Title: MANUFACTURE OF LARGE SIGN BACKINGS

Abstract: A machine and method for removal of protective backing material (82) from large self-adhesive flexible laminates and attachment to a permanent backing for the manufacture of large signs, posters, packaging and the like. Also disclosed are laminated workpieces (80) used in this activity.
MANUFACTURE OF LARGE SIGN BACKINGS

FIELD AND BACKGROUND OF THE INVENTION

The present invention, in some embodiments thereof, relates to the removal of protective backing material from large self-adhesive flexible laminates to facilitate attachment to a permanent backing or other second layer and other processing. More particularly, but not exclusively, the invention relates to machinery and methods for the manufacture of large signs, posters, packaging and the like. In some embodiments, the invention also relates to laminated materials used in this activity.

GENERAL BACKGROUND:

Large signs, advertizing posters and other advertizing materials and the like, for example, 24 or more inches (61 cm) wide, and length which could be considerably greater, are often manufactured by printing the required image using any suitable and desired technology, on a flexible sticker, usually comprised of a first layer having a self-adhesive coating on a reverse side and a removable protective backing layer or liner for the adhesive surface. For such construction, the printed layer is then separated from the protective backing and is attached to a permanent backing or substrate formed of a suitable plastic material, cardboard, carton blanks, or even metal, wood or glass. The permanent backing can be relatively rigid or flexible.

Conventionally, separation of the layers is performed manually. The edge of the separated printed layer is then directed manually to the right place on the permanent backing and attached to it manually. Afterward, the materials are fed to a laminator that bonds the rest of the printed layer to the permanent backing. This process, involves several manual steps, and is consequently costly, slow and prone to human errors, especially in the case of large-format signs. Disposal of the protective backing after removal is also done manually, which itself is time consuming and inconvenient.

One alternative that has been proposed to the manual process involves use of a flatbed (FB) printer, which can print directly on a permanent substrate (thus avoiding the need for bonding), but typically, additional finishing actions must still be performed (e.g., further lamination and cutting), after printing. Therefore, the printed workpiece
must still be transferred to additional work stations. Moreover, the faster the FB printer, a bigger blockage is created in the following stations. Generally speaking, FB printing is viewed in the trade as relatively very expensive and inefficient in terms of cost-performance.

The following prior art in this field generally is also known:

1. WO9853987: METHOD AND DEVICE FOR APPLYING A PATTERN ONTO A SUPPORT MEANS
2. NL1003698C: Pressing device for adhering foil laminate to carrier surface
3. JP2005041173: EQUIPMENT FOR STICKING SIGN SHEET
4. WQ9324325: METHOD OF COLD LAMINATING PERMANENT PLASTICS AND STATIONERY AND APPARATUS THEREFOR
5. US4491492: Methods of and apparatus for applying a sheet to a permanent backing
6. JP2007062321: LAMINATED FILM PASTING DEVICE
7. US5279699: Sticking apparatus
8. DE19641094: Stamping self-adhesive labels from plastic strip
9. US3399100: APPARATUS FOR THE APPLICATION OF A SELF-ADHERING BAND TO A SURFACE
    US4946539: Apparatus for applying contoured elastic to a substrate

Further automation of conventional practice as described would be advantageous.

SUMMARY OF THE INVENTION

According to an aspect of some embodiments of the invention, there is provided a workpiece having an adhesive coated first layer, a second layer providing a protective backing for the adhesive coating, and a delamination element formed from one of the layers and detached from the rest of the layer to facilitate machine-separation of the two layers.

According to an aspect of some embodiments of the invention, there is provided a composite structure comprising a plurality of workpieces as described above. Such a composite structure may be in the form of a roll, or in the form of a single sheet.
According to an aspect of some embodiments of the invention, a workpiece as described above includes machine-readable information providing operating instructions for controlling a machine adapted to process the workpiece. Optionally, information can also be provided in operator usable form for partial or complete manual machine control or other purposes such as online/internet, flash or combinations of these.

According to an aspect of some embodiments of the invention, a workpiece is provided wherein the delamination element as described is formed from the first layer, or optionally from the second layer.

According to an aspect of some embodiments of the invention, the delamination element is a strip formed by a cut extending through the one layer of the workpiece transversely of a direction of flow through a processing machine. According to an aspect of some embodiments of the invention, the cut extends the entire transverse width of the one layer.

According to an aspect of some embodiments of the invention, the cut is confined solely to the one layer, with the other layer remaining intact.

According to an aspect of some embodiments of the invention, there is provided a machine for processing a workpiece comprising a first adhesive coated layer, a second layer providing a protective backing for the adhesive coating, and a delamination element formed from one of the layers and separated from the rest of the one layer, wherein the machine includes a first station operative to initiate separation of the first and second layers by application of opposing forces to the layers.

According to an aspect of some embodiments of the invention, the operation of the machine is partially or completely controlled by machine-readable information on the workpiece.

According to an aspect of some embodiments of the invention, wherein the workpiece contains information for controlling the machine, the machine includes a station at which operator-interpretalble information is provided for manual control of some or all aspects of machine operation or other purposes.

According to an aspect of some embodiments of the invention, the machine further includes one or more additional stations for further processing of the workpiece including one or more of collecting the protective backing layer for disposal, aligning
the adhesive-coated layer for attachment to a permanent backing, initiating attachment of the adhesive-coated layer to the permanent backing, bonding the entire adhesive-coated layer to the permanent backing, and trimming the adhesive-coated layer to final desired dimensions.

According to an aspect of some embodiments of the invention, a machine is provided wherein the first station as described above includes first and second separating elements respectively engaging the first and second layers of the workpiece, each of the first and second separating elements including respective retaining arrangements for temporarily securing the first and second layer thereto, each of the first and second separating elements being operative while secured to the layers to move in opposite directions.

Optionally, the separating elements are operative simultaneously or in sequence.

According to an aspect of some embodiments of the invention, a machine is provided wherein the retaining arrangements as described are vacuum sources for applying negative pressure to the respective layers along a line of contact therewith. Optionally, adjustment of the length of the line of contact is done automatically or manually to accommodate workpieces of different sizes.

According to an aspect of some embodiments of the invention, each of the vacuum sources as described are formed by a plurality of vacuum outlets, each of which can be activated and deactivated manually or automatically to accommodate workpieces of different sizes.

According to an aspect of some embodiments of the invention, a machine is provided in which the first and second separating elements are formed by rollers movable toward and away from each other to engage opposite sides of the workpiece, the rollers being rotatable in opposite directions to initiate separation of the layers. Optionally, only one of the two rollers moves toward the other roller.

According to an aspect of some embodiments of the invention, one of the separating elements as described is further operative to transport the adhesive coated layer to a stamping station of the machine at which initial bonding of the adhesive layer to a permanent backing is performed.

According to an aspect of some embodiments of the invention, there is provided an arrangement operable to project out from one or both separation rollers to apply
pressure to the workpiece upstream of a line of separation until after the separation is initiated.

According to an aspect of some embodiments of the invention, a machine is provided which includes a second bonding element that continues the bonding of the adhesive coated layer to the permanent backing.

In some embodiments of the invention, a force applied during initial bonding is greater than a force applied during the continued bonding.

According to an aspect of some embodiments of the invention, there is provided a machine including a station operative to form the delamination element as described above.

According to an aspect of some embodiments of the invention, there is provided a method of forming a laminated structure, the method including forming a workpiece having a first adhesive coated layer, and a second layer providing protective backing for the adhesive coated layer, forming a delamination element from one of the layers, the delamination element being separated from the one layer, initiating separation of the first and second layers by application of opposing separating forces to the layers; and bonding the adhesive coated layer to a third permanent backing layer.

In some embodiments of the invention, the delamination element is formed by cutting through one of the layers in a direction transverse to a direction in which the workpiece will travel for further processing. Optionally, the delamination element is formed by cutting the adhesive-coated layer or the backing layer of the workpiece. Optionally, the cut is made across the entire transverse width of the workpiece.

According to an aspect of some embodiments of the invention, the method includes performing one or more of the following further operations on the workpiece: collecting the protective backing layer for disposal, aligning the adhesive-coated layer with the permanent backing for attachment thereto, applying additional lamination layers, trimming the adhesive-coated layer to final desired dimensions, and trimming the permanent backing after bonding to final desired dimensions. Optionally, these can be performed in various different orders.

According to an aspect of some embodiments of the invention, the adhesive coated layer is bonded to the permanent backing layer by applying a first force to the
adhesive coated layer to initiate bonding and applying a second force to the adhesive coated layer to complete the bonding.

Optionally, according to an aspect of some embodiments of the invention the initial bonding is performed by moving the permanent backing into contact with the adhesive layer.

Optionally, according to an aspect of some embodiments of the invention, the first force as described is greater than the second force.

According to an aspect of some embodiments of the invention, the delamination element is retained with the adhesive layer or the protective backing layer after separation of the two layers.

According to an aspect of some embodiments of the invention, at least one of the separating forces has a component in a direction other than perpendicular to the surfaces of the layers.

According to an aspect of some embodiments of the invention, the separation forces are applied by rolling the two layers in opposite directions.

Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.
In the drawings:

FIG. 1 is a schematic illustration of a workpiece according to an aspect of some embodiments of the invention;

FIG. 2 is a hybrid flow chart showing a method according to an aspect of some embodiments of the invention and mechanical implementation thereof;

FIG. 3 is a schematic illustration of part of the separation of a protective backing layer from an adhesive-coated layer of a workpiece according to an aspect of some embodiments of the invention.

FIG. 4 shows further features of the separation process implemented according to Fig. 3;

FIG. 5 is a schematic illustration of an implementation of the initial bonding of the adhesive-backed layer of the workpiece to a permanent backing according to an aspect of some embodiments of the invention;

FIG. 6 shows further features of the bonding process implemented according to Fig. 5;

FIG. 7 shows completion of the bonding process implemented according to Figs. 5 and 6; and

FIG. 8, 9, 10, 11 and 12 are several views of a mechanical implementation of a machine according to some embodiments of the invention.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The present invention, in some embodiments thereof, relates to the removal of protective backing material from large self-adhesive flexible laminates to facilitate attachment to a permanent backing or other second layer. More particularly, but not exclusively, the invention relates to machinery and methods for the manufacture of large signs, posters and the like. In some embodiments, the invention also relates to workpieces used in this activity.

According to an aspect of some embodiments of the invention, for a flexible workpiece formed of a first layer bearing an adhesive coated surface, and a protective backing for the adhesive coating, machine-separation of the two layers is facilitated by forming a delamination element as part of one layer, but detached, from the rest of the
layer. As used herein, the term "detached" does not exclude the delamination element being adjacent to or in edge-to-edge contact the layer from which it is formed, but rather that it is mechanically separated from the rest of the layer. According to an aspect of some embodiments of the invention, the workpiece may be in the form of individual sheets, or on a sheet or roll containing a plurality of workpieces.

According to an aspect of some embodiments of the invention, machine-readable information may optionally be printed on the workpiece to provide operating instructions for controlling a machine for example, for processing the workpiece. Optionally, the operating instructions may also be provided in operator-readable form for partial or complete control of the machine by an operator.

According to an aspect of some embodiments of the invention, the delamination element is in the form of a strip cut through the entire one layer extending transversely to a flow direction of the workpiece through a processing machine. According to an aspect of some embodiments of the invention, the other layer remains intact. Optionally, the strip can be formed only partway across the layer.

Optionally, the delamination element can be a tab cut off from a corner of one of the layers.

According to an aspect of some embodiments of the invention, the delamination element may optionally be formed from the first or the second layer of the workpiece.

According to an aspect of some embodiments of the invention, a protective layer is separated from a flexible workpiece including an adhesive coated layer and a delamination element formed from one layer by a method involving application of opposing forces to the two layers.

As used herein, the term "opposing" is intended to mean "not in the same direction" and is not intended to refer to forces applied in opposite directions along a single line of action. It can, by way of non-limiting examples, include initiating separation by rolling the two layers in opposite directions, while maintaining a delamination strip in contact with either the adhesive layer or the protective backing layer, or pulling two corners apart while maintaining a corner tab in contact with the backing layer, followed in either case by continuing to pull the layers apart.

According to an aspect of some embodiments of the invention, the separation is performed by a machine.
According to an aspect of some embodiments of the invention, the machine is optionally controlled by machine-readable information on the workpiece.

Optionally, according to an aspect of some embodiments of the invention, the machine which performs the separation also performs one or more additional operations such as transportation of the separated layers to locations for further processing, collecting the protective backing layer for disposal, aligning the adhesive-coated layer with a permanent backing for attachment thereto, attaching the adhesive-coated layer to the permanent backing, and trimming the adhesive-coated layer and/or the permanent backing to final desired dimensions.

According to an aspect of some embodiments of the invention, transportation of the separated layers is provided at least in part by one or more rollers which also initiate separation of the layers.

According to an aspect of some embodiments of the invention, separation of the layers is initiated by applying separating forces to the layers, at least one of the forces being applied at an angle other than perpendicular to the surface of the workpiece. Optionally, separating forces are applied by rollers through which holding forces are also applied to the layers. Optionally, the holding forces are applied by a vacuum source. Optionally, the vacuum source is applied through a plurality of vacuum outlets, each of which can be activated and deactivated to accommodate workpieces of different sizes.

Optionally, according to an aspect of some embodiments of the invention, the separation is initiated by rollers turning in opposite directions, and separation is continued by transporting the adhesive coated layer through the machine in a first direction for further processing and transporting the protective layer in a different direction for disposal.

Optionally, an additional mechanism may be provided to apply pressure to the workpiece upstream of the line of separation to help assure reliable separation. A suitable mechanism for this purpose may be comprised of a bar that moves radially out and in from the surface of one or both rollers and effectively squeezes the workpiece portion. After the separation begins, the bar retracts so that the roller surface is again uninterrupted.
Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The invention is capable of other embodiments or of being practiced or carried out in various ways.

Referring first to Fig. 1, there is shown a schematic illustration of a workpiece from which the sign or other item will be formed, generally denoted at 80. Workpiece 80 is shown in the form of a sticker having an adhesive coated first layer 86 and a protective backing layer 82 (sometimes referred to in the trade as a "silicone" or a "liner"). After processing, layer 86 will be attached to a permanent backing as described below. First layer 86 includes a side 86a on which an image will be printed, and an opposite adhesive coated side. Workpiece 80 is formed in a conventional manner using any suitable and desired materials, according to the required application.

To facilitate machine separation of layers 82 and 86 so that layer 86 can be attached to its permanent backing, a delaminating portion is formed in one of the layers. In an exemplary embodiment of the invention, delamination element 88 is a strip formed by laterally cutting fully across layer 86 parallel to and close to the leading edge 90. Optionally, delamination element 88 may be formed as a strip formed by laterally cutting fully across layer 82 parallel to and close to the leading edge 90. Optionally, delamination element 88 may be formed as a corner cut from layer 82 or 86 instead.

For illustrative purposes, delamination element 88 will be illustrated and described as formed from adhesive-coated layer 86 in the drawings.

As described below, delamination element 88 and the leading end of the other layer are held by vacuum and/or other mechanical forces while the separation is initiated.

One exemplary way to apply an additional mechanical force is a bar that moves radially out and in from the surface of one or both rollers and applies pressure to squeeze the portion of the workpiece just upstream of the line of separation to help assure reliable separation. After the separation begins, the bar retracts so that the roller surface is again uninterrupted.
The exact width of strip 88 in the direction of travel through the machine should be sufficient to assure that it is held firmly without slippage while separation is being initiated, but without wastage of excessive material. However, the strip should be wide enough to provide for alignment of the printed layer with the backing to which it will be attached to compensate for upstream registration or cutting errors. Strips 10 to 25 mm wide are found to give satisfactory results.

Further, it is found that reliable separation is facilitated if the layer (here 82) which does not contain delamination element 88 is not damaged by the formation of delamination element 88. This can be achieved by careful control of the depth of the cut to assure that the one layer is cut through completely and the other layer is not damaged. Optionally the depth can be adjustable automatically or manually to accommodate stickers of different thickness.

The cut by which delaminating portion 88 is formed may be performed by any technology such as a knife, laser saw or other suitable instrument, or by stroke on sharp corner laid on the workpiece (or vice-versa) along its width in the cutting place.

As shown in the illustrated embodiment, delamination element 88 may be formed by the same machine which performs the separation of the two layers, attachment to the permanent backing and final trimming. Alternatively, however, it may also be formed off line, e.g., at the time workpiece 80 is prepared, i.e., before printing, or after printing but before delivery for processing according to the invention.

Optionally, also, in the case of multiple images to be printed on a sheet or roll, the delamination element may be formed by longitudinal spacing of sections of the adhesive coated layer material along the protective backing, or in the case of sheets which will bear only a single printed image, by marginal spacing from the leading edge of the backing sheet. Description herein of the delamination element as formed from one of the layers is intended to include such formation by sizing. This, as well as pre-processing removal of the strip or tab may be advantageous in some instances, as it avoids the need for disposal of some scrap material on line.

Fig. 2 is a flow chart representative of machinery and methods according to some embodiments of the invention. The flow chart is a hybrid, illustrating various aspects of the method of the invention, and the operation of various stations of machinery for performing the method. Some aspects are optional, as discussed below.
As will be appreciated from the foregoing description, the method in full detail can involve separation of a self-adhesive layer from a protective backing layer of a flexible workpiece 80 as described above, then application of the self-adhesive layer to a permanent backing. Thus, the flow chart, generally labeled 100, involves a flexible route 102 for the printed workpiece and a permanent route 104 for the permanent backing. The two routes merge at an appropriate point to form the final product.

On flexible route 102, workpiece 80 as described above (see Fig. 1), but prior to formation of delaminating portion 88, may either be in the form of separate sheets or on a roll, as noted above. In either case, it is transferred from a source 106, and is loaded by a suitable feeder such as a roll cradle 108 or a sheet feeder 110. Optionally, manual sheet feeding and/or both mechanical sheet feeding and roll feeding may be provided.

In an exemplary embodiment of the invention, sheet or roll workpieces can be aligned to the desired zero line manually, or can be properly positioned automatically during feeding.

Automatic control of processing, including automatic alignment, is optionally facilitated by control information on the workpiece. A sensing station 114, shown located upstream of the feeding rolls 112, but optionally located downstream of the feeding rolls, receives and reads the control information or general job related information. Sensing station 114 optionally includes the capability for reading one or more kinds of machine-readable information: for example, registration marks and text or bar code. Such information can be applied to the workpiece by the image-printing machine or optionally by a separate printer.

As should be appreciated, printing of the image and the control information can optionally be done online by a printer integrated with the rest of the processing machine described herein, or as a separate off line preliminary operation. Information can be supplied also by a separate memory device or on line from the printer.

Registration marks are detected by an optical sensor, a video camera, optionally, a 1D or 2D array or other suitable sensor. For example, image location on the sheet can be identified by registration marks such as crosses. From these crosses, the leading edge of the printed image is detected in the flow direction and transverse to the flow direction. Optionally or alternatively, the width of the sticker may be detected or measured at any desired and convenient location, and as the sticker moves along, the image end can be
detected, so its length can be known in advance of further processing. The length and width information may be used, for example, for cutting to final size at the end of the image, or to annotate when the permanent backing does not match the dimensions of the workpiece to which it is to be bonded.

Text or barcode information can be detected by a bar code reader (not shown) or by artificial vision or optical or mechanical sensor. In this way, data can be collected related to the job fed to the machine including, for example, image dimensions, location of the image on the roll or sheet, etc. Information can also be obtained concerning the targeted permanent backing to verify fit and alarm the operator or the machine of impending faults before bonding. Other information can also be provided such as whether subsequent lamination is required, and if so, to what, cutting directions, next job set up information, etc.

Although the control information will normally be in machine-readable form, it may optionally be translated into operator readable form, allowing an operator to provide complete or partial manual control.

Additionally, online job workflow progress information can be provided to a central management computer system (not shown), either for real time use or later analysis. In this regard, numerous implementations of workflow management systems are possible, and detailed discussion is omitted in the interest of brevity.

Following the initial processing described above, the workpiece passes to a cutting station 116. In the illustrated embodiment, two types of cutting are provided for, namely partial and full cutting. Partial cutting creates strip forming the delamination element. Only one of the two layers is cut; the other layer remains essentially intact without damage. The cut may be performed in the protective backing layer or in the adhesive layer. Whichever layer is cut, it may be cut fully through and across its entire width, i.e., transverse to the flow direction. Optionally the cut may extend only partway across the workpiece.

As should be appreciated, formation of the delamination element can be performed off line, i.e., on a different machine before the processing depicted in the flow diagram of Fig. 2.

Full cutting involves cutting of both layers, and is optionally performed during a single machine stroke, for example, using a second blade that can be upstream from the
blade which performs the partial cut or downstream of the partial cutting blade. Optionally, the two cuts may be performed during separate machine strokes. Performing the full cutting downstream would be for final sizing. Performing the full cut upstream of the partial cut could be to line up the workpiece when the edge is not completely straight due to upstream inaccuracy, for example when the stickers are cut by hand and the edge is crooked, and to separate successive workpieces when fed from a roll having multiple images across its width or individual sheets bearing multiple images.

As should be appreciated, a sheet and roll will be completely parallel at this location in the machine, so the processing will be the same. Therefore, if the clearance between the workpieces on the roll or a sheet is proper, then only a single full cutting may be needed to finish one job and to start the next one. Likewise, for a sheet, if the margins are properly sized, then only one full cutting between two images may be needed. Otherwise, full cutting may be necessary at the start of the job, or at its end, or at both.

Both types of cutting may be performed at station 116 and also simultaneously. This can in most cases save time and avoid the need for a separate conveying system, thus, saving floor space or machine volume and reducing cost.

Turning now to the permanent route 104, the permanent backing, for example, sheets of cardbacking, plastic, carton blanks, wood, etc., is provided from a supply 118. These are fed either manually or optionally, by a permanent backing feeder 120 to engage a sensing station 122 at which dimensional or other desired information concerning the individual backing sheets is gathered. This may be used in addition to information obtained at sensing station 114 on flexible route 102 to control transfer by suitable feed rollers 124 downstream for further processing. Optionally, station 122 may be downstream from station 124.

As illustrated, the two routes merge at this stage for attachment of the separated adhesive layer to the permanent backing layer.

The remaining aspects of the illustrated embodiment and the implementation thereof represented by separation station 126, first stamping station 128, and pressing/exit station 130 in Fig. 2 are discussed individually in more detail below, but are briefly described here to provide introductory perspective.
Referring to Figs. 1 and 2, at separation station 126, separation of protective backing 82 from adhesive layer 86 is initiated. This is performed by two rollers 132 and 134 (see Fig. 3), which respectively attach to the adhesive coated layer 86 downstream of the new edge created by formation of delamination element 88 and to protective layer 82, at least in part, directly over delamination element 88. A vacuum force as described below provided by respective sets of vacuum outlets 138 and 136 holds the layer 86 to roller 132 and layer 82 to roller 134. In the illustrated embodiment, separation is performed by rotating the two rollers 132 and 134 in opposite directions (i.e., roller 132 clockwise and roller 134 counterclockwise, or vice versa to peel the two layers apart. The delamination element 88 remains attached to protective backing layer 82 by its adhesive coating. Optionally, if delamination element 88 is cut from layer 82, it is still attached to layer 86 by the adhesive coating and/or it may temporarily be held with the remainder of backing 82 by the vacuum force until it clears the separation area. At that point, any suitable means for disposal may optionally be provided.

As the separation proceeds, roller 132 carries the leading edge of adhesive layer 86 to the location of initial attachment to the permanent backing, and roller 134, together with a second feed roller 152 (See Figs. 4-7) carries layer 82 with delaminating portion 88 still attached to a disposal location 146. Optionally, if delaminating 88 is done on layer 82 it is attached to layer 86.

At first stamping station 128 the leading edge of the adhesive layer 86 is brought into contact with a permanent backing layer 140. This is accomplished by separation roller 132 which transports the leading edge of layer 86, and at the same time, continuing the separation of the two layers. Backing 140 is transported to stamping location for example, by opposed sets of rollers 143a, b, and 145a, b. At this point, optionally, a backing roller 147 raises backing 140 into contact with adhesive layer 86.

High pressure between roller 132 and backing roller 147 (see Figs. 5-7) at the area of contact 142 stamps the two layers together to assure a solid bond of the leading edge of layer 86 to backing layer 140. Then, a squeegee 144 (see Fig. 6) drops to layer 86 in its stamped location and presses the sheet to backing 140 as it and layer 86 advance together, driven by backing roller 147 and rollers 143a, and b, and 145a, and b.
Press/exit station 130 includes a set of advance rollers 148 and 150 as described below downstream of the squeegee. Rollers 148 and 150 also apply high pressure to the composite of layers 86 and 140 to help assure permanent bonding.

Figs. 3 and 4 illustrate further details of the operation of separation station 126. Separation rollers 132 and 134 which engage with layers 86 and 82 respectively of workpiece 80, are constructed to move toward and away from each other, and to rotate to either direction as directed by a master controller (not shown). Optionally, the illustrated construction enables fully cut flexible material to be dropped between the rollers.

Rollers 132 and 134 include respective temporary attachment mechanisms 136 and 138 running the entire length of the rollers at coordinated circumferential locations to provide temporary attachment to respective layers 82 and 86 of workpiece 80. This allows the workpiece to be held while the layers are separated and transported for further processing. The locations of temporary attachment mechanisms 136 and 138 are selected to permit attachment to layers 86 and 82 at the desired locations, as described below.

Temporary attachment mechanisms 136 and 138 may be constructed in various ways. One suitable way is to provide a vacuum source feeding respective lines of nipples on the surfaces of rollers 132 and 134. This is advantageous in that it allows the machine easily to be adjusted to accommodate workpieces of different widths. For example, if the full machine width allows working with a 160 cm wide workpiece, to accommodate a workpiece only 100 cm wide, the required number of vacuum nipples are activated or deactivated to provide the desired length. This can be done automatically according to information sent from sensing station 114 (see Fig. 2) or optionally, by a mechanism installed in the nipples or manually at the beginning of a run, or when a printed roll has been consumed and a new printed roll is mounted on the machine.

Another option is to configure the nipples to close when not engaged with part of the workpiece. This can be done, for example, by a mechanism within the vacuum nipples including an air-flow sensor that responds to an increased air flow resulting from the absence of a portion of the workpiece operate a valve mechanism that closes any exposed nipples.
The diameter of the nipples is not critical but do not need to be greater than the width of the delamination element when formed as a strip. Diameters in the range of 15 mm are found to give satisfactory results.

Other suitable attachment mechanisms include application of a temporary adhesive to the rolls, or leading edge pliers/graspers.

As further illustrated in Fig. 3, by proper positioning of attachment mechanisms 136 and 138 on rollers 132 and 134, roller 132 engages layer 86 just downstream of delaminating portion 88, and roller 134 engages layer 82, at least in part, behind delaminating portion 88 to facilitate initiation of separation of the layers, partially or substantially covering it. Optionally, the area of attachment to layer 82 may extend beyond delaminating portion 88.

Referring to Fig. 4, with rollers 132 and 134 temporarily attached to layers 86 and 82 of workpiece 80 along the entire sheet width as shown in and explained in connection with Fig. 3, the two rollers turn on their axes in opposite directions to begin peeling the layers apart. According to some embodiments of the invention, rollers 132 and 134 rotate about one half of a revolution and then stop in a position that will properly position workpiece 80 roll 132 to engage with and attach to permanent backing layer 140 when it is raised by backing roller 147, as described below.

With separation initiated, roller 132 carries adhesive layer 86 to first stamping station 128 as described above while rollers 134 and 152 transport backing layer 82 and delamination element 88 for disposal. Workpiece 80 is still being fed by feeding rolls 112, and the linear movement of roller 132 away from the point of initial separation continues the separation process.

Turning now to Figs. 5, and 6, with printed layer 86 having been transported to the required location at first stamping location 142 by roller 132, bonding of layer 86 to a permanent backing 140 is initiated by roller 147 raising backing 140 into contact with adhesive layer 86. Backing backing 140 is fed downstream in advance to location 142 by rollers 143a,b and 145a,b to bring backing 140 to an accurate point of contact with adhesive coated layer 86 in order to locate the image in any desired location on the permanent backing. Rollers which hold and advance permanent backing 140 may also be configured to accommodate permanent backings of different thicknesses.
The stamping is performed by the firm pressure applied between separation roller 132 against roller 147. Alternatively, instead of roller 147 lifting the permanent backing to meet adhesive layer 86, the initial bonding can be effected by downward movement of roller 132 toward roller 147, or by motion of both rollers 132 and 147. Further optionally, roller 132 can be operated to allow initial contact of layer 86 with backing 140 at a reduced pressure before the full stamping pressure is applied through interaction with roller 147, whereby the full stamping pressure is applied slightly beyond the leading edge of layer 86.

After the first stamping, the vacuum force holding layer 86 on roller 132 may optionally be turned off, and roller 132 returns to the separating position for receiving the next workpiece as the separation process of the current workpiece continues. Optionally, the vacuum force may be left on since that force can be made less than the holding force of the adhesive on backing 140.

The composite of permanent backing 140, with the leading edge of adhesive layer 86 now bonded at stamping location 142, continues to move perpendicularly to the direction of movement of rollers 132 and 147 toward an exit station as described below and pulls the attached adhesive layer 86 with it. This movement continues the separation while protective backing layer 82 is being pulled to the other direction.

Referring to Fig. 6, immediately after the first stamping and as the backing moves forward, a squeegee 144 moves down, and presses layer 86 onto backing 140 as the two layers continue to advance. According to some embodiments of the invention, pressure of squeegee 144 may be maintained over the entire length of layer 86 after it has been cut at or near the end of the image being bonded at this stage. The action of squeegee 144 helps assure wrinkle and bubbles-free smooth attachment of layer 86 to the backing 140 as the two continue to advance.

The contact surface of squeegee 144 is optionally made of sponge or felt, or other "soft" material and therefore the pressing action is relatively "soft". This helps avoid a line or other pressure mark along a stop line if downstream movement must be stopped temporarily for example to permit cutting the layer 86 at the end of the image or for any other purpose. It also can help to ensure smooth stamping without bubbles and wrinkles. Optionally, squeegee 144 may be permitted to have some side play...
(transverse to the path of motion of backing 140 and attached layer 86) further to help prevent bubbles and creases.

As previously noted, while backing 140 and attached layer 86 continue to advance toward exit station 130, rollers 134 and 152 guide backing layer 82 to a suitable disposal device 146. By way of example, this may be a mechanism that rolls the backing layer onto a disposal roller or a mechanism that slits the backing layer into strips, either in the flow direction or transversely of the flow direction. Such cutting may be performed immediately beyond roller 152 if desired.

Referring to Fig. 7, exit station 130 is comprised of a pair of rollers 148 and 150 located downstream of squeegee 140. Rollers 148 and 150 serve to advance permanent backing layer 140 toward exit from the machine, and also apply a high pressure to layer 86 after the "soft press" of squeegee 140 to help assure reliable permanent bonding.

According to some embodiments of the invention, the technology described in connection with Figs. 1-7 above can be applied to a variation of the final product in which a protective adhesive coated transparent layer is applied to the printed side of sticker 86. In such a case, the protective transparent layer itself includes a temporary protective backing for its adhesive coating. The delamination element is formed, the transparent layer and its backing are separated, and the transparent layer is laminated to the printed surface, as described above.

According to some embodiments of the invention, a final three-layer composite of a printed layer, a protective overlay and a permanent backing, may be formed by attaching the printed layer with its protective overlay to the permanent backing on a second pass through the machine a second time for attachment to the permanent backing. Optionally, the additional lamination can be performed in line at an additional lamination station, in which case, re-run through the machine is not needed.

As a variation of the above protective layer processing, according to some embodiments of the invention, the printed layer can first be laminated to the permanent backing, and the protective layer applied in a further laminating step, either in line by another like machine, or by re-run through the same machine.

Figs. 8-12 illustrate a fully engineered implementation of a machine generally denoted 200 which may be used in certain embodiments of the invention described in connection with Figs. 1-7 above, or to attach a protective layer to the printed image
before attachment of the printed layer to a permanent backing. The actual implementation of a machine for the embodiments of the invention described in connection with Figs. 1-7 such as shown in Figs. 8-12 is largely an application of sound engineering practices, and it will be appreciated that numerous such implementations are possible within the scope of the invention. A detailed description of the illustrated embodiment is therefore omitted in the interest of brevity.

For correlation with the description of the core processes, however, it may be noted that a roll 202 which may carry a transparent front layer or a printed adhesive backed printed layer is fed from a roll cradle 108 and a permanent layer such as a permanent backing is fed at 204. A laminated composite item (e.g., printed layer and permanent backing exits at 206. Formation of the delamination element 88 and full cutting (if performed by a second pass through the machine) take place at cutting station 116. In this particular implementation, the cutting is in layer 82, rather than layer 86 as shown in Fig. 1.

Separation station is shown at 126, including separation rolls 132 and 134. Stamping station is shown at 142 including support roller 147 and squeegee 144 and the laminated composite is driven toward exit point 206 and the final bonding pressure is applied by exit rolls 148 and 150. Movement of permanent backing layer 140 with the printed layer attached toward exit station 206 continues the separation process initiated at separation station 126.

Separated backing layer 82 is transported to a disposal location by means of rollers 134 and 152.

The following should also be noted.

The terms "comprises", "comprising", "includes", "including", "having" and their conjugates mean "including but not limited to". This term encompasses the terms "consisting of" and "consisting essentially of".

As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise. For example, the term "a compound" or "at least one compound" may include a plurality of compounds, including mixtures thereof.

The word "exemplary" is used herein to mean "serving as an example, instance or illustration". Any embodiment described as "exemplary" is not necessarily to be
construed as preferred or advantageous over other embodiments and/or to exclude the incorporation of features from other embodiments.

The word "optionally" is used herein to mean "is provided in some embodiments and not provided in other embodiments". Any particular embodiment of the invention may include a plurality of "optional" features unless such features conflict.

Throughout this application, various embodiments of this invention may be presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Whenever a numerical range is indicated herein, it is meant to include any cited numeral (fractional or integral) within the indicated range. The phrases "ranging/ranges between" a first indicate number and a second indicate number and "ranging/ranges from" a first indicate number "to" a second indicate number are used herein interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals therebetween.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all
such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention. To the extent that section headings are used, they should not be construed as necessarily limiting.
WHAT IS CLAIMED IS:

1. A workpiece comprising:
   an adhesive-coated first layer;
   a second layer providing a protective backing for the adhesive coating; and
   a delamination element formed from one of the layers and detached from the rest
   of the one layer to facilitate machine-separation of the two layers.

2. A composite structure comprising a plurality of workpieces each according to
   claim 1.

3. A composite structure according to claim 2 in the form of a roll.

4. A composite structure according to claim 2 in the form of a single sheet.

5. A workpiece according to claim 1 further including machine-readable
   information providing operating instructions for controlling a machine adapted to
   process the workpiece.

6. A workpiece according to claim 1 wherein the delamination element is
   formed from the first layer.

7. A workpiece according to claim 1 wherein the delamination element is
   formed from the second layer.

8. A workpiece according to claim 1 wherein the delamination element is a strip
   formed by a cut extending through the one layer of the workpiece transversely of a
   direction of flow through a processing machine.

9. A workpiece according to claim 8 wherein the cut extends the entire
   transverse width of the one layer.
10. A workpiece according to claim 8 wherein the cut is confined solely to the one layer, with the other layer remaining intact.

11. A machine for processing a workpiece comprising a first adhesive coated layer, a second layer providing protective backing for the adhesive coating, and a delamination element formed from one of the layers and separated from the rest of the one layer, the machine comprising:
   a first station operative to initiate separation of the first and second layers by application of opposing forces to the layers.

12. A machine according to claim 11 wherein the operation of the machine is controlled by machine-readable information on the workpiece.

13. A machine according to claim 11 wherein the workpiece contains information thereon for controlling the machine, and wherein the machine includes a station at which operator-interpretable information is provided for manual control of the machine.

14. A machine according to claim 11 further including one or more additional stations for further processing of the workpiece including one or more of:
   a) collecting the protective backing layer for disposal;
   b) trimming the adhesive-coated layer to final desired dimensions;
   c) aligning the adhesive-coated layer with a permanent backing for attachment thereto;
   d) initiating attachment of the adhesive-coated layer to the permanent backing;
   e) bonding the entire adhesive-coated layer to the permanent backing; and
   f) trimming the permanent backing after bonding to final desired dimensions.

15. A machine according to claim 11 further including a station operative to form the delamination element of the workpiece.
16. A machine according to claim 11 wherein the first station comprises:

first and second separating elements respectively engaging the first and second layers of the workpiece, each of the first and second separating elements including respective retaining arrangements for temporarily securing the first and second layer thereto,

each of the first and second separating elements being operative while secured to the layers to move in different directions, to initiate separation of the first and second layers.

17. A machine according to claim 16, wherein said separating elements are operative simultaneously or in sequence.

18. A machine according to claim 16, wherein the retaining arrangements each comprises a vacuum source for applying negative pressure to the respective layer along a line of contact therewith.

19. A machine according to claim 18, wherein the length of the line of contact is adjustable automatically or manually to accommodate workpieces of different sizes.

20. A machine according to claim 18, wherein the vacuum source comprises a plurality of vacuum outlets, at least some of which are operable automatically or manually for activation and deactivation to accommodate workpieces of different sizes.

21. A machine according to claim 16, wherein the first and second separating elements comprise rollers movable toward and away from each other to engage opposite sides of the workpiece, the rollers being rotatable in opposite directions to initiate separation of the layers.

22. A machine according to claim 16, wherein one of the separating elements is further operative to transport the adhesive coated layer to a stamping station
of the machine at which initial bonding of the adhesive layer to a permanent backing is performed.

23. A machine according to claim 22, wherein the initial bonding is performed by moving the permanent backing into contact with the adhesive layer.

24. A machine according to claim 21, further including an arrangement operable to project out from one or both separation rollers to apply pressure to the workpiece upstream of a line of separation until after the separation is initiated.

25. A machine according to claim 24, including a second bonding element which continues the bonding of the adhesive coated layer to the permanent backing.

26. A machine according to claim 25, wherein a force applied during initial bonding is greater than a force applied during the continued bonding.

27. A machine according to claim 24, further including an arrangement for applying an additional force to assure complete bonding as the adhesive layer and the attached permanent backing approach an exit end of the machine.

28. A method of forming a laminated structure, the method comprising:
   forming a workpiece having a first adhesive coated layer, and a second layer providing protective backing for the adhesive coated layer;
   forming a delamination element from one of the layers, the delamination element being detached from the one layer;
   initiating separation of the first and second layers by application of opposing separating forces to the delamination element and to the leading end of the second layer; and
   bonding the adhesive coated layer to a third layer.
29. A method according to claim 28, wherein the third layer contains printing on one side and the adhesive coated layer forms a protective coating for the printing on the third layer.

30. A method according to claim 28, further including attaching the first and third layers to a fourth layer which forms a relatively permanent backing thereby forming a three-layer composite comprised of a printed layer, a protective layer and the backing layer.

31. A method according to claim 29, wherein the first and third layers are attached together, and the fourth layer is thereafter attached to the third layer.

32. A method according to claim 29, wherein the third and fourth layers are attached together and the first layer is thereafter attached to the third layer.

33. A method according to claim 28, wherein the first layer contains printing on one side and the third layer is a relatively permanent backing for the first layer.

34. A method according to claim 28, wherein the delamination element is formed by cutting through the one layer or the second layer in a direction transverse to a direction in which the workpiece will travel for further processing.

35. A method according to claim 34, further including applying pressure to the workpiece upstream of the cut until after the separation is initiated.

36. A method according to claim 34, wherein the cut is made across the entire transverse width of the workpiece.

37. A method according to claim 28, including performing one or more of the following further operations on the workpiece:
   a) collecting the protective backing layer for disposal;
b) aligning the adhesive-coated layer with the permanent backing for attachment thereto;
c) trimming the adhesive-coated layer to final desired dimensions; and
d) trimming the permanent backing layer to final desired dimensions.

38. A method according to claim 30, wherein bonding the adhesive-coated layer to the permanent backing layer includes:
   applying a first force to the adhesive-coated layer to initiate bonding; and
   applying a second force to the adhesive-coated layer to complete the bonding.

39. A method according to claim 33, wherein the third layer and the attached first layer move toward an exit point while the second force is being applied, the movement continuing separation of the first and second layers.

40. A method according to claim 38, wherein the first force is greater than the second force.

41. A method according to claim 28, wherein at least one of the separating forces has a component in a direction other than perpendicular to the surfaces of the layers.

42. A method according to claim 28, wherein the delamination element is retained with the adhesive layer or the protective backing layer after separation of the two layers.

43. A method according to claim 28, wherein the separation forces are applied by rolling the two layers in different directions.
FIG. 6
A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B32B B65C B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"D" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"S" document member of the same patent family

Date of the actual completion of the international search: 23 December 2010

Date of mailing of the international search report: 07/01/2011

Name and mailing address of the ISA:
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Fax: (+31-70) 340-3016

Authorized officer: Lanspeze, Jean
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