Laminated Damascus steel had its origins in the early days of the Iron Age. It was found that by folding and welding iron in a carbon fire you could produce steel, a hardenable iron product capable of producing superior tools and weapons. Nearly every culture in the world developed some form of laminated steel. There are Viking era swords extant that clearly show intricately developed patterning. In Malaysia, the Kris is renowned for its complicated laminated patterned steels. Perhaps the highest form was developed in Japan. The Japanese through a process of forge welding wrought iron and a high carbon product called tamahagane produced swords of exceptional quality and beauty. An excellent reference for the background history of Damascus is found in *A Search for Structure*, by Dr. Cyril Stanley Smith, MIT Press.

In Germany, during World War II a great many Damascus steel blades were made for the military, but it was not rediscovered in this country until the 1970's. Bill Moran introduced the first Damascus blade to the knife collecting world at the Knifemakers Guild show in 1973. There were others working with this "new" material at the time as well and after a hammer in Lumpkin, GA where it was demonstrated, Daryl Meier returned to Carbondale and began his lifelong research into the mysteries of this process. A book that greatly influenced me was *Decorative and Sculptural Ironwork*, by Dona Z. Meilach, published in 1976 by Crown Publishers, Inc.

This book featured the work of Bill Moran, Robbin Hudson and the "Damascus research team" of Daryl Meier, Jim Wallace, present curator of the National Ornamental Metals Museum in
Memphis, Tennessee, and Robert Griffith. The chapter on Damascus steel provided a starting point for working with this steel and inspired me and many others to begin working with it. My first lesson on making Damascus came from a meeting with Jim Schmidt at Jimmy Fikes shop in 1978. Jimmy showed us how to forge weld a billet and we were off.

**Pattern Development**

The patterns that can be developed in the steel are endless, but they currently are broken down into a few basic categories.

!["W's Pattern" Don Fogg. MS]

**Straight laminated billets**

The billets are made by cutting and stacking layers of different steels together and welding them into a solid piece. This piece is called a billet. This billet is then drawn and cut into two or more pieces, restacked and welded. The number of layers in the final billet will depend on the number of distinct layers in the initial billet and the number of times it is folded and welded. Each fold is a geometric progression 4, 8,16,32,64,128,256,512 etc. Howard Clark has done some studies and has determined that after two folds the carbon has been evenly dispersed throughout the billet and it is for all intents a homogeneous piece of steel. Optimal for pattern development in straight laminated billets is between 300 to 500 layers. Going the next step to 1,000 layers makes the pattern too fine and staying under 300 it appears wide and bold. There are exceptions to this and it is a matter of taste, but this is my page and my opinions. Once the billet has been welded there are several basic patterns that can be developed.

Wood grain: Wood grain is the pattern that results from forging the billet to the shape of the blade. It can be directed, but mostly it is left to reflect the hammer blows the smith imparts as he creates the blade. I left wood grain patterns for years, but recently have come back to them with a greater respect for their natural reflection of the metal and seemingly organic patterns. The very best wood grain patterns hold many surprises for those who are willing to look. The steel does not look imposed upon.
Twist patterns: Twist patterns involve usually a lower layer count in the billet. The billet is drawn into a square or round cross section and then actually twisted hot. The development of twist patterns was at its height during the heyday of the Damascus shotguns. These guns represent some truly incredible craftsmanship and creativity. Twist patterns work nicely in blades too and there are many variations that can be developed from the basic twist. The twist has the distinguishing character stars that are revealed whenever it is cut into.

Incised patterns: Incised patterns are created by starting with a straight layer billet and cutting into it. As a cut is made into the billet it exposes a cross section of the layers. When the billet is reheated and forged flat again, the bottom of the cuts are brought to the surface and the cross section is revealed. The most common incised pattern is the ladder pattern distinguished by tightly space rungs or bands running across the width of the blade.

Straight layer billets may be patterned by using any number of combinations of the various techniques i.e., it can be incised, twisted, and much more. One technique that I like is called jelly rolling the billet. Starting with a low layer count, seven layers for instance. Make the weld, draw the billet out until it is roughly 1.5"x.25" and however long it draws out to. Cut off any arc weld material on the end of the billet, taper the end slightly thinner than .25" and start to scroll it back on itself. Heat and roll it up, keeping it as tight as possible without being obsessive. When you finish, you will have a jelly roll of steel. Cut the roll off the handle and reweld the handle to the edge of the roll and weld the billet solid. You will have to roll the billet in the direction of the scroll to tighten it as you weld with light blows. Once it is solid, you may draw it out and continue to fold and weld as you would a normal billet. Or you may draw it out, square it up and cut and stack to make scrolls on the end grain of the billet. The possibilities are endless.
Often the best patterns fall on the end of the billet. There are various ways of getting this pattern to show on the flats of the blade. Going back to the basic patterns, you can cut into the billet and where ever you cut through the end grain, the pattern will show. If you want complete coverage you can make alternating cuts in from either side of the billet and unfold the cuts. This method is called accordian the billet and it may be done with a hot cutter or by cutting on a bandsaw.

Another method of revealing the end grain is to stand the billet on edge and cut into on a diagonal. This will make a long slice across the end grain and expose the pattern. The pieces are then reversed and rewelded into a solid piece with the now exposed end grain showing on the outsides. This method will give total exposure for the end grain pattern, but also distorts the pattern by nature of the long diagonal; the effects can be quite interesting.

Don Fogg, Master Smith
www.dfoggknives.com
dfogg@dfoggknives.com