# EXTERIOR PANEL STRAIGHTENING- PART ONE

SOME believe that straightening damage to exterior panels is becoming somewhat of a lost art form. In the pre-unibody era, a large percentage of damaged panels were repaired instead of replaced. For a variety of reasons, many more damaged panels are now being replaced rather than repaired. This doesn't mean that metal technicians don't still need to have metal straightening as part of their repair skill set and knowledge base. Straightening an exterior panel when it's practical can have advantages, some of which may be overlooked at first thought.

This article, part one of a two-part article on straightening exterior panels, discusses the science and theory behind metal shaping and how it relates to straightening damaged panels. Part two of this series will show practical application of this science when straightening a panel and specific procedures used during the straightening process.

## Intrusiveness of a Repair

Something that should be considered when making a repair or replace decision is the intrusiveness of the repair. Replacing welded-on exterior panels requires disturbing many factory spot welds, and the factory-applied corrosion protection. While the straightening process will also disturb some corrosion protection, it typically does not in the flange areas where it is the most difficult to properly restore. Because of this, there may be an advantage to straightening a welded-on panel when possible. Depending on the location of the damage on the panel, straightening may also avoid the need to blend the finish into adjacent panels.

So how do you make a decision whether to repair or replace a panel, and how do you proceed once the decision has been made to straighten a panel? First you need to understand a little about the properties of metal, how it is formed, and what happens to it when it is damaged.

## Metal Properties

Metals, both steel and aluminium, are made up of a basic crystalline structure. The atoms of the metal are bonded together in lattice-like arrangements that form crystals. These individual crystals are then arranged in a granular structure that makes up the metal (see Figure 1). The crystalline and granular structures of metal are in a relaxed state when the metal has not been formed or damaged.

To understand what happens to metal when it is formed or damaged, you need to understand the difference between elastic and plastic deformation. When an external force is applied to the metal it will bend. Elastic deformation is when the metal returns to its original shape after the force is removed. There is no permanent change to the crystalline structure of the metal. Once the metal is bent beyond its elastic limit, it is said to be in the plastic deformation range. In the plastic deformation range, the metal will not return to its original shape when the force that is bending it is removed. There has been a permanent change in the crystalline lattice structure of the metal. The individual atoms that make up the crystals have shifted in position in relation to each other and will not shift back when the force is removed. This also causes a change to the grain structure of the metal compressing some grains and stretching others. This change to the grain structure is what causes stress buildup and work hardening of the metal.

If the grains are stretched into the plastic range in one area only, this will place a stress or force on the metal around the stretched area. If the force is great enough, it will also cause the metal around the stretched area to move. This movement will be in the elastic range so it wants to return back to its original shape, but cannot because of the force placed on it by the stretched metal. This places the panel under stress and makes it unstable and unpredictable. This is exactly what causes what we know as the "oil canning" effect.

## Two- and Three-Dimensional Shape

Exterior panels are a combination of two-dimensional shape, created by simple bending and rolling of the metal, and three-dimensional shape, created by shrinking and stretching the metal. Two-dimensional shape typically does not require plastic deformation to create, but three-dimensional shape typically does. When panels are hand fabricated, the three-dimensional shape is created first and the two-dimensional shape is refined or added. Panels that are made by pressing into a die create both the two- and three-dimensional shapes at the same time. A simplified way to think of this would be that two-dimensional shape is the length and height of the panel and the basic curvature in one direction only. Three-dimensional shape is the refined shape made up of compound curves, such as the end of a quarter panel around the tail lamp pocket, or a curvature that forms a crown in both the length and height directions at the same time.

## Plannishing for Stress Relief

To avoid causing areas of high stress and oil canning, panel fabrication requires both stretching and shrinking of the metal. Still, when a panel is formed, there may be areas of spot stress and work hardening. To form a panel that is stress-free, all of the metal movement done to put three-dimensional shape into the panel needs to be in the plastic range. If it is not, the panel has to undergo some form of stress relieving after forming. Heat treatment is an example of how some formed panels may be stress relieved. Another method of stress relieving an unstable panel is to lightly plannish every part of it.

"Plannishing" is basically slightly stretching the entire panel evenly by hammering lightly using the on-dolly technique. This smoothes any small irregularities in the panel and evens the stresses in the metal. This is the method often used to stress relieve hand-fabricated panels. If a panel is stress-free, you could cut it in half and both halves would maintain their shape. If there are stresses in areas of the panel and it is cut through, the stressed areas will move and change shape after it is cut.

## Applying the Theory

How does all of this apply to repairing a damaged panel? When straightening collision-damaged exterior panels, two-dimensional shape is restored first and three-dimensional shape is refined and added, the exact opposite of the fabrication process. Restoring two-dimensional shape makes up the majority of the straightening work during collision repairs to exterior panels.

As an example, a truck that has been hit in the rear with the bumper pushed into the lower part of the bedside (see Figure 2). The buckle over the wheel opening is a change in two-dimensional shape. The damage behind the bumper is a change in both two- and three-dimensional shape. The majority of the damage to this bedside is a change to two-dimensional shape or length. The change in length has placed forces on the entire panel that have caused elastic deformation, creating the buckle. The first step in repairing this type of damage would be restoring the length to the bedside by pulling. This would remove most, if not all, of the buckle over the wheel opening. Next, the dent behind the bumper could be pushed back into its basic shape from behind. Only after these two operations should any stretched areas, or changes to three-dimensional shape be repaired.

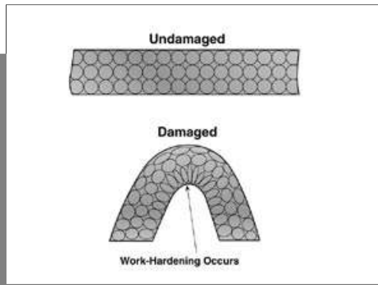


FIGURE 1

*This illustration shows how individual crystals are arranged in a granular structure to make a metal.*

FIGURE 2

*The majority of the damage to this bedside was caused by stress introduced from a change in length.*

FIGURE 3

*The dent in this quarter panel is primarily a change in two-dimensional shape.*

Let's look at another example; this time a vehicle that has been hit from the side and has the quarter panel pushed in above the wheel opening (see Figure 3). As with the truck example, the majority of this damage is a change in two-dimensional shape. The first step in the repair would be to push the damage out from the backside, restoring the two-dimensional shape to the panel. Then any stretched areas could be repaired by shrinking the metal, restoring any change to the three-dimensional shape.

It is important that whenever restoring three-dimensional shape that all metal movement be in the plastic deformation range. This usually requires shrinking the metal more so than stretching. Collision forces will typically stretch the metal much more than shrink it, so repairing the damage requires removing the stretched areas and the stress that has been introduced. A large amount of change to the three-dimensional shape of a panel, basically meaning a lot of stretched metal, like on the side of this truck (see Figure 4), will typically make a panel difficult to repair. Repairable panels typically do not have a large amount of three-dimensional shape change or stretched metal.

FIGURE 4

*The damage to the side of this truck consists of large amounts of both two-dimensional and three-dimensional shape.*

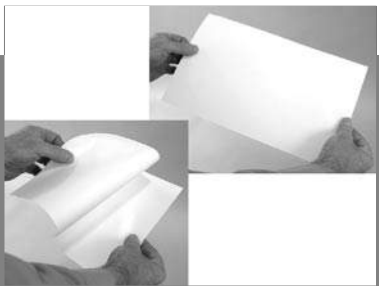

FIGURE 5

*This sheet of paper shows what happens with a mostly two-dimensional shape change caused by shortening the length and how restoring the length removes most of the damage.*

FIGURE 6

*This sheet of paper shows what happens with large amounts of both two and three-dimensional shape change, and how restoring the length in this situation does not remove all of the damage.*

## The Paper Prop

Using a plain sheet of paper, hold the paper up and push the ends of it close together (see Figure 5). The majority of the "damage" to the paper is a change in two-dimensional shape. The original shape of the paper is easily restored simply by pulling the ends back to the original position.

Now take the same sheet of paper and fold it up into a ball, causing large amounts of both two- and three-dimensional shape change (see Figure 6). The paper would now be very difficult to restore back to original shape and condition. The creases in the paper are similar to stretched areas of metal and would hold incorrect shape unless completely removed.

## Conclusion

Exterior panels are a combination of two-dimensional shape, created by simple bending and rolling of the metal, and three-dimensional shape, created by shrinking and stretching the metal. During fabrication, three-dimensional shape is created first, followed by two-dimensional shape. For repair, the process is reversed.

Damaged panels with mostly two-dimensional shape loss are the best candidates for straightening. Panels that have large amounts of three-dimensional shape loss are difficult to straighten because they typically require a lot of metal shrinking to restore the proper shape. Think about the forces acting on the panel and be sure to remove any outside forces created from misalignment of the vehicle structure before attempting to straighten the panel itself.

In part two of this series in the next issue of PanelTalk, we will discuss patterning of panels, techniques for restoring two-dimensional shape, and procedures used for shrinking and stretching metal to restore areas that have a three-dimensional shape loss.

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