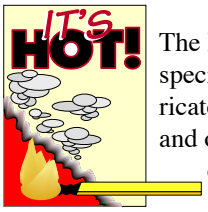
The
ABC's of Diemaking & Diecutting

*This **free** electronic publication is dedicated to creating a cooperative information, education, and solutions network for **Design, Diemaking** & **Diecutting** technicians, supervisors, and managers. **You can be a part of this initiative!** Share or forward this to a colleague, a customer or a supplier.*

Value in Diemaking...

One of the challenges the Converting Industry is facing is the commoditization of products and services. *For example..* ***"In the world of business, a commodity is an undifferentiated product, good or service that is traded based solely on its price, rather than quality and features."*** Does this sound familiar? And how is it possible or practical, to classify the steel rule die as a commodity?



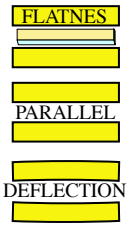
The Professional Diemaker specifies, designs and fabricates tools of great value and of extraordinary quality, often set against unrealistic and unreasonable time constraints. With minimal and often incomplete information, they are required to use their knowledge of each customer's products, processes, and people, to anticipate every problem, and to maximize the productive capability of a diverse range of diecutting systems. Obviously, there are sometimes problems in this fast moving transaction, but the performance of the commercial diemaker, under less than ideal situations, is generally spectacular.

This does not mean the mean the diemaker escapes responsibility. They have to form a sound technical partnership; they have to make an effort to understand the customer process and products; they have to commit to mutual process improvement; they have to use a systematic approach to tool specification, design and fabrication; they have to have transparent, open pricing and an accurate, interactive scheduling system; they have to have the ability to respond immediately to a customer crisis and provide effective technical support.

And, if this is not your experience, remember, there is no relationship in a commodity transaction!

Designing & Fabricating the Press Calibration Mapping Die.

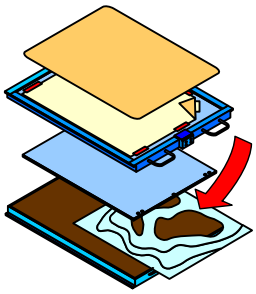
"Opportunities multiply as they are seized." *Sun Tzu*



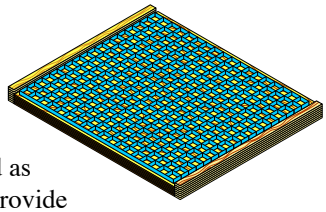
There is a dangerous assumption, which frequently undermines performance in diecutting. Many professionals seem to believe, in the face of considerable evidence to the contrary, that the three key attributes of an effective diecutter, the flatness of the upper and lower surfaces, the parallel alignment of these surfaces, and the deflection of either or both surfaces under compressive load, are always in optimal condition. ***See right.***

The reality is very different. Every diecutter has a distinct and an inherent pressure distribution imbalance, which significantly undermines the ability of the diecutter to generate a fast, simple and effective kiss-cut impression. The discipline of Press Calibration is used to minimize and eliminate this imbalance.

Press Calibration is the precise mapping of the Z-Axis Measurement under compressive force, to illustrate high areas and low areas in the cutting anvil; it is a simple method of measuring the Flatness, the Parallelism, and the Deflection of the platen mechanism under compressive load; and it is a technique designed to eliminate key variables undermining the ability to generate a kiss-cut make-ready.



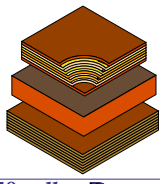
Press Calibration is an essential converting maintenance action, designed to test and to compensate for deficiencies in the cutting precision of a platen diecutting press; it is a discipline of converting the pressure mapping image into a compensation underlay, which is made from industrial grade foil, and which is permanently inserted into the platen stack, ***see left***, usually under the cutting plate; and it is basically a press physical, which is built around a mechanical stress test.



To conduct an effective Press Calibration procedure requires a Press Mapping Die. The first of the three primary components of the Mapping Die, the Dieboard, plays a key role as the Tool Holder for the Creasing Rule Grid, and as a Platform for the Ejection Material. As the dieboard will provide the foundation for the measurement and testing of platen mechanism pressure distribution pattern, it is important it is specified and designed with some care. There are two parts to this. The Specification and the Design of the Dieboard and the Machining of the Dieboard.

Specification & Design of the Mapping Dieboard

The first step in this process is to choose the dieboard material. As Z-Axis precision is critical, it is obvious that a stable dieboard material, such as Rayform and derivatives from Rayner, ***see right***, and Permaplex from Weidmann Industries, would be effective choices.



If plywood is being used to form the dieboard, there are some preventative measures which must be taken to ensure dieboard stability and Mapping Tool precision. The most effective thickness for the mapping

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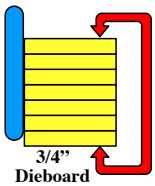
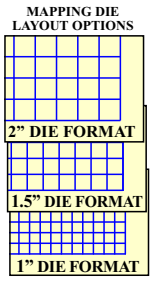
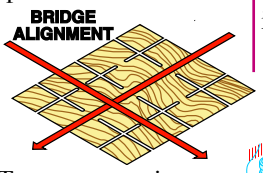
dieboard is 3/4 of an inch or 18 millimeters. ***See right***. This is important as this thickness of plywood will provide maximum support for each creasing rule, to prevent deflection under load.

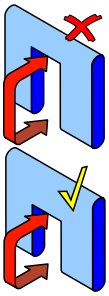


The first step in designing the Mapping Tool is to choose the size of the grid, which will be machined into the dieboard. For most large format presses the most effective grid size is 2 inches or 50 millimeters, however, for smaller presses, and for smaller format presses. 1.5 inches and 1 inch are also effective. ***See left***. The next step is to focus on the bridging pattern.

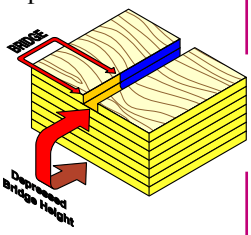


One of the primary causes of dieboard warping, is a combination of too few and too small; and improperly positioned and aligned bridges. To ensure maximum stiffness and stability in the finished dieboard, each grid section should have the maximum sized bridges, and the bridges must align from grip to back-edge and from side-to-off lay. ***See above***.

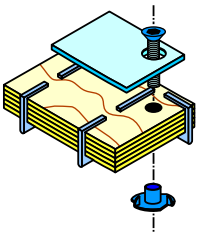




Although aligned, maximum width bridges are essential for dieboard stability. The use of the thicker dieboard would result in the standard bridge severely weakening the crease rule. ***See left***. The solution to enable the lower bridge height in the illustration to the right, is to implement Bridge Depression in the dieboard.



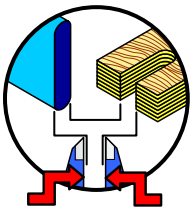
This can be accomplished on many laser cutting systems automatically, however, if this is not available, bridge depression can be executed manually.



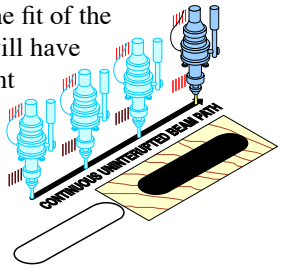
It is useful during the design stage to program the dieboard to be formatted precisely to the diecutting chase it will be used in, and obviously, that would include pre-cutting the bolt hole pattern. ***See left***.

Machining the Mapping Dieboard

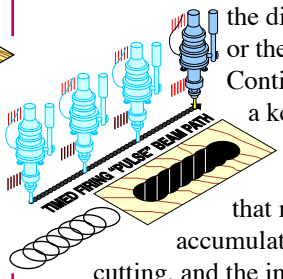
There are a number of choices to be made at this point if using plywood to fabricate the mapping tool dieboard. Applying a thin coat of shellac to a dieboard after laser cutting is a standard practice to prevent excess changes in veneer moisture content. This practice helps to prevent dieboard warping and kerf expansion, which could lead to loose rules. For this application it is recommended to apply a thin coat of shellac to the dieboard both before and after lasercutting, as pre-coating provides an additional degree of protection, and it limits the degree of moisture loss during laser cutting.



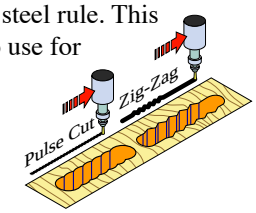
The next choice is the type of lasercut kerf to use. However, an important requirement is to use the rule from the batch to be used to fabricate the creasing grid, to verify the fit of the kerf. To ensure the machined dieboard will have the self-leveling characteristics, important to mapping die performance, it is vital to integrate the rule to be used, ***see bottom of previous column***, with the set-up and verification of the laser cut kerf.



There are two forms of lasercutting. The first is ***Continuous Wave***. ***See above right***. When the beam is released, laser cutting of the kerf channel begins, and either the dieboard is moved under the laser head, or the laser is traversed across the dieboard. Continuous Wave or CW Lasercutting creates a kerf channel with straight sides, which theoretically provides continuous contact with the steel rule it is securing. While that may seem an advantage, because of the accumulation of excess heat in Continuous Wave cutting, and the inherent variability of plywood, the kerf is often too tight or it is too loose.

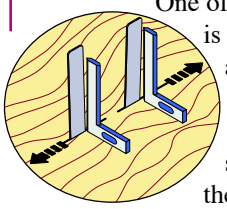


The alternative is to use Pulse Cutting. ***See above left***. In pulse cutting the laser is used in a similar fashion to a drill press, in that the beam is fired, closed, fired, closed and fired again, in a sequence tied to the speed of the laser nozzle or the traversing dieboard. This provides a kerf channel with serrated sides, which enables the rule to be held with a flexible pressure which can accommodate variation in the kerf and in the steel rule. This is the most effective lasercutting method to use for the Mapping Die.



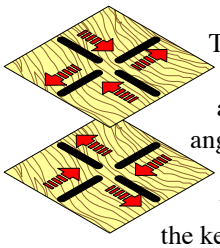
For those with Continuous Wave Lasers, which are not capable of Pulse Cutting, the alternative is to cut a slightly ***"loose"*** kerf, but integrate a programmed ***"Zig-Zag"*** mode at regular intervals. ***See right***. The Zig-Zag Technique is basically replicating the profile of the pulse channel, however, it is an effective, if complex alternative.

Which ever method is selected, it is important to set the kerf width to provide a very ***"light"*** hold on the rule. When setting up the kerf it should be relatively easy to push the crease rule into the slot, and remove it with equal ease. The bottom line in kerf parameters, is if the kerf is too ***"tight"*** you must begin again!

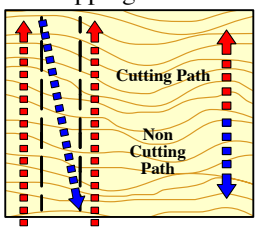


One of the ***"potential"*** Achilles Heels of lasercutting, is how the ***"beam mode"*** can impact the vertical alignment of the kerf, and subsequently the rule inserted into the dieboard. In the ***illustration shown to the left,*** this phenomena demonstrates that cutting a channel in one direction, the verticality of a rule inserted is angled in one

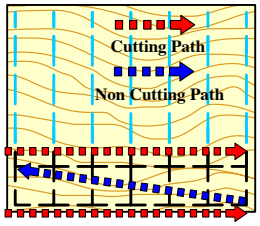
direction, and by simply reversing the direction of the cutting path, the verticality is angled in the opposite direction.



There is a common danger in lasercutting of assuming the system will consistently generate a kerf channel, which is a perfect right angle to the base or the surface of the dieboard. However, for any dieboard, and particularly the Mapping Dieboard, the verticality of the kerf should be verified carefully and adjusted precisely if necessary. It is obviously a requirement to check the parameters of the kerf channel in all cutting directions, ***see left***, as this will provide a guide when laser cutting the mapping dieboard.

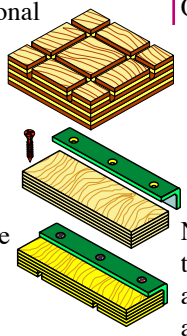


To eliminate potential problems, lasercutting of the dieboard should be constrained to two directions to minimize any potential variation in verticality. This would mean cutting all of the kerf channels in one direction, and against the plywood grain, to minimize the impact of shrinkage during the lasercutting process. ***See above***. Naturally, this is rather wasteful in non-cutting laser moves, however, the additional time consumed is offset by the elimination of another potential source of variation.

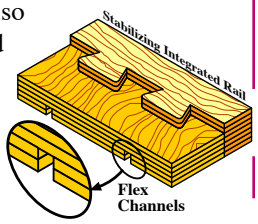


The second pass, cutting the kerf channels parallel to the grain of the dieboard, would follow the same practice. ***See left***. This will certainly reduce the degree of potential variation in key kerf parameters and it will minimize the impact of shrinkage impacting the integrity of the grid design.

Now that the dieboard has been lasercut and the kerf parameters verified and approved, there are a number of additional factors which should be considered. When using a plywood dieboard, and even a Rayform or Permaplex dieboard, warping is caused by a moisture imbalance, by poor kerf parameters, by a poor bridging pattern, and by the stress of ruling. There are two actions designed to further minimize the possibility of dieboard distortion. The first is the use of Flex Channels, and the second, the integration of Metal or Wooden Rails. ***See right***.



The channels are routed or cut with a circular saw into the underside of the finished dieboard, and the slot should penetrate through at least two veneer layers. ***See right.*** This also shows wooden rails, which are programmed into a matching dovetail pattern in the end of the mapping dieboard. The wooden rails can be made from 7/8 inch plywood, Permaplex, and/or Rayform, and are glued or epoxied into position while the dieboard and the rails are clamped flat.

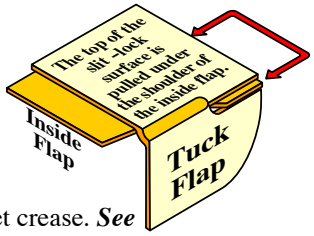


The final factor, is the dieboard must be ***ruled as soon as possible***, as the exposed end grain in the walls of each kerf channel, will enable the dieboard to continue leaching moisture into the surrounding drier atmosphere. Now we are ready to rule the Mapping Dieboard.

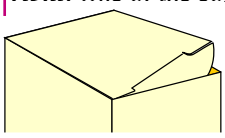
The next step, Ruling and Fabrication of the Press Mapping Die will be included in the next issue of ABC News. The complete and unabridged article "How to Design & Fabricate Press Mapping Tools" can be downloaded from the DIE Web Site. The Reference Number is DIE.05.06.

Curved Crease for Structural Integrity

"It is much easier to be critical than to be correct."
Benjamin Disraeli

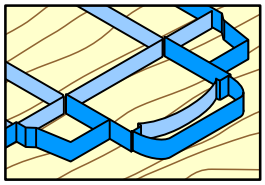


A critically important feature of the reverse slit lock-tuck-in carton, is the locking relationship between the shoulder of the flap and the tuck slit pulled under the shoulder by the offset crease. ***See right***. One of the common methods to assess the integrity of the tuck assembly and to ensure the lock between the two components is secure, is to flick a finger to sharply strike against the front of the carton where the lock is located. If the lock pops open, ***see left***, the carton is rejected and the problem of then figuring out how many of the complete production run should be checked for a similar failure!



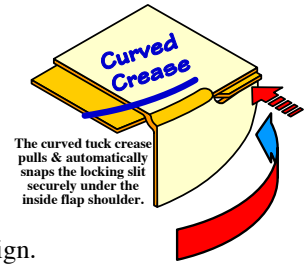
The Curved Crease Innovation

One simple method of preventing this problem and ensuring every tuck locks securely, is to slightly curve the tuck crease. ***See left***. Naturally as this configuration folds through 90 degrees it pulls the ends of the panel inward, ***see below***, which pulls the slit lock under the protruding flap shoulder!



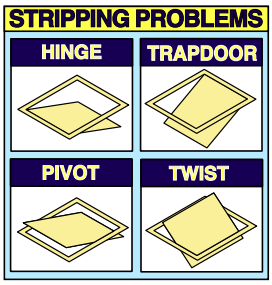
No matter how many times you strike the tuck with your finger, the lock is impossible to accidentally dislodge. This is a simple and effective method of improving folding carton performance and it clearly illustrates the importance of good tool specification and design.

Curved creases are a key innovation in structural design, as a very slight curvature of the crease/fold produces important attributes in structural design, in gluing and in cartoning. There are applications for a curved crease in almost every carton and container design.



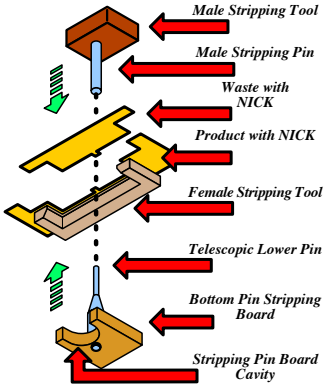
Nick/Tag & Stripping Pin Alignment

"Vision is the art of seeing things invisible." *Swift*



One of the key challenges of high speed stripping are to prevent parts hinging, pivoting, trapdooring and twisting, as they are driven through each female board aperture by the male stripping pins. ***See left***.

This is made more difficult by the often essential need to nick the waste pieces, both to keep the diecut sheet of waste and products together until they are in position and registered to the female stripping tool, and to keep each waste piece aligned so it can be sheared free of the sheet and pushed down through the aperture. In stripping the pins are positioned to apply a balanced spread of pressure to the waste piece as it is stripped.

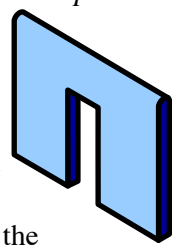


However, when adding nicks to the layout, it is a great advantage to make sure the nicks and the upper and lower stripping pins align. ***See right***. If there is misalignment between the nick and the stripping pin, pivoting and hinging are inevitable.

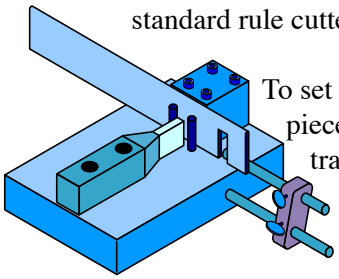
So when you add nicks to the die make sure the position of the pins and the female aperture trapping points line up with the added nicks.

Bridge First - Cut Second

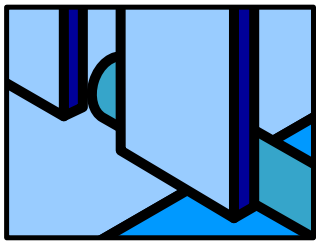
"Imagination rules the world." *Napoleon Bonaparte*



It is often necessary to fabricate small lengths of steel rule with a single bridge in the piece. ***See right***. The standard approach would be to cut the pieces to length then bridge each piece individually. While this is not that complex it is faster, more accurate, and simpler to bridge the rule first, ***see below***, and then cut the lengths second on a standard rule cutter.



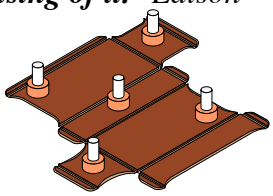
To set the bridge position for multiple pieces the side gage is set to the trailing edge of the first bridge, ***see below***, and the gage is set for the correct distance from bridge to bridge, which would be identical to the length of the finished piece.



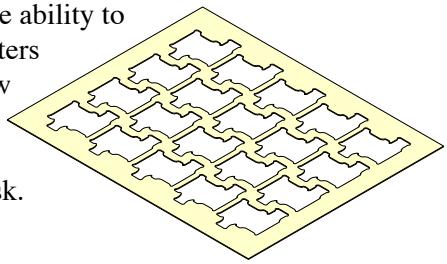
This technique simplifies the creation of small pieces with a bridger, it is safer, it is faster, and there is far less distortion to the finished piece.

The Fiberglass Counter Mask

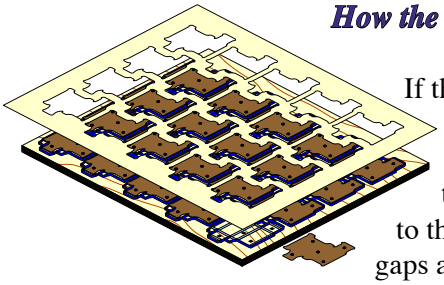
"The value of an idea lies in the using of it." *Edison*



One of the most effective creasing tools guaranteed to generate exceptional paperboard or fluted material creasing and folding are fiber glass counters. ***See right***. These are simple to use, fast to install, and provide trouble free high quality performance for the length of several production runs. One method, which is gaining acceptance to further improve the use of these tools, is the ability to transfer all of the counters simultaneously in a few minutes. This is made possible by the creation of a Counter Mask. ***See right***.

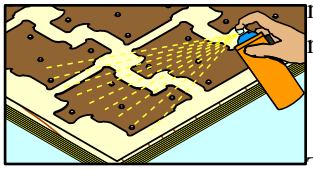


How the Counter Mask Works



If the pins were inserted in the counter positioning holes and the counters mounted to the die there would be gaps around each counter, which would make spraying impossible. However, by cutting a mask on the plotter from scrap paperboard, the mask can be superimposed over the counters mounted on the die, ***see above***, and the counters all sprayed at the same time. ***See below***.

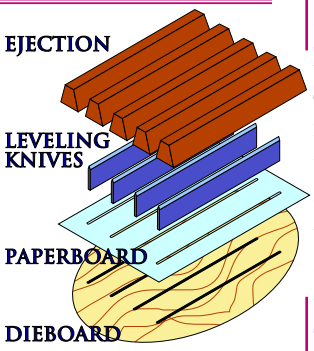
This is fast, quick, and obviously very simple, and it reduces the on-press time for counter transfer from 20 minutes to five minutes! Positioning and spraying them like this eliminates transfer variation, and it is far easier and less time consuming than spraying them individually and then positioning each counter on the die.



It is certainly easier to spray all of the counters when they are mounted in this way and the adhesive film is far more consistent. The single transfer impression provides better registration accuracy, and there is far less chance of damaging counters using this approach.

The Correct Use of Leveling Knives

"It is better to solve problems than crises." *John Guinther*



One of the key features of a platen diecutting steel rule die is the provision of ***"Leveling"*** or ***"Bearer"*** knives, which are designed to prevent the press deflecting under an unbalanced load.

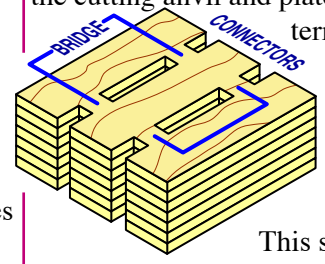
However, many make a critical mistake in this application, because the leveling knives and the steel rule die are supposed to be balanced in pressure distribution. The problem is in the die area you have steel rule and ejection and paperboard, but in the balancing leveling knives area you have the knives and the ejection material, ***but no paperboard***!

Therefore, to balance the diecutter correctly, the leveling knives should have the paperboard of the job pushed down onto the leveling knives, to the dieboard surface, and then the ejection material adhered to the paperboard. ***See above.***

The Cumulative Bridging Technique

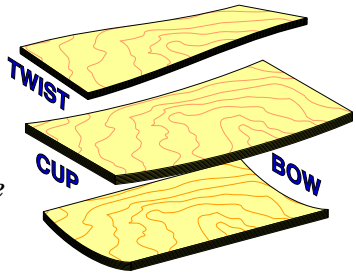
"Problems are messages." *Shakti Gawain*

The focus of diecutting is the control of the Z-Axis, or the setting of the Platen Gap. Both these terms refer to the optimal setting for a platen diecutter, when at the top of the stroke the distance between the tip of each blade and the surface of the cutting anvil and plate is zero. ***See above***. This is often termed as Kiss-Cutting, as it implies the ability to so precisely make the press ready the cutting edge of each blade barely ***"kisses"*** the surface of the cutting plate.

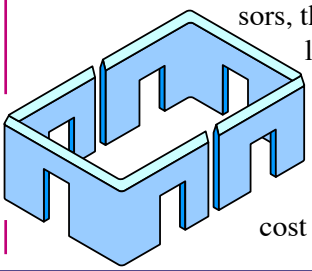


This setting is only possible if the platen is level and deflection free, and the cutting die is perfectly level. However, if the dieboard is warped, achieving a kiss-cut impression is very difficult, the cutting make ready is long and never really complete, and the steel rule die suffers rapid and progressive knife-edge damage.

The Critical Dieboard Connector: The Bridge

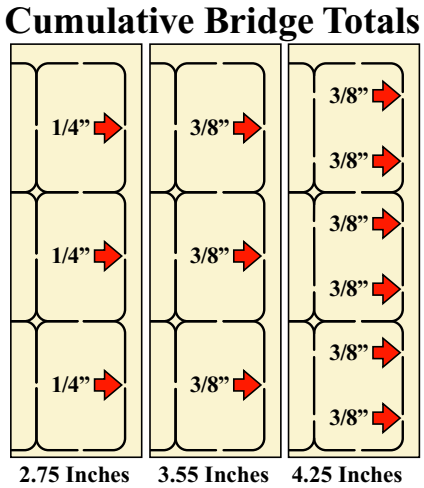


The ability to prevent a dieboard from warping is controlled by the accumulated strength and alignment of the connecting bridges, which hold the dieboard together. ***See above***. The problem with the majority of steel rule dies is there are insufficient bridges to prevent the dieboard from cupping, twisting or bowing. ***See above right***. The failure to use the correct number of bridges or the correct width of bridges stems from the effort, the time, and the cost it took to jig every separate line, and to bridge every rule. The diemaker progressively reduced the number of bridges, however, with automated dieboard cutters and rule processors, the labor content of bridging is no longer an issue. However, with the advent of new technology, it is possible to add sufficient bridges to stabilize the dieboard, ***see left***, without impacting the time or the cost of the manufacturing process.



Dieboard Stabilization: Cumulative Bridging

One of the most effective methods of strengthening a dieboard is to adopt the Cumulative Bridge Technique. This is an effective technique in which the cumulative value of all of the connecting bridge widths is calculated to determine the strength of the dieboard. This is calculated from the grip to back-edge and from side to side.

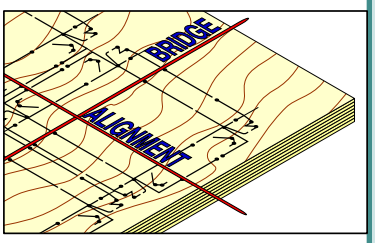


For example, in the illustration to the left the section of dieboard on the far left has thee die stations, each with a single 1/4" width bridge. When the width of the grip on the dieboard and the width of the back-edge strip are added, we get a cumulative value of 2.75." The middle section the design has been changed from a 1/4" bridge to a 3/8" bridge, and the cumulative value has increased to 3.55." In the final section on the right, the design has been modified to include two x 3/8" bridges, which give a total cumulative value of 4.25."

Which of these configurations is more resistant to warping, to stacking, to loose rules, and to dimensional change?

Cumulative Bridging: Summary

Even if the diemaker were making the dieboard using traditional methods and practices, these bridge design changes are neither complex nor are they time consuming. However, the impact on the finished steel rule die in terms of flatness, dimensional stability, and on-press kiss cut performance, is difficult to ignore.



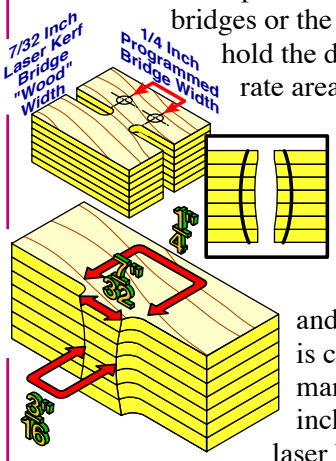
Finally, one golden rule! It is critical that one or two sets of bridges align from side-to-side and from back-to-front, right through the dieboard, as this adds greater strength and stability to the finished tool.

Question: How Strong is a Laser Bridge?

"Much of your pain is self-chosen." *Kahlil Gibran*

In designing and fabricating an effective steel rule dieboard it is important to understand every element of the machining process and the impact on on-press converting performance.

One of the most important elements of lasercut tools are the bridges or the sections of uncut plywood which hold the dieboard together by linking separate areas of the design. Unfortunately, as these bridges are generally inserted automatically by the CAD CAM program used to design the tool they are frequently overlooked as a key factor in tool quality. In practice the size and the integrity of each bridge is critical to steel rule die performance. When a bridge of 1/4 of an inch is programmed the width of the laser beam results in the quarter of an inch dimension being short by two halves of the width of the beam. In addition, because the laser cuts with a concave shape the actual width of the bridge at the important central core veneer layer is less than 3/16 of an inch. ***See above***.



Therefore, in assessing the strength of a bridge set at a specific width of 1/4 inch the actual width and/or core strength of the bridge is less than 3/16 of an inch.