A method and system for construction of building structures from a variety of standard size panels having integral dovetail tenons on all four edges and a variety of connectors with corresponding mortises for interlocking the panels. The panels may be horizontally disposed to form floors, ceilings or roofs or may be vertically disposed to form walls. The panels are produced from blow-molded plastic. Panels are interlocked in columns and rows of a planar array to form walls, floors, roofs, etc. Panels can also be interlocked edge to edge in a non-planar orthogonal manner, allowing the panels to be interconnected in virtually unlimited ways. Plastic frame members with trussing interconnect to the panels to provide rigidity and strength to the assembled building structure. The panels may be formed of opaque material for ordinary sheds or of transparent or translucent material for greenhouses.
Fig. 10
(Prior Art)
Fig. 23
Fig. 28
METHOD AND SYSTEM FOR A MODULAR BUILDING STRUCTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to building structures generally and to a method of producing a building structure from pre-fabricated modular components. More particularly, this invention provides for assembling a warehouse, aircraft hanger, workshop, garage, storage building, garden or utility shed, greenhouse, cabinet, locker, or similar enclosure from pre-fabricated modular components.

2. Description of the Prior Art

There has long been a need for affordable, low-maintenance, and easy-to-assemble prefabricated building structures. Considerable economies of scale can be achieved by the construction of warehouses, hangers, storage buildings, workshops, garages, garden and utility sheds, lockers and cabinets in modular fashion using prefabricated paneling. The panels can be prefabricated in standard sizes by relatively high-speed automated factory manufacturing lines. The panels, which can be made from materials not subject to rot, weathering or insect attack, can be shipped to the installation sites and simply assembled to erect complete structures. Generally, the lighter the panels are, the lower the costs are to transport the panels to the job site.

For example, several storage enclosure systems exist that use modular interlocking components made of vinyl, plastic, galvanized steel or aluminum to form a structure. For example, U.S. Pat. Nos. 6,591,558 and 6,889,475, issued to De Zen, disclose a prefabricated plastic shed, shown here in FIGS. 1-3. Referring to FIG. 1, a shed (10) includes walls (11) and roof (13) formed from long extruded plastic panels (12A, 12B) that interlock along vertical seams. The length of the panels (12A, 12B) defines the height of the walls (11). A unitary triangular gable panel (18) is also provided for use above the doors (20). As shown in FIGS. 2 and 3, respectively, the walls (11) and the roof (13) are assembled by sliding the panels (12A, 12B) into interlocking engagement.

FIG. 4 illustrates the De Zen shed (10) in a disassembled condition, in a pre-staged arrangement for assembly. The shed (10) is assembled from interlocking plastic wall and roof panels (12A, 12B), plastic floor panels (14), plastic corner posts (16), a plastic gable panel (18), plastic doors (20), plastic ridge extensions (24), a plastic ridge cover (26), plastic ridge end caps (27), a plastic lintel (28), plastic base channels (30), plastic gable fascias (32), plastic sloped wall caps (34), and roof caps (36). The profiles of these components are shown in FIGS. 5-7. The De Zen shed, as with other prior art utility sheds, employs steel ridge channel members (22) to provide the required structural strength.

FIGS. 5 and 6 are end views of the wall panels (12A, 12B) detailing their interlocking structure. FIG. 5 shows a female-style panel (12A) having first and second opposite faces (38) and first and second opposite mortises (40) for sliding engagement with the male panel (12B). The male panel (12B) likewise has first and second opposite faces (42) and first and second opposite tenons (44), each of which is slidingly receivable into a mortise (40). Referring to FIG. 6, the female panel (12A) is shown in interlocking relation with the male panel (12B).

A plastic ridge cover (26) and a ridge end cap (27) are also shown. Although these extruded fittings are made of plastic as taught by De Zen, prior art sheds using similar panels and fittings formed from vinyl, steel or aluminum are known in the art.

As illustrated in FIGS. 3, 5 and 8, although the panels (12A, 12B) interlock at each of their two longitudinal edges (40, 44), their top and bottom ends (46, 48) are unfinished. Although open upper and lower ends of panels may be advantageous for filling hollow panels with concrete for structural strength or foam for thermal insulation, generally, the unfinished panel ends (46, 48) require the addition of finishing end caps, such as end cap (36) of FIGS. 7 and 8, to prevent water ingress and to give the building a finished and pleasant look. The step of covering the open transverse ends of extruded panels often requires the use of cements or sealants, is time consuming, and increases the total installed cost of the shed.

FIG. 9 illustrates a common interior shelving arrangement used in sheds of prior art. Typically, either fixed brackets (not illustrated) or an adjustable bracket system with rails (50) and interlocking arms (52) are screwed into a wall panel. Shelves (54) are supported by the fixed or adjustable bracket. Such installed shelves generally have fairly limited load capacity.

FIGS. 10-13 illustrate another common prior art shed arrangement (60). Corrugated wall panels (62) are stacked on top of another, sliding within grooves (63) of vertical frames (64) and secured by screws (65). Triangular gable panels (66) are provided. Horizontal headers (68) connect to the vertical frames (64) to complete the wall structure, adding strength and rigidity to the shed (60). Additionally, as shown in FIG. 11, vertical stiffening studs (67) may be employed as structural backing to the mid-portions of the wall panels (62). The wall panels (62) are typically screwed to the stiffening studs (67) by screws (69). FIG. 13 shows the interlocking relationship of the corrugated wall panels (62A, 62B). The upper horizontal end of the lower wall panel (62A) has a tongue (70) that fits within a groove (71) of the lower horizontal end of the upper wall panel (62B). This tongue and groove relationship helps to stiffen the walls of shed (60) and keeps the horizontal seam between the panels (62A, 62B) from separating.

Greenhouses are also known in prior art. Typically, prior art greenhouses employ individual wall and roof panels each having steel or aluminum frames glazed with shatter-resistant glass or plexiglass. The glass panels are then assembled into a shed-like structure similar to the shed (10) of FIG. 1 or the shed (60) of FIG. 10.

Identification of Objects of the Invention

A primary object of the invention is to provide a building system of components that are capable of low-cost factory manufacture and may be erected to form an inexpensive enclosure in a rapid and efficient manner using minimal on-site labor with minimal specialized skill and equipment.

Another object of the invention is to provide a low cost construction technique in which all portions of a building structure may be prefabricated in a factory using durable, long lasting materials which are not subject to rot, weathering or attack by insects.

Another object of the invention is to provide a system of complementary interlocking panels and connectors which can be combined in nearly limitless ways to build diverse structures, including warehouses, aircraft hangars,
storage buildings, workshops, garages, garden and utility sheds, lockers, cabinets, and similar enclosures.  

Another object of the invention is to provide a system of complementary interlocking parts which can be used to construct building floors, walls and roofs.  

Another object of the invention is to provide a modular interlocking building system which requires no special form of fasteners or use of specialized fastening tools.  

Another object of the invention is to provide a low-cost flame-retardant ultra-violet resistant building capable of withstanding hurricane and earthquake shocks.  

Another object of the invention is to provide a building structure constructed entirely of plastic, with no metal reinforcements.  

Another object of the invention is to provide a system of complementary interlocking transparent or translucent panels made entirely of plastic that can be easily assembled to provide a low-cost window, sunroof, skylight, or greenhouse of nearly any size or configuration.  

SUMMARY OF THE INVENTION  

The objects identified above, as well as other features and advantages of the invention are incorporated in a method for manufacturing building structures including warehouses, aircraft hangers, garages, workshops, storage buildings, sheds, greenhouses, cabinets, lockers, and similar enclosures which preferably includes a variety of standard size panels and connectors for interlocking the panels. The panels may be horizontally oriented to form floors, ceilings, or roofs, or may be vertically oriented to form walls. The panels are preferably made of a blow-molded plastic. Using a connector element, panels may be interlocked, one vertically above the other to form walls in a vertical direction. Likewise, panels can also be interlocked side by side with the connector element to form continuous walls in a horizontal direction. A connector element also allows the interconnection of vertical to horizontal panels. The storage enclosure is preferably supported by plastic frame elements of truss design which are likewise interlocked together to form-frames, joints and beams. Plastic shelving support arms preferably interlocked directly to the frame elements. The panels may be made of a transparent or translucent plastic material for providing sunroofs, windows, or for constructing greenhouse structures.  

BRIEF DESCRIPTION OF THE DRAWINGS  

The invention is described in detail below by reference to the embodiments illustrated in the accompanying figures, in which:  

FIG. 1 is a perspective view of a prior art shed constructed of interlocking vertically-oriented wall panels;  

FIG. 2 is a perspective view of an exterior portion of the prior art shed of FIG. 1 during the assembly phase showing sliding longitudinal interlocking engagement of the vertically-oriented wall panels;  

FIG. 3 is a perspective view of an exterior portion of the prior art shed of FIG. 1 during the assembly phase showing sliding longitudinal interlocking engagement of the roof panels;  

FIG. 4 is a plan view of the prior art shed of FIG. 1 in a disassembled condition, shown in a pre-staged arrangement for assembly;  

FIG. 5 is a perspective end view of female and male panel members of the prior art shed of FIG. 1 showing extrusion profiles designed for sliding interlocking engagement;  

FIG. 6 is a perspective end view of the female and male panel members of FIG. 5 shown connected in interlocking engagement;  

FIG. 7 illustrates perspective end views of various members of the prior art shed of FIGS. 1 and 4, detailing their extrusion profiles;  

FIG. 8 is a perspective view of an exterior portion of the prior art shed of FIG. 1 during the assembly phase showing the addition of end caps to cover the open, unfinished ends of extruded panels;  

FIG. 9 is a perspective view of an interior portion of the prior art shed of FIG. 1 showing installed shelving consisting of racks fastened to the wall, arms which interlock into the racks, and a shelf which rests on the arms;  

FIG. 10 is a perspective view of a prior art shed constructed of interlocking horizontally oriented wall panels;  

FIG. 11 is a perspective view of an exterior portion of the prior art shed of FIG. 10 during the assembly phase showing sliding interlocking engagement of the transverse ends of the horizontally-oriented wall panels between vertical frames;  

FIG. 12 is a perspective view of an interior portion of the prior art shed of FIG. 10 detailing the sliding interlocking engagement of the transverse ends of the horizontally-oriented panels within a vertical frame member;  

FIG. 13 is a cross-section taken along lines 13-13 of FIG. 11 illustrating the longitudinal interlocking arrangement of the horizontally-oriented wall panels characterized by the ability to directly connect the wall panels without sliding one wall panel longitudinally along side the other;  

FIG. 14 is a perspective view of a storage shed according to a first embodiment of the invention showing construction of building wall, floor and roof surfaces by arrays of generally square shaped plastic panels interlocked with plastic connection members;  

FIG. 15 is a perspective view of a panel for constructing the shed of FIG. 14, showing tenons of fan-like dovetail shape on all four edges;  

FIG. 16 is a perspective view of a connector element for interlocking multiple panels of the shed of FIG. 14, showing four orthogonally-disposed fan-shaped mortises for sliding interlocking engagement with the dovetail tenons of the panel of FIG. 15;  

FIG. 17 is an enlarged perspective view of a corner edge of the shed of FIG. 14 showing the interlocking engagement of four panels of the type illustrated in FIG. 15 and four connector elements of the type illustrated in FIG. 16;  

FIG. 18 is an enlarged perspective view of a plug element designed and arranged to be connected longitudinally between adjacent connector elements of the type illustrated in FIG. 16;  

FIG. 19 is an enlarged perspective view of a portion of a wall of the shed of FIG. 14 according to one embodiment of the invention showing the plug element of FIG. 18 interlocked and filling the interstitial void between four panels of the type of FIG. 15 and four connector elements of the type of FIG. 16;  

FIG. 20 is an enlarged perspective view of a portion of a ridge connector element according to one embodiment of the invention showing three fan-shaped mortises for slidingly interlocking panel fan-like dovetail tenons;
FIG. 21 is an enlarged perspective view of a ridge plug element for use with ridge connector elements of the type of FIG. 20 to fill interstitial voids between panels along the roof ridge and roof-wall intersections;

FIG. 22 is a perspective view of the shed of FIG. 14 in a partially assembled stage, showing only assembled floor panels and frame elements;

FIG. 23 is an explosion diagram illustrating a portion of the shed of FIG. 22 according to one embodiment of the invention showing a frame element and a frame coupling having four arrow-shaped mortises;

FIG. 24 is a perspective view of the shed of FIG. 14 in a partially assembled stage, showing assembled floor panels, frame elements and shelving members;

FIG. 25 is an explosion diagram of a shelving support arm assembly according to one embodiment of the invention;

FIG. 26 is an explosion diagram of shelving and an assembled shelving support arm assembly;

FIG. 27 is a perspective view of a greenhouse according to a second embodiment of the invention formed by an array of generally square-shaped transparent plastic panels interlocked with a number of opaque plastic connector elements;

FIG. 28 is a front elevation of the greenhouse of FIG. 27; and

FIG. 29 is a right-side elevation of the greenhouse of FIG. 27.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

A preferred embodiment of the invention includes a system of intersecting building components to form a shed as shown in the perspective view of FIG. 14. The building system includes a number of interlocking panels 100, each of which may be used to interchangeably form a portion of a wall 102, floor surface 104, ceiling surface (not illustrated), or roof surface 106 of shed 99. Although shed 99 is shown and described herein as having a floor surface 104 formed by interlocking panels, alternative materials, such as a concrete slab, for example, may be used to create the floor surface 104 if desired.

Referring to FIG. 14, each panel 100 is ideally manufactured in one of five standard sizes to allow buildings of various dimensions and complexities to be built entirely from a limited number of panel sizes. This reduces production and inventory costs. Standard panel types include standard panel 130, short panel 132, elongated roof panel 134, trapezoidal panel 136, and floor panel 138. Standard panels 130 are intended for use to form the major portion of the walls 102 of shed 99. Each standard panel 130 has a base dimension x and a height dimension y. Preferably, x and y are equal or close in magnitude so that standard panel 130 has a face 112 that has a square or near-square shape. Floor panels 138 are used to form floor surface 104 of shed 99 and are preferably square in shape, with each side having a length x. Additionally, floor panels 138 are preferably molded with ribs or corrugations 140 to provide additional strength. Because the roof has a pitch angle from the horizontal of 0, the roof panels 134, which form roof surface 106 of shed 99, ideally have an elongated rectangular shape. Roof panels 134 thus have rectangular dimensions of x by w, where w equals x/cosine 0. The gable and upper portions of walls 102 are formed of short panels 132 and trapezoidal panels 136. Short panels 132 are preferably rectangular in shape with dimensions of x by z, where z equals x/tangent 6. Similarly, trapezoidal panels 136 have a base dimension of x, first and second parallel side dimensions of z and 2z, respectively, where z equals x/tangent 6, and a top dimension of w, where w equals x/cosine 0.

FIG. 15 shows a perspective view of a generic panel 100, which is generally representative of wall panel 130, short panel 132, roof panel 134, trapezoidal panel 136, and floor panel 140. Panel 100 preferably has a one-piece outer shell that defines two planar faces 112, 114 bounded by four edges 116, 118, 120, 122. The two planar faces 112, 114 form the vertical wall surfaces 102 (or sloped surfaces 106 when panel 100 is used as a roof panel 134, for example) and are each suitable for either indoor or outdoor use. Each of the panel's four edges has a profile defining a fan-like dovetail tenon 124, although other interlocking shapes may be used as appropriate. The dovetail tenon 124 is ideally symmetrical about an imaginary plane parallel to and midway between planar faces 112, 114 so that either face 112, 114 can be disposed as the outer surface. Thus, if face 112 and face 114 are molded in different colors, shed 99 can be constructed of either two colors from the same set of panels. Alternatively, a checkered shed 99 can be assembled, if desired.

Although the panel 100 may be made of any suitable material, it is preferably formed of a polymer, for example, polyvinylchloride (PVC). The compound or mixture may optionally include flame retardants and ultraviolet stabilizers. Preferably, panel 100 is manufactured by a blow molding process to form an integral and completely sealed hollow body. In the blow molding process, a polymer material is melted and extruded through an annular die and then fed vertically down into a hollow mold. Air pressure is applied to the polymer material once it has left the extruder die and entered the mold. The air pressure forces the material against the sides of the mold, thus creating a hollow molding having the shape of the mold. Once the material has cooled and hardened in the mold shape, it is removed from the mold. As blow molding processes are well known in the art, they are not discussed further herein.

A variety of thicknesses may be used for panel 100, where thickness is defined as the distance between planar faces 112 and 114. For example, panel 100 may be thicker or thinner than the thickness of conventionally constructed walls or floors. A panel thickness of about one to two inches should be adequate for most building applications. The two planar faces 112, 114 are preferably sufficiently small so as to maintain the faces in a parallel relation, prevented from bowing by the edges 116, 118, 120, 122, which act as structural ribs for the wall, roof, floor or ceiling constructed of the array of panels. The void spaces within the panels 100 between the planar faces 112, 114 may be injected with an expanding self-curing foam thermal insulation material, if desired.

FIG. 16 illustrates a connector element 150. Connector element 150 preferably includes four orthogonally-disposed fan-shaped mortises 154, each of which is designed for sliding interlocking engagement with dovetail tenons 124 (FIG. 15). Accordingly, a plurality of panels 100 can be arranged, one adjacent another, and interlocked by connector elements 150 to form a continuous wall, floor, ceiling or roof surface. Connector element 150 can be used with its longitudinal axis vertically disposed to connect two, three or four wall panels 130 together. The connector element can also be used with its longitudinal axis disposed horizontally to con-
nect floor panels 138, ceiling panels, or roof panels 134 together, or to connect floor panels or ceiling panels to wall panels.

Although fan-shaped profiles are preferred, various other interlocking arrangements can be used. The dovetail 124 is designed and arranged to slide into and be held tightly by the mortise 154. Other interlocking arrangements are shown in U.S. patent application Ser. No. 10/992,497 and U.S. Pat. No. 5,237,790 of Smalley, which are incorporated herein by reference. Connector element 150 is preferably made from the same material as the shell 28 of panel 10 (Figs. 1-3), such as PVC, but other resilient materials may be used. Additionally, the connector element 150 is preferably extruded, although other manufacturing processes may be used. An extrusion process allows optional co-extrusion of a bead of resilient weatherstripping material 153 (best seen in Fig. 17) within the mortises 154. The weatherstripping 153 will compress between the walls of mortise 154 and the interlocking tenon 124 to seal the joint.

Each connector element 150 ideally has a longitudinal length of w, x, y, z, or 2z to match the edge lengths of the various panels 130, 132, 134, 136, 138 (Fig. 14). However, other longitudinal lengths may be used as desired. For example, a connector element 150 may have a longitudinal length equal to the height of a wall of shed 99, for vertical placement therein.

FIG. 17 is an enlarged view of the front right corner edge of shed 99 of FIG. 14, showing the interlocking engagement of four wall panels 130A, 130B, 130C, 130D and four connector elements 150A, 150B, 150C, 150D. Each panel dovetail 124 is designed and arranged for sliding interlocking engagement with connector element mortise 154. Resilient weatherstripping beads 153 are used to seal the mortise-tenon joints.

FIGS. 18 and 19 show a plug element 160 used to fill intersitial void spaces between an array of panels 100A, 100B, 100C, 100D connected by connector elements 150A, 150B, 150C, 150D. Plug 160 includes a body 162 and two angled arms 164. The angled arms 164 are sized to fit snugly within an inner cavity 152 (Fig. 16) of connector element 150 along any of the four cardinal orientations.

FIG. 20 is a perspective view of a portion of a ridge connector member 170. Ridge connector 170 is preferably an extruded polymer. Ridge connector 170 includes three fan-shaped mortises 172, 174, 176, each adapted to slidingly receive and interlock a fan-like dovetail tenon 124 (Fig. 15). Mortises 172 and 174 face 180-20 degrees away from each other, where 90 is the roof pitch angle from horizontal (Fig. 14). Thus, for use at the ridge 107 of the roof 106 (Fig. 14), ridge connector is oriented substantially as shown in Fig. 20, with mortise 176 facing upwards. Roof panels 134 (Fig. 1) will interlock in mortises 172 and 174 at the proper roof pitch angles. Ridge connector 170 is also used to join the sloped roof 106 to the walls 102 and 104 that are parallel to the ridge 107 (Fig. 14). When used at roof edges 109, ridge connector 170 is oriented upside down compared to the orientation of Fig. 20. In other words, mortise 176 faces downwards for joining to the upper wall panel 132 edges. Then, depending on the side of the shed, either mortise 172 or 174 is used to connect to the roof panel 134. Although not illustrated, mortises 172, 174, 176 may include co-extruded weatherstripping beads similar to optional weatherstripping beads 153 (Figs. 16-17) in connector members 150.

Ridge connector 170 ideally has a longitudinal length of x to match the edge lengths of roof panels 134 and wall panels 132 (Fig. 14). However, ridge connector elements 170 may be provided with other longitudinal lengths, for example, the length of the entire ridge 107 if shed 99.

FIG. 21 is a perspective view of a ridge plug member 180. Just as plug members 160 fill intersitial voids between adjacent connectors 150 (Figs. 18-19), ridge plug members 180 fill intersitial voids between adjacent ridge connectors 170. Ridge plug member 180 includes a body 182 and two angled arms 184. Body 182 has a shape that substantially matches the contours of ridge connector 170, and arms 184 are designed and arranged to snugly fit within central cavity 178 (Fig. 20) of ridge connector 170. The angled arms 184 are preferably dimensioned so that ridge plug member 180 can be comfortably inserted into ridge connector 170 in only one orientation. The “V” apex 186 of the angled arm 184 fits in the space 177 between mortises 172 and 174, and the two bases 188 of the “V”-shaped angled arm profile fit in the spaces 179 between mortises 176 and mortises 172 and 174.

FIG. 22 is a perspective view of the shed 99 of FIG. 14 shown with all wall panels 130, 132, 136, roof panels 136, connector members 150, 170, and plug members 160, 180 removed to show the frame structure of the shed 99. The frame structure includes five basic component types: Two straight frame members 190, 192, two angled frame members 194, 196, and a frame coupling 198. Ideally, frame members 190, 192, 194, 196 are plastic components, with internal trussing for strength, which interlock with each other by frame couplings 198 and/or with panels 100 by connector elements 150. Each frame member 190, 192, 194, 196 ideally has an externally-facing longitudinal edge with a fan-shaped dovetail tenon 191 for coupling to connector elements 150, and both transverse edges have arrow-shaped dovetail tenons 199 for connecting to frame coupling 198 (best seen in Fig. 23). Straight frame members 190 are intended for use to form vertical posts to support the walls 102 and roof 106 (Fig. 14) of shed 99. Ideally, straight frame members 190 each have a longitudinal length y to match the wall panel 130 height dimension. Roof angle frame members 194 are elbow-shaped and ideally have a lower external dimension of z, where w=x+104 degrees, an upper external dimension of w/2, where w=x+104 degrees, and an interior angle of 90+4 degrees. The z dimension matches the height dimension of short panels 132 in walls 102 of shed 99 (Fig. 14). Likewise, ridge angle frame members 196 are boomerang-shaped and have external half-lengths of w/2 an interior angle of 180-20 degrees. Roof straight frame members 192 are used to support the roof 106 (Fig. 14), and have a longitudinal length w to match the length dimension of roof panels 134. However, the dimensions noted herein are general, and precise component dimensions must take into account the dimensions of frame couplings 198 and connector elements 150, 170 to assure a proper fit.

FIG. 22 shows a frame member 190 disposed at every intersection between two floor panels 138 about the perimeter of floor 104, except for the location where the doors are to be located. Door frame elements 200 (Fig. 14) provide structural support in lieu of frame members 190 at the doors. However, other frame spacing intervals may be used as appropriate, such as placing a frame at every other panel about the perimeter of the shed.

FIG. 23 is an enlarged explosion diagram of a frame member 190, 192, 194 or 196 and a frame coupling 198.
Frame member 190, 192, 194, 196 includes a fan-shaped dovetail tenon 191 along one longitudinal edge that is used to connect to wall panels 130 via connector 150 (FIG. 14). Dovetail 191 slingly interlocks within mortise 154 of connector 150. Each transverse edge 189 (only one is shown) of frame member 190 also includes an arrow-shaped tenon 199 that is used to connect to another frame member 190, 192, 194, 196 via frame coupling 198. Frame coupling 198 includes four orthogonally-disposed arrow-shaped mortises 197 which open at one end of the coupling 198 and are arranged and designed to slingly interlock with arrow-shaped tenons 199 of frame members 190, 192, 194, 196. The other end of frame coupling 198 preferably includes a cap 200 that helps to maintain frame coupling 198 locked in place, particularly when coupling 198 is used in a longitudinally vertical orientation. Although arrow-shaped dovetail tenons and mortises are described, other suitable interlocking shapes can be used as appropriate. Because frame coupling 198 has four orthogonally-disposed mortises 197, cross-bracing frame members of length x can be readily added to the shed frame structure as required (not illustrated). Each frame member 190, 192, 194, 196 has interior struts 202 that form the trussing of the frame member and define triangular regions 204 within the frame member. The interior perimeter of each triangular region 204 within the frame member 190, 192, 194, 196 preferably includes a lip 206 extending into the triangular region to provide added strength to the frame member.

FIG. 24 illustrates the partially disassembled shed 99 of FIG. 22, having no wall panels 130, 132, 136, roof panels 134, door frames 200 (FIG. 14), or associated connectors 150, 170 installed. Two levels of U-shaped members 208 are shown to be completely supported by straight frame members 190 via bracket assemblies 212 that interlock to the straight frame members 190. Shelves 208 include larger shelf pieces 210 and smaller shelf pieces 211 that fit above bracket assemblies 212 and allow for the width of the frame members 190. Shelves 208 and bracket assemblies 212 are preferably made of plastic materials.

FIG. 25 is an explosion diagram of a bracket assembly 212 that interlocks to straight frame member 190 according to an embodiment. Bracket assembly 212 consists of a pair of complimentary triangular connector halves 214A, 214B and two truss arm members 216. Each of the triangular connector halves 214A, 214B has a triangular base 220 dimensioned so that the base fits snugly in a triangular region 204 of frame member 190. The perimeter 222 of base 220 abuts struts 202. The base 220 includes a recessed ledge 224 around the perimeter 222 that accommodates lip 206 of triangular region 204. Thus, the bases 220 of triangular connector halves 214A, 214B are assembled one against the other within a triangular region 204 in frame member 190 to form a solid hanger to hold arms 216 perpendicular to frame member 190, even under substantial loading. The mating surfaces of bases 220 may include complimentary pins 226 and sockets 228 to increase the holding power of connector half 214A with respect to connector half 214B when assembled, thus minimizing chances of inadvertent disassembly. Furthermore, connector halves 214A, 214B may be cemented together and to the frame member 190, if desired. Connector halves 214A, 214B each include a triangular body 225 that extends away from base 220. The triangular bodies 225 receive truss arm members 216 by fitting tightly within triangular receptacles 230.

FIG. 26 shows the bracket assembly 212 assembled and connected to straight frame member 190. Arm members 216 preferably include one or more pins 232 along their upper edges that are received into sockets (not shown) located on the undersides 234 of shelves 210 to help keep shelves 210 securely in place on arms 216. A smaller center shelf piece 211 fits between two larger shelf pieces 210 and is supported thereby with fingers 236 that fit into receptacles 238 on shelf pieces 210.

FIGS. 27-29 illustrate a second embodiment of the invention. FIG. 27 is perspective view of a greenhouse 99', and FIGS. 28 and 29 are front and right side views, respectively. Greenhouse 99' of FIGS. 27-29 is identical to the shed 99 of FIG. 14 except that wall panels 130, 132, 136 and roof panels 134 are made of a transparent plastic material. The interiors of panels 100 are not filled with foam but may be filled with a clear inert gas to prevent condensation within the panels 100. Although all of the panels 100 of shed 99' are shown as transparent, a mix of transparent and opaque panels 100 may alternatively be used. For example, clear panels may be used to form a sunroof or window (not illustrated) in shed 99 of FIG. 14.

The Abstract of the disclosure is written solely for providing the United States Patent and Trademark Office and the public at large with a means by which to determine quickly from a cursory inspection the nature and gist of the technical disclosure, and it represents solely a preferred embodiment and is not indicative of the nature of the invention as a whole.

While one or more embodiments of the invention have been illustrated in detail, the invention is not limited to the embodiments shown; modifications and adaptations of the above embodiments may occur to those skilled in the art. Such modifications and adaptations are in the spirit and scope of the invention as set forth herein:

1. A method of constructing a building structure comprising the steps of:
   forming a polymer into a plurality of generally planar panels each characterized by four edges, each of said four edges having an integral tenon of a dovetail shape;
   forming a polymer into a plurality of connector members each characterized by an extrusion profile defining four orthogonally disposed mortises, each of said four orthogonally disposed mortises dimensioned to slidingly receive a tenon of said dovetail shape in interlocking engagement therein;
   assembling a two-dimensional planar array of said plurality of panels into a first building surface by connecting the adjacent edges of each of two adjacent panels in said array together by one of said plurality of connector members, said tenons of said adjacent edges being slidingly received and interlocked in two oppositely disposed mortises of said one of said plurality of connector members; and
   connecting said first building surface with a plurality of other building surfaces to form said building structure.

2. The method of claim 1 further comprising the steps of:
   forming said plurality of panels from a clear polymer; and
   assembling said plurality of panels of said clear polymer into said building structure.

3. The method of claim 1 further comprising the step of:
   forming said plurality of panels by a blow-molding process.
4. The method of claim 1 further comprising the steps of: forming a polymer into a plurality of generally planar rectangular wall panels each characterized by edge dimensions of x by y, each of the four edges of each of said rectangular wall panels having an integral tenon of said dovetail shape; forming a polymer into a plurality of generally planar rectangular short panels each characterized by edge dimensions of x by z, where z equals the quotient of x/tangent θ, where θ defines the pitch angle of a roof of said building structure to a horizontal reference, each of said four edges of each of said short panels having an integral tenon of said dovetail shape; forming a polymer into a plurality of generally planar trapezoidal panels each characterized by a base dimension of x and first and second parallel edge dimensions of z and z2, respectively, each of the four edges of each of said trapezoidal panels having an integral tenon of said dovetail shape; assembling a first number of said plurality of wall panels, a second number of said plurality of short panels, and a third number of said connector members into first and second opposite side walls of said building structure; and assembling a fourth number of said plurality of wall panels, a fifth number of said plurality of short panels, a sixth number of said plurality of trapezoidal panels, and a seventh number of said connector members into front and back walls of said building structure connected to said first and second opposite side walls.

5. The method of claim 4 further comprising the steps of: forming a polymer into a plurality of generally planar rectangular roof panels each characterized by edge dimensions of x by w, where w equals the quotient of x/cosine θ, each of the four edges of each of said wall panels having an integral tenon of said dovetail shape; forming a polymer into a plurality of roof connector members each characterized by an extrusion profile defining first, second and third mortises with 180–20 degrees between said first and second mortises and 90±0 degrees between said second and third mortises, said first, second and third mortises of said roof connector each dimensioned to receive a tenon of said dovetail shape; and assembling an eighth number of said plurality of roof panels, a ninth number of said connector members and a tenth number of said roof connector members into a roof connected to said first and second side walls and said front and back walls.

6. The method of claim 4 further comprising the steps of: forming a polymer into a plurality of generally planar floor panels each characterized by edge dimensions of x by y, each of the four edges of each of said floor panels having an integral tenon of said dovetail shape; and assembling an eighth number of said plurality of floor panels and a ninth number of said connector members into a floor connected to said first and second side walls and said front and back walls.

7. The method of claim 1 further comprising the steps of: forming a polymer into a plurality of frame members each characterized by having first and second tenons disposed along first and second transverse edges, a third tenon of said dovetail shape disposed along a first longitudinal edge, and interior trussing that defines a number of triangular regions; forming a polymer into a plurality of frame couplings each characterized by having four orthogonally disposed mortises each dimensioned to slideably receive in interlocking engagement said first and second tenons of one of said plurality of frame members; assembling said plurality of said frame members and said plurality of said frame couplings into a frame structure; connecting said frame structure to said building structure by slidingly interlocking said third tenon of one of said plurality of frame members into one of said four orthogonally-disposed mortises of said one of said plurality of frame members; and supporting said building structure by said frame structure.

8. The method of claim 7 further comprising the steps of: forming a polymer into a bracket arranged and designed to fit in one of said triangular regions; securing said bracket to said one of said triangular regions; and supporting a shelf on said bracket.

9. The method of claim 1 further comprising the steps of: forming said plurality of connection members by an extrusion process; and co-extruding a resilient weather-stripping seal on to one of said plurality of connection members.

10. A building structure comprising:

1. first, second, third and fourth generally planar panels each disposed vertically and characterized by top, bottom, left and right edges having dovetail tenons; and
2. first, second, third and fourth connector members each characterized by first and second mortises extending longitudinally on opposite sides along said connector member and dimensioned to slidingly interlock with one of said dovetail tenons, said right tenon of said first panel slidingly interlocked in said first mortise of said first connector member, said left tenon of said second panel slidingly interlocked in said second mortise of said second connector member, said top tenon of said third panel slidingly interlocked in said second mortise of said second connector member, said left tenon of said third panel slidingly interlocked in said first mortise of said second connector member, said left tenon of said third panel slidingly interlocked in said first mortise of said third connector member, said right tenon of said fourth panel slidingly interlocked in said second mortise of said third connector member, said top tenon of said fourth panel slidingly interlocked in said first mortise of said fourth connector member, and said bottom tenon of said first panel slidingly interlocked in said second mortise of said fourth connector member;

whereby said first, second, third and fourth panels and said first, second, third and fourth connector members form a wall surface of said building structure.

11. The building structure of claim 10 further comprising:

1. a fifth generally planar panel vertically disposed and characterized by top, bottom, left and right edges having dovetail tenons; and
2. a fifth connector member characterized by first and second mortises extending longitudinally on orthogonal sides along said fifth connector member and dimensioned to
slidingly interlock with one of said dovetail tenons, said left tenon of said first panel slidingly interlocked is said first mortise of said fifth connector member, said right tenon of said fifth panel slidingly interlocked in said second mortise of said fifth connector; whereby said first panel, said fifth panel and said fifth connector member form a corner of said building structure.

12. The building structure of claim 10 further comprising: a fifth generally planar panel disposed horizontally and characterized by first, second, third and fourth edges having dovetail tenons; and a fifth connector member characterized by first and second mortises extending longitudinally on orthogonal sides along said fifth connector member and dimensioned to slidingly interlock with one of said dovetail tenons, said bottom tenon of said fourth panel slidingly interlocked in said first mortise of said fifth connector member, said first tenon of said fifth panel slidingly interlocked in said second mortise of said fifth connector; whereby said fifth panel forms a floor surface of said building structure.

13. The building structure of claim 10 further comprising: a fifth generally planar panel disposed at an angle of 0 from a horizontal reference and characterized by first, second, third and fourth edges having dovetail tenons; and a fifth connector member characterized by first and second mortises with an angle of 90+0 degrees therebetween extending longitudinally along said fifth connector member, said top tenon of said first panel slidingly interlocked in said first mortise of said fifth connector member, said first tenon of said fifth panel slidingly interlocked in said second mortise of said fifth connector member; whereby said fifth panel forms a roof surface of said building structure.

14. The building structure of claim 10 wherein: said first panel has a trapezoidal shape characterized by said left edge being parallel to said right edge and said top edge disposed at an angle of 0 degrees from an imaginary line parallel to said bottom edge; and the building structure further comprises, a fifth generally planar panel disposed at said angle of 0 degrees from a horizontal reference and characterized by first, second, third and fourth edges having dovetail tenons, and a fifth connector member characterized by first and second mortises extending longitudinally on orthogonal sides along said fifth connector member and dimensioned to slidingly interlock with one of said dovetail tenons, said top tenon of said first panel slidingly interlocked in said first mortise of said fifth connector member, said first tenon of said fifth panel slidingly interlocked in said second mortise of said fifth connector member; whereby said fifth panel forms a roof surface and said first panel forms a portion of a gable of said building structure.

15. The building structure of claim 10 further comprising: a plastic frame member characterized by first and second dovetail tenons disposed along first and second transverse edges, a third dovetail tenon disposed along a longitudinal edge, and an interior trussing that defines a number of triangular regions; and a third mortise extending longitudinally along said first connector member orthogonally to said first and second mortises of said first connector member, said third mortise of said first connector member dimensioned to slidingly interlock with one of said dovetail tenons, said third tenon of said frame member slidingly interlocked in said third mortise of said first connector member; whereby said building structure id at least partially supported by said frame member.

16. The building structure of claim 15 further comprising: a bracket arranged and designed to fit in one of said triangular regions; and a shelf disposed on said bracket and supported thereby.

17. The building structure of claim 10 wherein: said first panel is made of a generally transparent polymer material.

18. The building structure of claim 10 wherein: said first panel is made of a polymer material; and said top, bottom, left and right edges of said first panel have dovetail tenons integrally formed with said first panel.