The ABC's of Diemaking & Diecutting

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Diecutting is a Toolmaking Process!

Operating a diecutting press is relatively simple, that is until you install the tools and the substrate to be diecut! Although I am being accurately facetious, when you examine the portrayal of steel rule dies and associated tools in the current market as commodities, it is difficult to equate this with the real challenge of maximizing quality and productivity in diecutting.

Why is this approach ineffective?

In practice, if we use commodity tools, we should not be surprised to generate poor productivity results. To generate value added products, to achieve quality and consistency, and to maximize the productive potential of the diecutting system, we need to invest in Value-Added Tools.

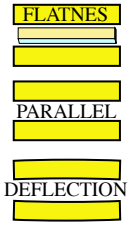
Diecutting is a toolmaking process. When you examine the time involved in press changeover, it is obvious tool deinstallation and installation, and tool adjustment and modification absorbs the largest percentage of make-ready time. If you examine repeated statistical breakdowns of the sources of stoppages and lost time in production, they demonstrate that adjusting and re-working tools on-press is responsible for more than eighty percent of lost productive time!

Still think tools are commodities?
While poor productivity in diecutting is primarily associated with poor tool performance, this failure is far less likely to be the result of an ***"error,"*** in fact ninety percent of the time it is the result of an incomplete or an incorrect tool specification discipline, which leads to poor tool design and fabrication, and ultimately inadequate on-press performance.

The bottom line? To succeed in diecutting it is essential to add value to the process by building a professional and effective working relationship between the diemaker and the diecutter. Or, just keep regarding steel rule dies and related tools as commodities ***... you never know, you may just survive!***

Designing & Fabricating the Press Calibration Mapping Die.

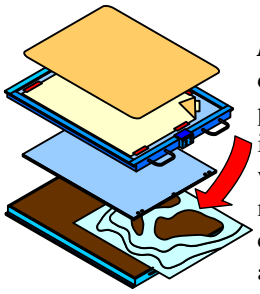
"Never mistake motion for action." *Hemingway*



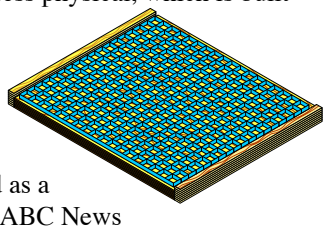
There is a dangerous assumption, which frequently undermines performance in diecutting. Many professionals seem to believe, in the face of considerable evidence to the contrary, that the three key attributes of an effective diecutter, the flatness of the upper and lower surfaces, the parallel alignment 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.



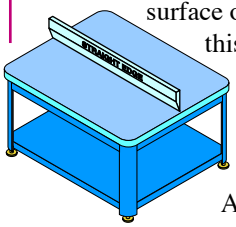
Press Calibration is an essential converting maintenance action, designed to test and to compensate for deficiencies in the cutting precision of a platen diecutting press; it is a discipline of converting the pressure mapping image into a compensation underlay, which is made from industrial grade foil, 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. In the previous issue of ABC News we discussed the specification and design of the Mapping Die, and in this issue we will address Mapping Die Fabrication & Finishing.

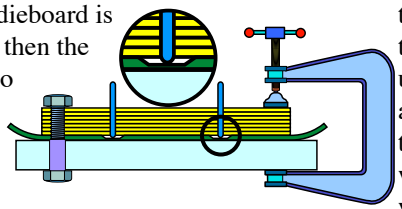
How is the Mapping Dieboard Fabricated & Finished?

One of the hidden causes of poor diecutting performance in steel rule dies, is generated by assembling on a steel ruling surface which is not flat or level enough. The standard tolerance of most steel rule is plus or minus 0.001 inches or 0.025 millimeters. The steel surface of the diemakers table is ground to a specific degree of flatness, and this flatness should be as accurate and as consistent as possible. Therefore, the dieboard should be ruled on a Mattison Ground, Calibrated Steel Rule Die Table. ***See left.***

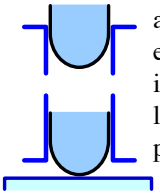


The ruling procedure is equally specific and equally important. A sheet of 0.005" thick machined finished paper is placed on the

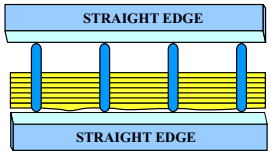
surface of the ruling table, the dieboard is placed on top of the paper, and then the dieboard is clamped or bolted to the ruling surface. ***See right***.



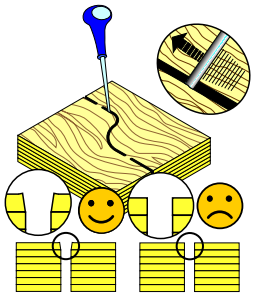
When the rule is inserted into the dieboard, the action of driving the crease rule into the dieboard will cause the round tip of the crease rule to protrude though the underside of the dieboard and indent the paper. Clearly, some of the advantages of using Double Round Creasing Rule, ***see left***, is it is easy to drive into the kerf channel, it is less likely to cause damage to the kerf walls, and it will protrude very easily through the dieboard.



Remember, the dieboard is only the toolholder, the heavy lifting of the mapping die will be done by the creasing rule grid, therefore, it is important that no variation in dieboard veneer flatness or moisture change, interfere with the performance of the rule. ***See right***.

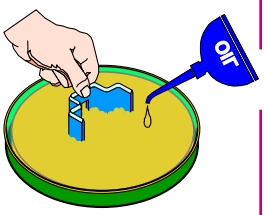


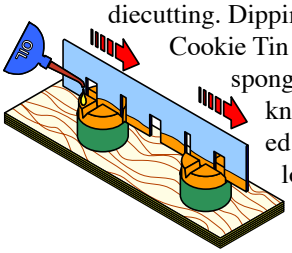
Although we are using double round creasing, which will make entry of the rule into the top of the kerf channel far easier, we will be using some very long lengths of rule. Therefore, it is an advantage to take a Marlin Spike, and with slight downward pressure, track every kerf in the dieboard to slightly open the top veneer. ***See left***.



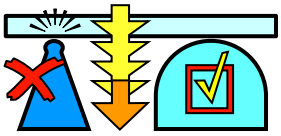
This is called the ***Kerf Open Technique***. This is a very common practice in diemaking as it makes it easier, safer and faster to insert rule, particularly long lengths of rule; it does so with minimal damage to the kerf channel and upper veneer layers of the dieboard; and it ensures precise rule seating, and a reduction in the challenge of cleaning the underside of the finished die.

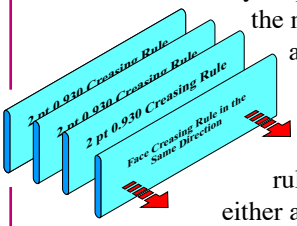
The next diemaking technique to consider is Oil Ruling. ***See right***. This is another established and proven practice, which provides a number of important benefits. First, it makes the rule easier to insert, second, it seals and protects the exposed end-grain in the walls of the kerf channel from losing moisture, and third, it generates better seating, better self leveling capability, and ultimately, better diecutting. Dipping each piece of rule into an inverted Cookie Tin Lid which is filled with oil soaked sponge, is difficult with long lengths of knife. Therefore, a simple jig is constructed for coating the lower portion of each long length of creasing rule. ***See left***.



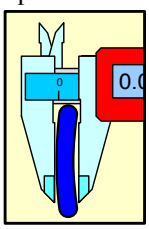


Before we discuss ruling it is important to reiterate the use of crease rule rather than knife in the Mapping Die. If we use knife in the Mapping Tool, there is always the chance of over-pressurization, and the possibility the knife edges will be damaged by the existing press imbalance. ***See right***. This would render the Mapping Tool useless, it would compromise the integrity of the mapping procedure, and it would require the tool to be reruled for every mapping procedure. Crease rule is by far the most effective choice, and it will generate a clearer image during mapping.

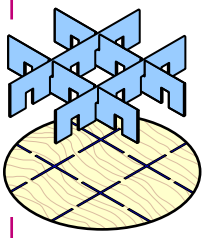




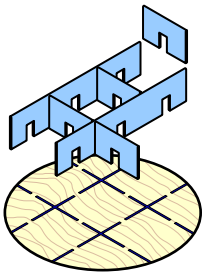
It is also important to further minimize variation by orienting all of the crease rules in the mapping die in one direction, either all toward the grip or toward the side lay. ***See above***. This is designed to minimize the impact of potential crease rule dish. ***See above.***



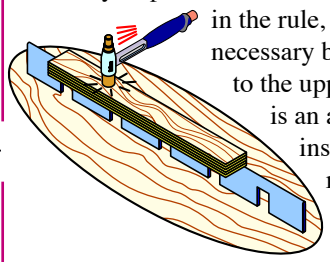
In the illustrations of the crease rule grid, it is shown as an interlocked design, ***see below left,*** which provides more effective image capture, however, it is more complex to fabricate and rule the dieboard.



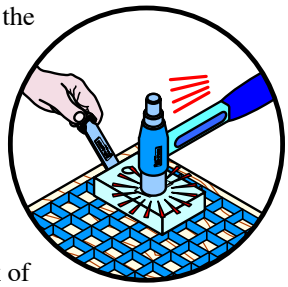
However, as long as care is used, it is equally effective to use full lengths of crease rule in one direction, and short bridging pieces in the other direction. ***See right***.



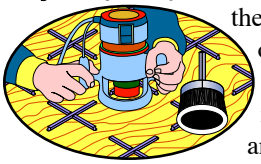
It is particularly critical when inserting the long crease rules, to use strips of wood in conjunction with a mallet or a hammer to drive them into the dieboard. ***See left***. It is obviously important to avoid creating a kink in the rule, weakened by the necessary bridging process, or to create damage to the upper veneer layers of the dieboard. It is an advantage to use two people in the insertion of these full length creasing rules.



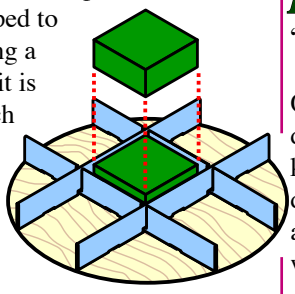
On completion of the ruling process, the entire die, meaning all of the rule forming the grid, should be planed flat using a planer with a dead blow hammer. ***See right***. This is intended to ensure every rule is properly seated, and are all set at the exact same height in the dieboard.



When this is completed, the ruled die is unbolted or unclamped from the bend, the paper removed, the table cleaned, and then the die is placed upside down on the bench. Using a Router with a Rotary Wire Brush attachment, the back of



the dieboard is carefully scoured and thoroughly cleaned. ***See left***. When this is completed, the Mapping Die is re-bolted or re-clamped to the bench, and the planing process repeated. With the dieboard still clamped to the bench the die should be rubbered using a dense ejection material. ***See right***. Note, it is important that the square of rubber in each cavity is identical in size, and the rubber is 0.25 inches or 6.5 millimeters smaller than the inside dimensions of the cavity, formed by the creasing rules.

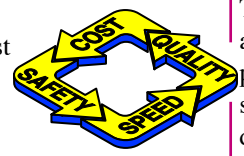


The die is ready to be used or ready for management and storage.

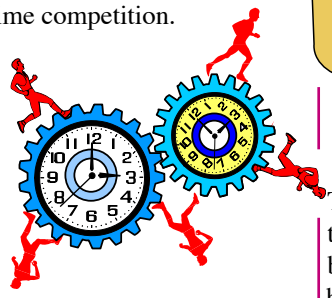
The complete and unabridged article "How to Design & Fabricate Press Mapping Tools" can be downloaded from the DIE Web Site. The Reference Number is DIE.05.06.

In Manufacturing: Every Second Counts!

*"**Time is the fire in which we burn**."* D. Schwartz

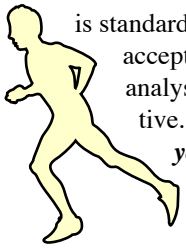


Time is at once the most valuable and the most perishable of all of our possessions, and in manufacturing, this means every second counts! The secret of effective manufacturing is contained in the mission directive Safety, Speed, Quality, and Cost. ***See right***. Using this focus, it is clear speed of processing is the dominant discipline, with cost being an equal partner. However, in the production environment taking about cost has little relevance to day-to-day activity, therefore, cost in manufacturing is converted to time management or time competition.



This is further refined and turned into a pragmatic and understandable improvement tool by using a basic and a consistently applied measurement of a specific time block. In numerous time and motion studies it has been demonstrated that even the simplest action takes one tenth of a minute or six seconds. This means that every step, every reach for a tool, and every basic movement will consume six seconds of valuable time.

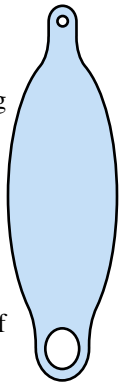
This is a valuable measurement tool because as each process is standardized or stabilized, without a universally accepted method of time measurement and time analysis, performance becomes highly subjective. As Horace Mann wryly pointed out: ***"Lost, yesterday, somewhere between sunrise and sunset, two golden hours, each set with sixty diamond minutes. No reward is offered for they are gone forever."***



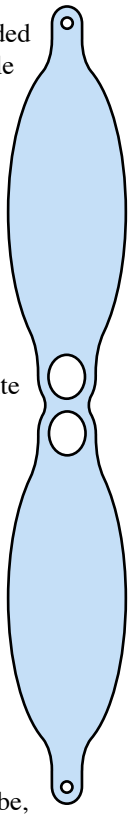
Every Step is Six Seconds!

Diemaking Mallet Hand Protection!

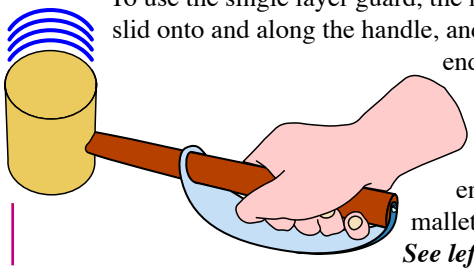
"***Precaution is better than cure***." ~ *Edward Cok*



One of the most common injuries in ruling a steel rule die is to strike your knuckles against an exposed cutting knife, when driving rule into a dieboard using a standard mallet. This is often the result of racing against a compelling deadline, tiredness and fatigue, and when reaching or stretching across a large dieboard. A fast, a simple and a highly effective modification to a hammer handle prevents this types of accident and it does so without interfering with the speed or the ease of ruling.

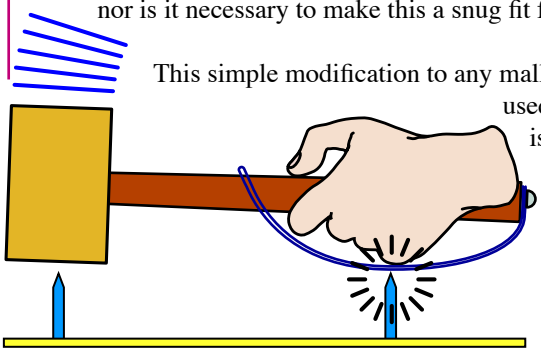


The mallet hand protection guard is made from discarded Lithography Printing Blankets which are a thin, flexible and slightly elastic sheet materials, composed of a tough composition rubber and canvas reinforcement. The material can be cut by hand or programmed into a CAD System and cut on a tangentially controlled plotter cutting knife. The guard can be made in a single layer of material, ***see the shape above***, or in a double layer, ***see the shape right***.



To use the single layer guard, the material is slid onto and along the handle, and the opposite end is folded around and screwed into the end of the mallet handle. ***See left***.

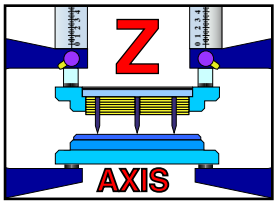
The double layer guard is simply folded in half and the process repeated. The length of the guard should be adjusted so it makes a curved arc under the mallet handle to make insertions and removal of the fingers simple and easy. ***See below***. However, this should not be, nor is it necessary to make this a snug fit for the hand.



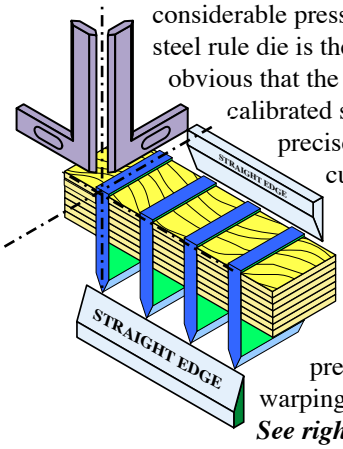
This simple modification to any mallet or hammer used in diemaking, is both practical and an important safety measure. If you have any tips you would like to add, please call.

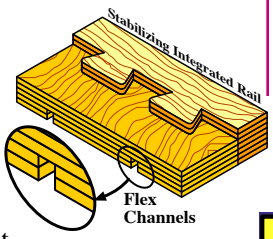
The "Kiss-Cut" Steel Rule Die

"***Mishaps are like knives that either serve us or cut us as we grasp them by the blade or the handle.***" ~ *James Lowell*

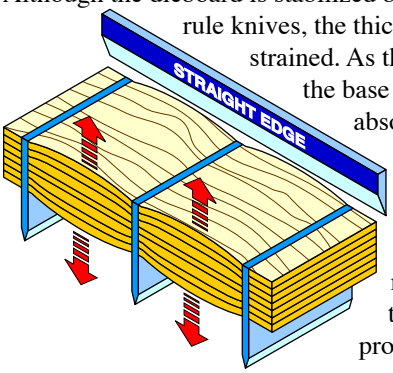


One of the most difficult challenges of diecutting is to get a perfect kiss-cut impression on every knife in the layout. To achieve this it is necessary to calibrate the platen press so the Z-Axis Distance between the upper tool holder, and the lower anvil or cutting surface is identical, even when under considerable pressure. ***See above***. Naturally as the steel rule die is the primary converting tool, it is obvious that the steel rules in the dieboard must be calibrated so every cutting edge is seated at precisely the same height as every other cutting edge at every point in the die layout. ***See left***. In addition, as the steel rule die can only be as accurate in the Z-Axis as the dieboard, the tool holder, it is vital the dieboard is stabilized and prepared in such a manner there is no warping or distortion of the finished tool. ***See right***.

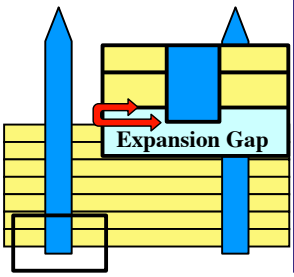




However, even with these precautions there is a potential key weakness in the finished plywood dieboard. Plywood is hygroscopic, which simply means it loves to absorb moisture from whatever environment it is in. Unfortunately, the platen well is like a greenhouse, in other words it is hot and moist! Although the dieboard is stabilized by the insertion of the steel rule knives, the thickness of the dieboard is unrestrained. As the production run progresses, the base veneers of the dieboard absorb moisture from the platen well, and the dieboard gradually swells. ***See left***. Even a slight increase in thickness will lift the steel rules off their feet, and lead to additional patch-up as the production run progresses.



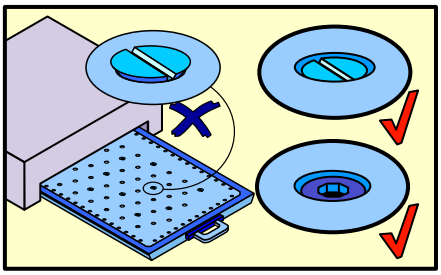
The solution is to fabricate the die so there is a space or an Expansion Gap between the base of the dieboard and the base of every steel rule. ***See right***. Another effective alternative is to use a Melamine Coated Dieboard or a Rayform material, which is resistant to changes in moisture content.



Eliminating Patch-Up Problems

"A common mistake that people make when trying to design something completely foolproof is to underestimate the ingenuity of complete fools." ~ *Douglas Adams*

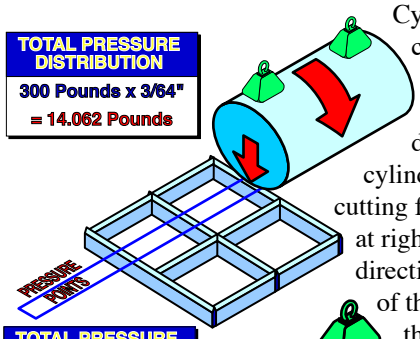
One of the most frustrating elements of diecutting, is many of the problems which undermine on-press performance are both trivial and yet persistent. For example, if you wish to accelerate damage to a steel rule die, if you wish to expend excess time in patching-up, if you wish to permanently damage the chase, the cutting plate and the patch-up cover sheet, if you wish to undermine productivity and quality, leave the heads of the bolts securing the die in the chase, protruding above the chase backplate surface. ***See below***.

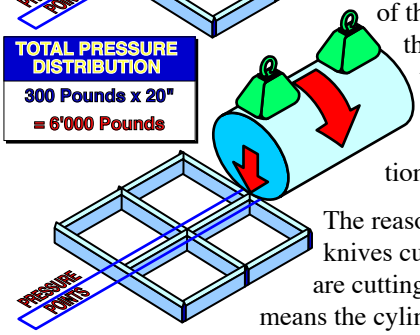


This is a common error, which although it creates serious make-ready problems and undermines both productive output and product quality, the toolmaker and the diecutter often ignore this damaging mistake. When the die is locked and bolted into the chase, run your hand or a straight edge across the backplate surface to detect any bolt head protrusion. If there is any, you need to replace the bolt or carefully file the head down using a sharpening stone!

Cylinder Diecutting: Pressure Distribution

"*Murphy's Law of Thermodynamics*
Things get worse under pressure."





Cylinder diecutting is characterized by the ease of cutting those knives aligned with the machine direction, or ***"around"*** the cylinder, and the difficulty of cutting for those knives cutting at right angles to the machine direction, or in-line with the axis of the cylinder. To minimize this problem it is important to understand why there is such a contrast in cutting efficiency in the two directions.

The reasons are simple. Those knives cutting around the cylinder are cutting ***"incrementally"***, which means the cylinder is only in contact with a very short length of the cutting edge at any one time. However, those knives aligned with the axis of the cylinder are cutting ***"simultaneously"***, which means the complete length of each knife must cut all at the same time. Applying the standard calculation of 300 pounds per inch of cutting knife, the knives cutting incremental around the cylinder in the illustration only require an efficient 15 pounds of pressure to diecut. However, the knives cutting simultaneously at right angles to the machine direction require 6000 pounds of pressure to diecut?

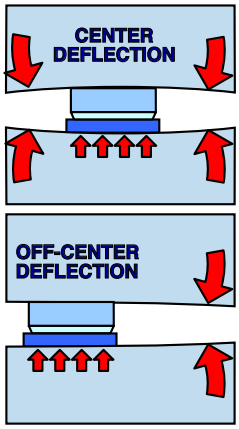
Unfortunately, it is necessary to make the press ready to the simultaneous cutting knives which inevitably leads to damage to the incrementally cutting knives. ***The solution? Use a higher Bevel Knife Incrementally, Around the Cylinder, and use a Lower Bevel Knife Simultaneously, in line with the Cylinder Axis!***

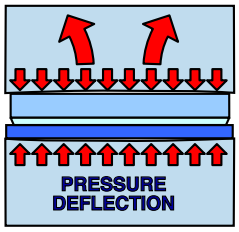
The Challenge of Press Deflection

"*A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty.*"

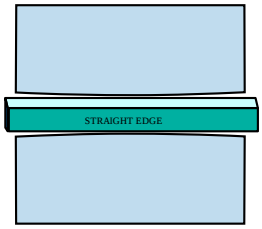
One of the key problems undermining a precise and fast press make-ready, is the problem of the upper and lower platen bending or deflecting under converting loads. ***See above next column***. Although this is an invisible phenomena, it is very real and it will generate steel rule die damage, it will accelerate press mechanical wear, and it will compromise diecut product quality.

The graphics show ***Center Deflection*** and ***Off-Center Deflection***, however, it is important to understand the stress the platen mechanical system is under. This shows most clearly when a full size die is made ready. You would assume if the entire surface of the platen is covered, there would be minimal deflection? Unfortunately, it is not uncommon to have to patch the center of the die to get it to cut, because what is happening is the upper platen is deflecting out of shape, and patching is only making the deflection worse! This is called ***Pressure Deflection. See left***.





One of the innovative techniques used to minimize this form of pressure/resistance deflection is to pre-curve the upper and the lower platen. ***See below***. This is being done with both fixed and adjustable curvature.

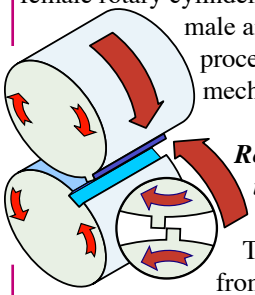


Diecutting is about balance and the reality of the potential for damaging deflection must be integrated into tool design with the integration of leveling knives and pressure balancing bearers in the die, and the insertion of press stops between the upper and the lower platen.

What is Rotary Pressure Diecutting?

"*We create our fate every day we live.*" ~ *Henry Miller*

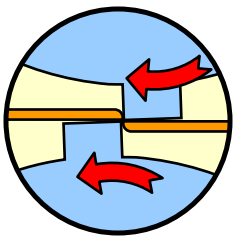
In Rotary Pressure Cutting the material being processed is a web of paper or a substrate which is often pre-printed in-line prior to reaching the diecutting section of a press. In this system creasing and cutting are separated with the first set of matched male and female rotary cylinders focused upon creasing. The second set of male and female cylinder completes the converting process and usually incorporates a pin stripping mechanism.



Rotary Pressure cutting is unique as the tools do not touch each other.

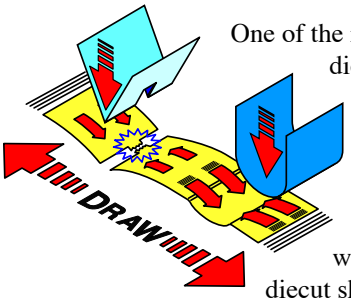
The web of material is severed by being burst from both sides by a raised land on the male cylinder, which is coordinated to match a raised land on the lower cylinder. ***See above***.

The two ***"lands"*** are designed to leave a minute gap so there is no tool-to-tool contact or damage. ***See right***. Rotary Pressure Cut Diecutting is amongst the cleanest form of diecutting and is characterized by smooth, dust and fiber free diecut edges.



Nicking Rails to Increase Press Productivity

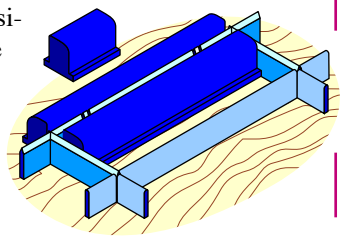
"***Time cannot be expanded, accumulated, mortgaged, hastened, of retarded.***" ~ *Anon*



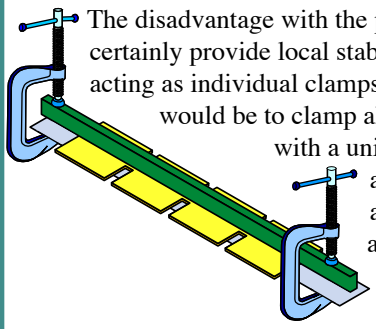
One of the more complex challenges for the diemaker and the diecutter is the ability to manage and to minimize the impact of draw forces, grinding of gaps called nicks into the profile of the finished steel rule die. Naturally, the diecutter would add nicks to strengthen the diecut sheet and the customer demands less ugly tags of uncut material disfiguring the finished diecut product. ***The customer wins this argument!***

Unfortunately, the bottom line is it is essential to find an efficient and an effective way to overcome lateral stress and draw, ***see above***, if an acceptable size nick is to be approved and the required productive output is to be achieved.

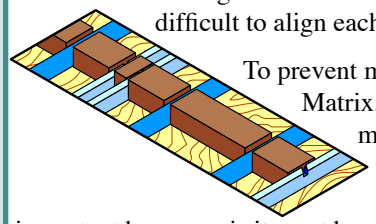
To strengthen each nick, and to isolate the lateral draw forces acting upon each nick the diemaker positions asymmetric, very dense profile rubber either side of the nick/knife position to provide a stabilizing and tensile stress reducing force. ***See right***. However, this is not always effective and the solution, particularly for thinner materials, is to use the ***Nicking Rail Technique.***



The Nicking Rail Clamp



The disadvantage with the profile rubber is although they certainly provide local stabilization, each combination are acting as individual clamps. The more effective method would be to clamp all of the parts simultaneously with a unified clamp, which would be aligned through as many nicks as possible. ***See left.*** This is accomplished by attempting to align the nicks from grip to back-edge or from side lay to off lay, and then by running a continuous strip of rubber across the entire die. ***See below***. The reason this ejection-nicking rail is so wide is it is designed to cover all of the nicks even when it is difficult to align each nick correctly.



To prevent marking when using counters. Matrix, or vulcanized fiber make-ready material, the strip of rubber can use several different durometers as it crosses the die. What is important however, it is must be continuous, from cut-to-cut to-crease-to-crease, through the entire tool.

Summary

This has proven to be highly effective as it reduces the number of nicks requires and the size of each nick can be similarly reduced. However, the results demonstrate less sheet break-up and faster running speeds, and a happier press operator and customer!

Trapezoidal Shaped Ejection Material

"***Quality is not an act. It is a habit.***" ~ *Aristotle*

One of the most important changes to the traditional rubber material used to fit ejectors to steel rule dies, is the development of the Trapezoidal Shape. ***See below.***

This shape has a wide base for stability; the angled walls provide a simple method of positioning the rubber against the knife, however, the angle provides an effective expansion gap; and the small upper strike surface reduces compressive load but helps to preserve important resiliency attributes.

Sticking standard square rubber against the cutting knife is a serious mistake. This approach increases the pressure required to diecut; it increases flaking; it breaks nick tags prematurely; it reduces the effectiveness of the ejection action; it flexes knives and fractures joints; and it reduces press speed. This is why Trapezoidal Rubber is becoming the ejection standard for high speed, productive diecutting.