and the width rr is no greater than one third the length sq. In both examples, the length ss is sufficiently small for the tab to be easily gripped by a user.

In one specific example for building element 1220 comprised of a substantially flexible material, the length sq is 4.0 in, the width rr is 1.8125 in, the length ss is 0.5625 in, and the length tt is 0.625 in. In another example for building element 1220 comprised of a substantially rigid material, the width rr can be less than 1.8215 in (i.e., no greater than 1.333 in). It will be appreciated that the specific dimensions above are only two examples and the building element can have any dimensions that maintain the designated ratios described above.

Building element 1220 can be manufactured from a substantially flexible material such as foam, ethylene vinyl acetate, poster board, and/or laminated paper. Additionally or alternatively, building element 1220 can be manufactured from a substantially rigid material such as wood veneer, acrylic, and/or sisal. The reader should understand that the building elements described herein may be manufactured from virtually any material currently known or yet to be discovered that would allow the building elements to interconnect and form 3-D structures.

FIG. 16 illustrates an icosohedron constructed from twenty building elements 1220, which define pin wheel shape building elements.

Finally, turning to FIG. 17, another example 3-D structure is shown, a tetrahedron 1400 constructed from four building elements 20 (3-pointed stars). Each of the building elements has the configuration and structure shown in FIG. 1 and described above, and thus has the advantages for assembly and disassembly described above. FIG. 17 illustrates a bottom view of tetrahedron 1400 where the final building element (i.e., one of building elements 20) is in alignment to be attached to the other three building elements at their respective notches. Specifically, the final building element is 60° away from its assembled position, and can be rotated by a user to bring the building element into connection with the other building elements (i.e., mating of notches).

In the present configuration, underlying polygon 29 for the final building element is offset (i.e., offset 60°) relative to an underlying polygon 1402 (i.e., a triangle). Underlying polygon 1402 is formed by one of notches 26 from each of the other three building elements. In other words, on one side of tetrahedron 1400, notches 26 of the other three building elements lie along underlying polygon 1402. Underlying polygon 1402 is congruent with underlying polygon 29. Although not specifically shown, it should be understood that when notches of the final building element are mated to notches of the other three building elements, underlying polygon 29 will align with underlying polygon 1402.

In order for the final building element 20 to fit into the final position to complete the 3-D structure, there is a limit on the width of each of the tabs. Specifically, each side of underlying polygons 1402 and 29 (i.e., equilateral triangles offset by 60°) is substantially divided into three segments (i.e., a center segment and two end segments). Each of the tabs of the final building element must fit into the center segment in order to slidingly mate the notches of the final building element to the notches of the other building elements in the 3-D structure. Because the two end segments are equal to the center segment, the total length of one side of the underlying polygon (underlying polygon 29) is equal to three times the tab width. Accordingly, the maximum tab width is one third the length of one side of the underlying polygon for a building element comprised of a substantially rigid material.

If the building element is flexible (i.e., comprised of a substantially flexible material), the width of the tab can be wider, but no greater than one half of the length of one side of the underlying polygon. As the tab is made wider, more deformation of the structure may be necessary to complete the construction, leading to increasingly difficult assembly and/or disassembly. Experimentally, once the tab width is greater than one half of the side of the underlying polygon, assembly becomes too difficult, especially for children.

The geometry of the building elements, namely the width of the tab relative to the length of the side of the underlying polygon and the length of each notch relative to the width of each of the tabs (specifically described above in reference to FIG. 1), allows for the tabs of building elements to be easily manipulated by a user to rotate and slidingly mate the final building element into the tetrahedron and limits interference by the tabs of the other building elements of tetrahedron. Further, the width of the tabs is sufficient to allow easy engagement of the mating notches and provide sufficient holding power to retain a shape of the tetrahedron after assembly. It will be appreciated that the above described
features also contribute to ease in disassembly of the tetrahedron. It will be further appreciated that although FIG. 17 demonstrates assembly for building element 20 in one specific example configuration for a 3-D structure, similar limits are applied to other building elements in other 3-D structures. Because a tetrahedron formed from triangular (3-pointed star) building elements is the smallest 3-D structure constructed from the smallest building elements, it may have the tightest limitations on tab width relative to underlying polygons.

[0164] The disclosure above encompasses multiple distinct inventions with independent utility. While each of these inventions has been disclosed in a particular form, the specific embodiments disclosed and illustrated above are not to be considered in a limiting sense as numerous variations are possible. The subject matter of the inventions includes all novel and non-obvious combinations and subcombinations of the various elements, features, functions and/or properties disclosed above and inherent to those skilled in the art pertaining to such inventions. Where the disclosure or subsequently filed claims recite “a” element, “a first” element, or any such equivalent term, the disclosure or claims should be understood to incorporate one or more such elements, neither requiring nor excluding two or more such elements.

[0165] Applicant(s) reserves the right to submit claims directed to combinations and subcombinations of the disclosed inventions that are believed to be novel and non-obvious. Inventions embodied in other combinations and subcombinations of features, functions, elements and/or properties may be claimed through amendment of those claims or presentation of new claims in the present application or in a related application. Such amended or new claims, whether they are directed to the same invention or a different invention and whether they are different, broader, narrower or equal in scope to the original claims, are to be considered within the subject matter of the inventions described herein.

1. A geometric system for building 3-D structures comprising:
   - a plurality of 2-D building elements configured to connect together for building 3-D structures, each of the plurality of 2-D building elements having a body that is at least:
     - a central main body,
     - a plurality of tabs at least partially continuous with and extended away from the central main body, and
     - a plurality of notches, one of the plurality of notches being disposed between each of the plurality of tabs and the central main body,
   wherein the plurality of building elements is configured to fit together at respective notches of each building element to form a 3-D structure, and wherein each of the plurality of notches is oriented relative to adjacent notches to form an underlying polygon of the central main body, a width of each of the plurality of tabs being no greater than one half a length of one side of the underlying polygon.

2. The geometric system of claim 1, wherein a length of each of the plurality of notches is no greater than one half the width of each of the plurality of tabs.

3. The geometric system of claim 1, wherein each of the plurality of 2-D building elements is comprised of a substantially rigid material.

4. The geometric system of claim 3, wherein the width of each of the plurality of tabs is no greater than one third the length of one side of the underlying polygon.

5. The geometric system of claim 1, wherein each of the plurality of 2-D building elements is comprised of a substantially flexible material.

6. The geometric system of claim 5, wherein the width of each of the plurality of tabs is no less than one third the length of one side of the underlying polygon.

7. The geometric system of claim 1, wherein the plurality of 2-D building elements are comprised of one or more of ethylene vinyl acetate, poster board, laminated paper, wood veneer, acrylic, and sisal.

8. The geometric system of claim 1, wherein the plurality of building elements comprises at least a first building element and a second building element, and wherein the plurality of notches are rectilinear for the first building element and non-rectilinear for the second building element, opposing longitudinal sides of the plurality rectilinear notches comprising two straight lines and opposing longitudinal sides of the plurality of non-rectilinear notches comprising a straight line and a curved line.

9. The geometric system of claim 8, wherein the second building element is comprised of a rigid material.

10. The geometric system of claim 1, wherein each of the plurality of notches is of equal dimensions relative to others of the plurality of notches, and each of the plurality of tabs is of equal dimensions relative to others of the plurality of tabs.

11. The geometric system of claim 1, wherein the distance from each of the plurality of notches to the center of the building elements is selected such that the plurality of building elements to form a 3-D structure having faces that are equiangular and equilateral when interconnected.

12. A geometric system for building 3-D structures from a plurality of 2-D building elements, comprising:
   - a plurality of 2-D building elements configured to connect together for building 3-D structures, each of the plurality of 2-D building elements having a main body which is at least:
     - a central main body,
     - a plurality of elongate projections continuous with and extended away from the central main body, and
     - a plurality of notches, one of the plurality of notches being disposed in each of the plurality of elongate projections, portions of the plurality of elongate projections extended beyond the plurality of notches being a plurality of tabs,
   wherein the plurality of building elements is configured to fit together at respective notches of each building element to form a polyhedron structure.

13. The geometric system of claim 12, wherein each of the plurality of notches is oriented relative to adjacent notches to form an underlying polygon of the main body, each of the plurality of tabs having a width that is no greater than one half a length of one side of the underlying polygon.

14. The geometric system of claim 13, wherein each of the plurality of 2-D building elements is comprised of a substantially rigid material, and a width of each of the plurality of tabs is no greater than one third a length of one side of the underlying polygon.

15. The geometric system of claim 13, wherein each of the plurality of 2-D building elements is comprised of a substantially flexible material, and a width of each of the plurality of tabs is no greater than one half a length of one side of the underlying polygon.
16. The geometric system of claim 15, wherein a width of each of the plurality of tabs is no less than one third a length of one side of the underlying polygon.

17. The geometric system of claim 12, wherein a length of each of the plurality of notches is no greater than one half a width of each of the plurality of tabs.

18. A geometric system for building 3-D structures, comprising:
   a plurality of 2-D building elements configured to connect together for building 3-D structures, each of the plurality of 2-D building elements having a main body that is at least:
   a central main body,
   a plurality of tabs at least partially continuous with and extended away from the central main body, and
   a plurality of notches, one of the plurality of notches being disposed between each of the plurality of tabs and the central main body,
wherein the plurality of building elements are configured to fit together at their respective notches to form a 3-D structure,

19. The geometric system of claim 18, wherein each of the plurality of notches is oriented relative to adjacent notches to form an underlying polygon of the main body, each of the plurality of tabs having a width that is no greater than one half a length of one side of the underlying polygon, and

20. The geometric system of claim 18, wherein each of the plurality of notches is no greater than one half the width of each of the plurality of tabs.