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MULTI-PART OR FLAT-FORMED MOLDED BOTTLE ARCHITECTURE

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Multi-Part or Flat-formed Molded Fiber Bottle Architecture

Abstract

This disclosure describes a paper bottle design and manufacturing method to enable cost-effective, high-volume production of an eco-friendly alternative to plastic and metal bottles.

Currently, there are no practical methods to produce paper bottles in high-volume production that are sufficiently cost effective, dimensionally accurate, functional, and cosmetically pleasing to compete or supplant the existing industry standard plastic or metal bottles. The only current high-volume molded fiber liquid containing product is a urinal bottle which due to its unique use case can tolerate coarse dimensional tolerances and rough surface finishes and does not require the typical bottle features to hold and store liquids for a long shelf-life like a barrier lining, screw-on top caps, or pull-off foil tops.

As a first step to develop a functional paper bottle, a preliminary method of forming a one-piece molded fiber bottle – but this method requires that the newly formed molded fiber bottle remain inside the 3D printed forming screen until sufficiently dried which is not compatible with high-volume production. Drying the bottle in the screen requires many duplicate screens to achieve a sufficiently short cycle time and inherently hinders the drying process by capturing the water thereby increasing dry time and energy consumption which are major contributors to the bottle production costs. Methods have been developed to accelerate the water removal from the wet molded fiber while still constrained by the screen like the use of an inflatable bladder inserted into the inside of the bottle to force the water out through the screen with pressure, or the use of vacuum oven chambers to lower the boiling point of the water to speed drying. These methods add additional costly manufacturing steps that are also not compatible with the high-volume and cannot compete with traditional plastic or metal bottle manufacturing processes.

This disclosure describes several paper bottle constructions that achieve high-volume, manufacturable designs by splitting up the bottle into two or more easily manufactured sections each compatible with current existing methods of high-volume production including but not limited to traditional molded fiber tooling, rotary molding machines, hot-pressing, and automated part transfers. The bottle body parts can be split along the long axis (coaxial to the bottle shape) or traverse (orthogonal to the bottle shape) or any combination of the two. In addition to utilizing multiple separate parts this method also suggests being able to produce the bottle sections in a ‘flat form’ with the two or more sections sharing a common side thus being ‘one-piece’. (See Figure 6)

Problem Solved by Invention

Current molded fiber manufacturing methods employ either linear or rotary molded fiber molding machines which dip a bespoke tool set into a vat of water/fiber slurry. The parts formed are usually ‘open’ (not closed like a bottle). Notable exceptions are the molded fiber urinal bottle or the Choose bottle. The parts then need to be transferred to either a post processing station or a dryer. Current molded fiber bottles are both closed and constructed out of thin wall sections thus preventing part transfer as they will simply rip apart or crush under their own weight. Additionally, single-piece molded fiber bottles cannot be cold-pressed or hot-pressed without the use of an additional complicated and costly step of using an internal inflatable bladder since without the internal support, the press will crush the bottle.

By breaking the bottle into multiple parts or two conjoined flat parts they can now be formed as 'open parts' thus enabling the utilization of existing machines and traditional methods to press and dry the parts to enable fast energy-efficient drying, dimensional accuracy, and cosmetic surface finishes and embossing.

Another key advantage of breaking the bottle into multiple parts or flat forming is the elimination for the need to add a secondary action to the bottle forming tooling to produce what is known as a Punt or Push Up which is a concave recess on the bottom of the bottle. Every commercial bottle currently formed (ex. PET plastic or glass) has this bottom feature to provide additional structure and prevent ballooning to ensure a bottle sits flat without wobbling. With the schemes proposed the formation of the punt is included in the tooling without added complexity.

Prior Solutions

None in the multi-part space that this team is aware of. A few close but not exact examples include:

Urinal bottles: these have very large throats/openings and have course surface finishes both inside and outside which are insufficiently refined for the target customer segment. Additionally, urinal bottles lack the required accuracy for high volume production.

Choose Packaging: another one-piece bottle design but the solution needs to be dried in-screen which does not support high volume production as the extraction of water simply takes too long.

Multi-piece assemblies using plastic laminates for barriers and seaming solutions do not offer true sustainability solutions that are commensurate with current and impending environmental goals and mandates, particularly in Europe.

Description

A traditional closed bottle shape is split into two or more sections. For example, a bottle shape can be split just below the Shoulder and above the Body. (See Figure 4) Based on the end bottle shape another split can be made below the Body and above the Bottom. (See Figure 5) This can be repeated as many times as needed depending on the overall bottle size and unique features like grab handles or embossed/debossed logos. Now each section can be molded, transferred, and post processed using transitional machines and methods as the parts are no longer 'closed' in construction.

To attach the two or more sections different methods can be employed including but not limited to pressure hemming, heat staking, recyclable and compostable adhesives, or bands (made from paper, plastic, metal, rubber or any other suitable material/shape). In the case of adhesives these can be part of the bottle liner or additional materials. Rapid curing methods can be employed including but not limited to heat, microwave or ultraviolet. In the case of bands these can be an added industrial design or label with information or logos or simply a color highlight or element.

As a final construction technique two or more flat-formed but attached or conjoined bottle parts can be formed using traditional tooling and manufacturing techniques. (See Figure 6) In this case the two or more halves also would require attachment as mentioned in the prior paragraph.

Figure 1 shows a CAD image of a traditional one-piece molded fiber bottle design from Choose

Figure 2 shows a CAD image of a variant of a split or multi-piece bottle architecture

Figure 3 shows a hand-drawn image of a hypothetical two-part bottle design

Figure 4 shows a hand-drawn image of a hypothetical alternative two-part bottle design

Figure 5 shows a hand-drawn image of a hypothetical alternative three-part bottle design

Figure 6 shows a series of Power Point-generated multi-part and flat-formed bottle designs

General Advantages

As mentioned before, the proposed multi-part or flat-formed molded fiber bottle architecture enables part transfer and consequently enables high volume production.

Figure 1. CAD generated image of the Choose one-piece molded fiber paper bottle

Figure 2. CAD generated image of a hypothetical multi-part bottle (three parts for this example)

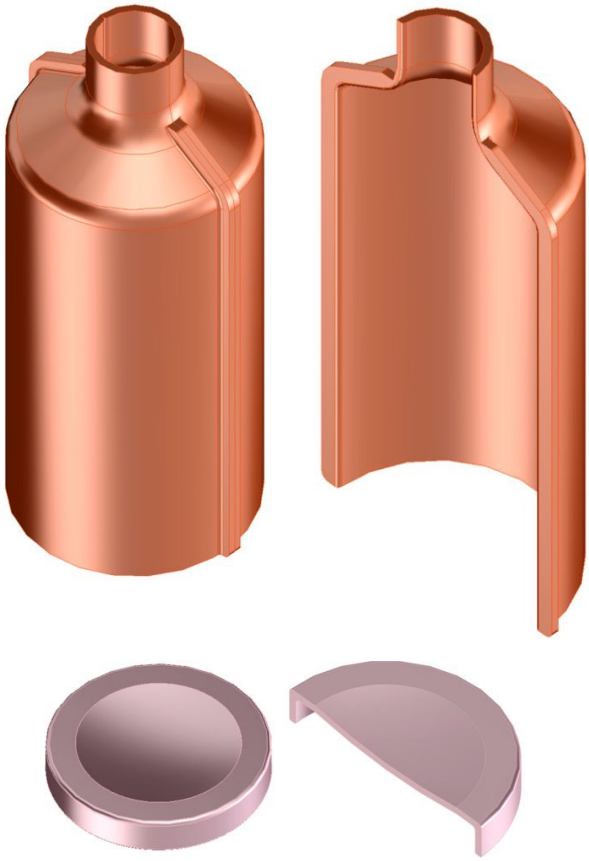


Figure 3. Hand drawn image of a hypothetical multi-part bottle (two parts for this example)

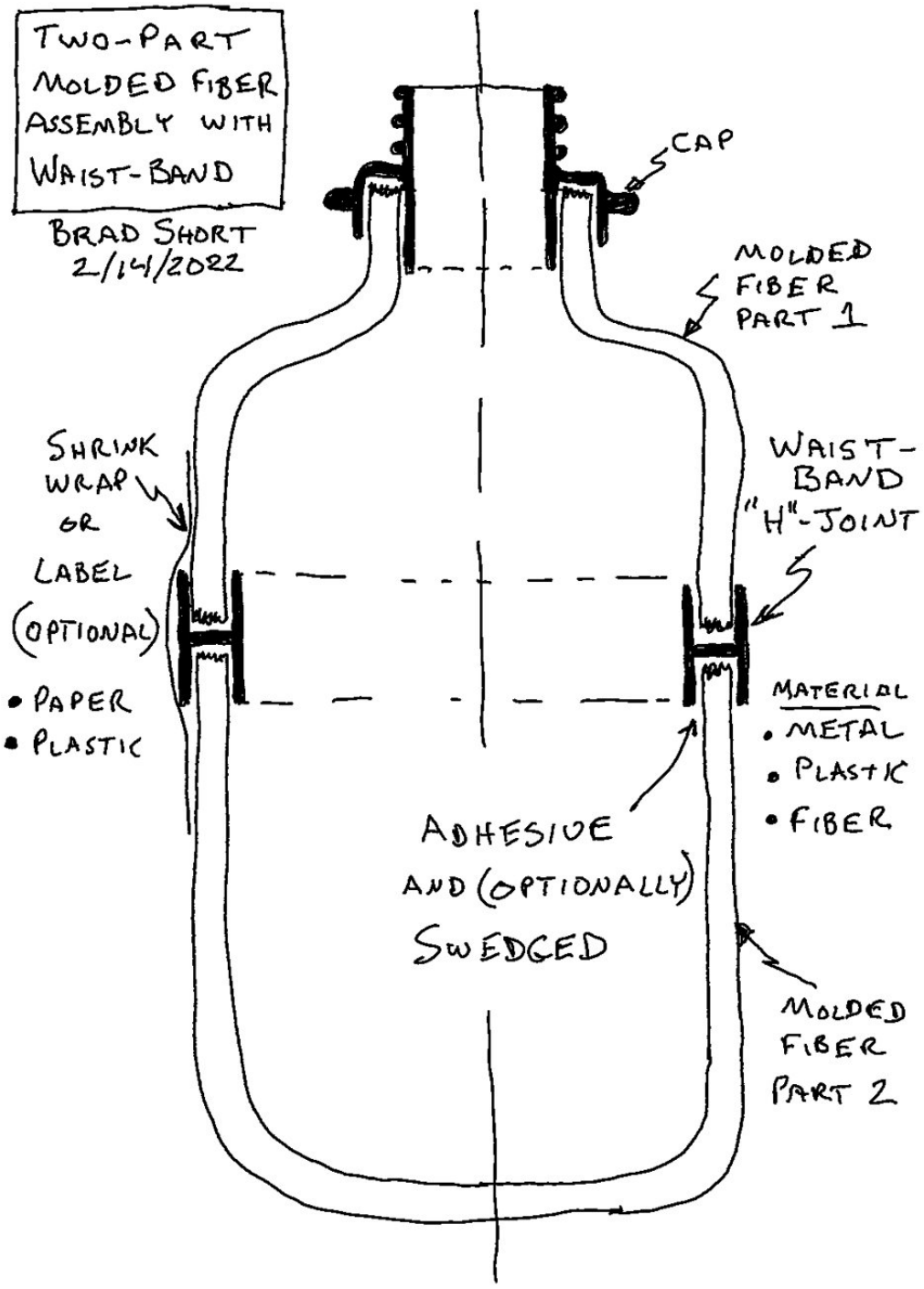


Figure 4. Hand drawn image of a hypothetical multi-part bottle (two parts for this example)

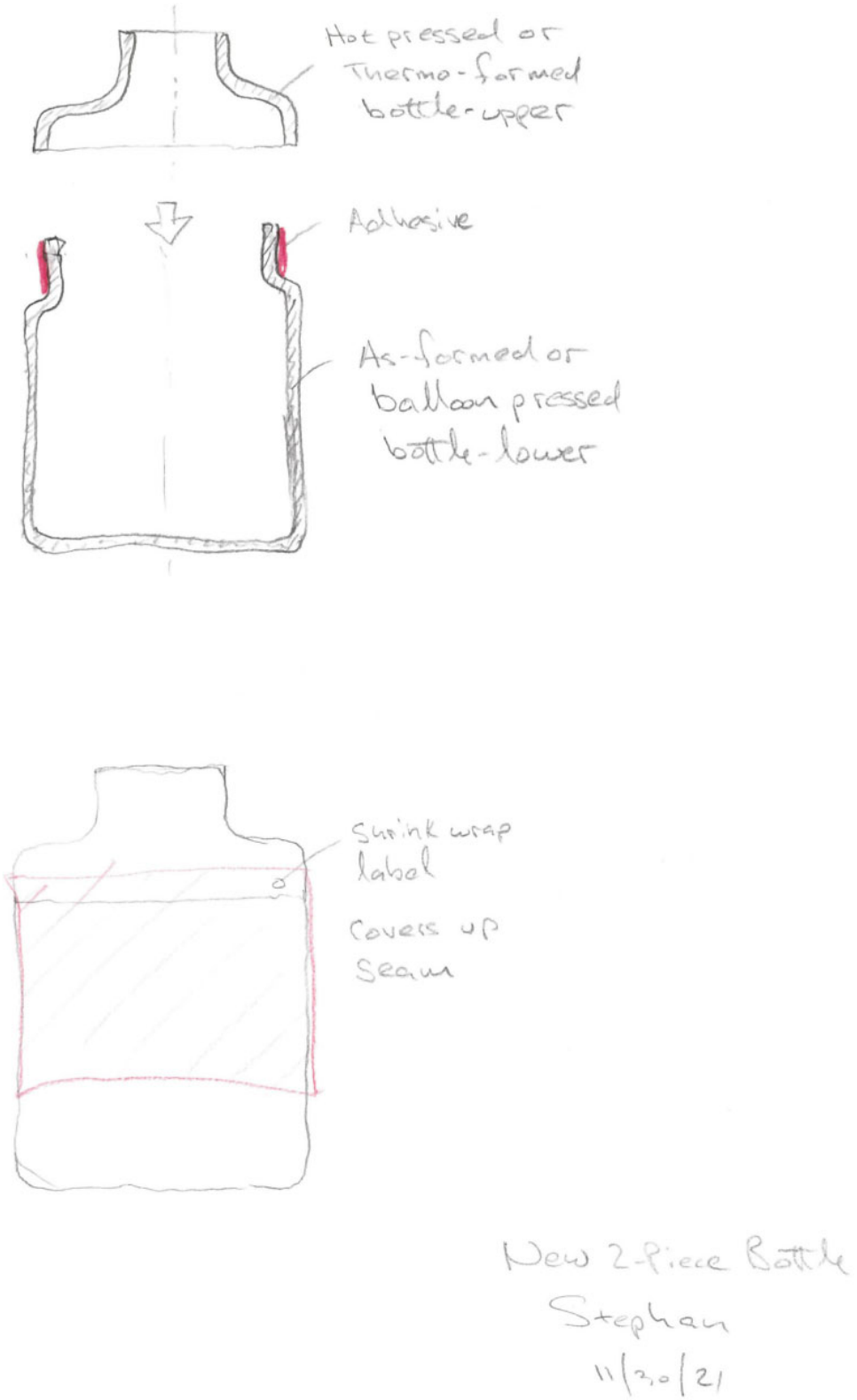


Figure 5. Hand drawn image of a hypothetical multi-part bottle (three parts for this example)

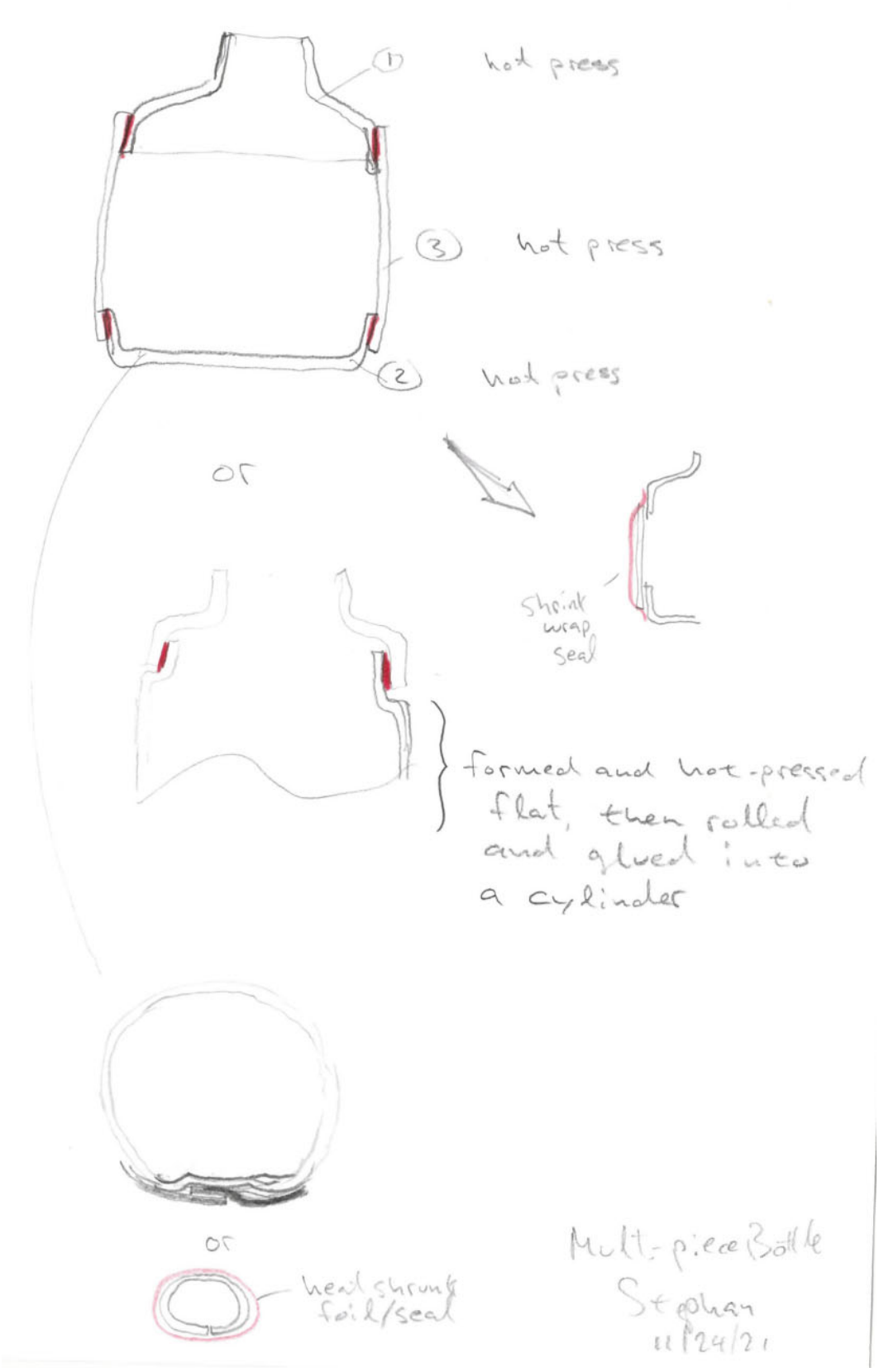
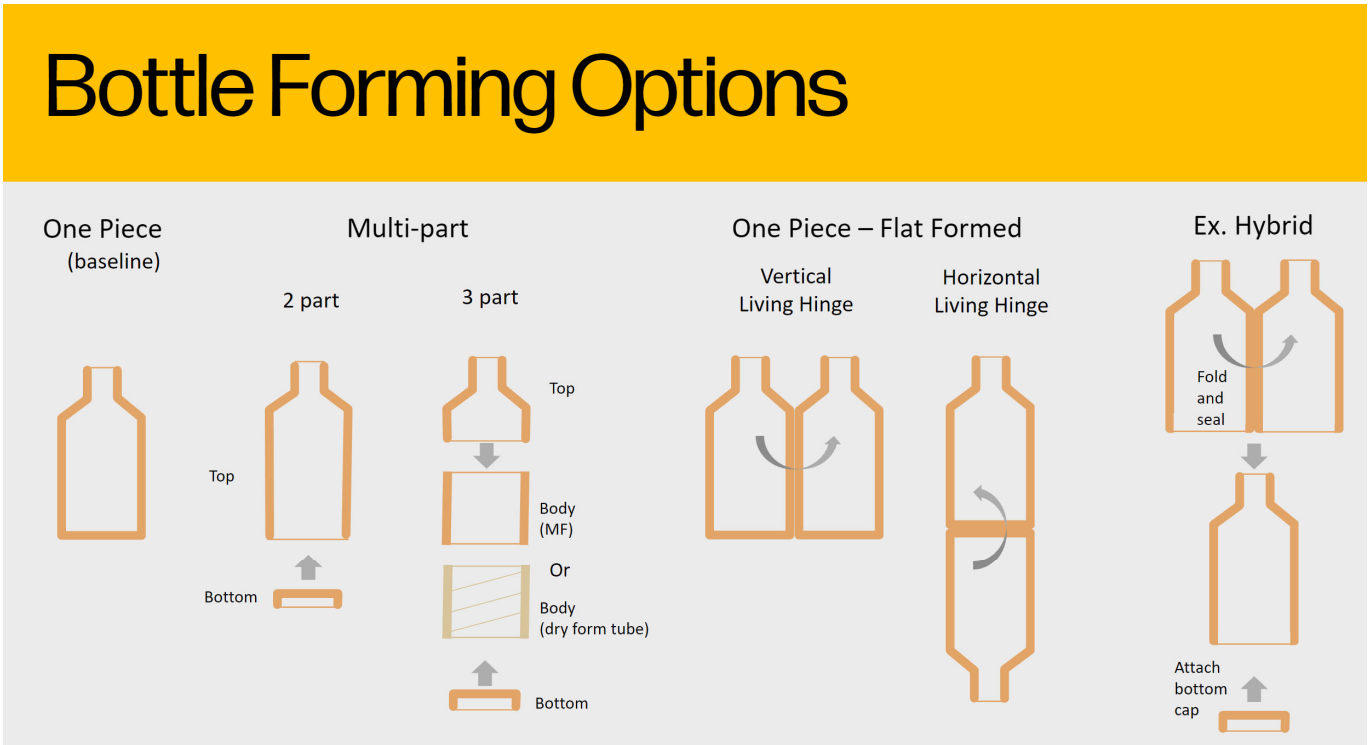


Figure 6. Power Point images of a hypothetical multi-part or one-piece flat formed bottle construction techniques



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