DIEINFO Converting Information into Knowledge

There is not substitute for knowledge,
nothing else matters, it is the most important thing.
- Dr. W. Edwards Deming

"How To Crease & Fold Paperboard & Fluted Material, to Eliminate Problems, Forever!"

A Dieinfo Publication

Author: Kevin B. Carey

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About the Publisher & Editor

Carey has been involved in converting, diecutting, diemaking, and related technology for more than 40 years. Kevin began his career with an intense five year apprenticeship in a large folding carton company in England. Over the next decade Kevin was a printer, diemaker, press operator, trainer, trade union leader, supervisor, and manager in a number of companies.

Carey immigrated to the United States in 1979 and formed an innovative organization called Lasercomb America. As President and CEO of the company; Kevin and his partners led the organization to become the dominant commercial diemaker; the innovator of ground-breaking CAD CAM and Computer-Integrated-Manufacturing systems, and to originate the use of computer graphic systems in packaging.

From the moment I picked up your book until I laid it down, I was convulsed with laughter. Some day I intend reading it.
Groucho Marx

The experience gained in creating an industry leading technology and toolmaking company, induced Carey to change career paths in 1990, when he formed a training and process development company dedicated to education in converting.

First as a technical consultant, then as a trainer, and as a publisher, the company began to define the problem of productive performance in converting manufacturing, and to develop solutions to seemingly intractable problems and to fill knowledge gaps.

It became apparent during this time there was a poor understanding of the difference between training, information, and technical data management. Poor performance was often diagnosed as a training problem, when it was more likely the absence of good technical information, which inhibited progress and performance.

These experiences culminated in the formation of Diecutting Information Exchange, and later Dieinfo. The mission of these organizations remains focused upon developing converting excellence, by collecting, collating, and focussing information from each manufacturing discipline, to optimize diecutting performance.

The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable man.
George Bernard Shaw

Since 1990 Carey has worked with the largest companies in the industry, and one man operations, and makes no apologies for his energetic, humorous and dynamic presentation of exceptional material, to ensure optimal knowledge and skill development.

Carey has given hundreds of presentations to the Converting Industry, in Europe, the Pacific Rim, and North and South America. He was the publisher of Packaging Productivity and the Diemaker's Resource for many years, and is currently publishing DieInfo Converting Diecutting Productivity, DieInfo Converting Diemaking Productivity, North West Converting, and several other publications for his Technical Director clients.

Carey was honored in 1984 by the International Association of Diecutting and Diemaking, when they presented him their prestigious ***"Man of the Year"*** award, in recognizing his contribution to the industry.

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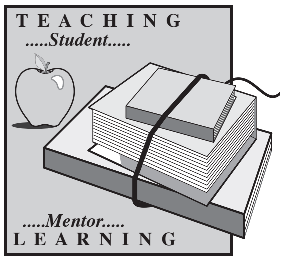
Chapter A:
Introduction: A Path to a More Productive Future.

"Commit yourself to lifelong learning. The most valuable asset you will ever have is your mind and what you put into it." Brian Tracy

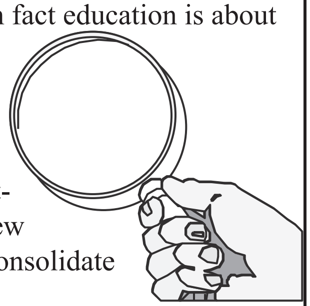
Cautious Skepticism is Healthy!

"All uncertainty is fruitful ... so long as it is accompanied by the wish to understand." Antonio Machado

One of the most important and healthy instincts we posses is our insatiable curiosity. It is in our nature to inquire, to seek knowledge, to find better ways to do things, and to pursue a safer, more secure, and a more rewarding life for our family and ourselves. Every day we gain new information about our world, about our environment, and about our work. When we are tuned in we focus on turning this stream of valuable data to our advantage. Even our cautious skepticism and our occasional cynicism are healthy responses to the challenge of new knowledge.



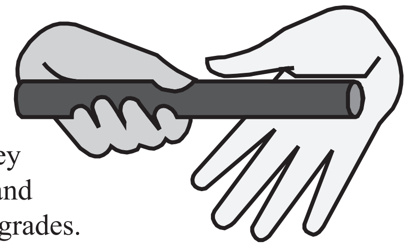
However beneficial, new knowledge is challenging. Education generates information, fostering change, action, adjustment, and sometimes uncertainty. The danger is not in how we respond to new information but in an occasional urge to resist change and attempt to live in the past. Not that the past is necessarily bad. In fact education is about progressive change where we build upon a foundation of past success and with the experience gained from inevitable failure, old methods are upgraded, outdated practices are discarded, and new procedures are incorporated, to consolidate the best of the best.



Create a Team Approach to Progressive Change.

"Education makes people easy to lead, but difficult to drive; easy to govern, but impossible to enslave."
Henry Peter Brougham

Unfortunately, this is where we can struggle as an industry. It is true most people are uncomfortable with constant daily change, and each person has a different ability to accept and assimilate new ways to do things. The most effective method of dealing with process improvement is to assemble the work team or a number of key players to brainstorm and determine potential upgrades.



This team would then design an implementation plan for a limited number of changes, review the results after a specified period of time or a number of production cycles, and then approve or modify and retest the new methods. Even then the procedures should be carefully documented, benchmark time standards established to determine performance measurement, and then the complete sequence or the upgraded practice videotaped. The team would then determine a period of time for the work team to get used to the new way of doing things, to practice the new techniques, and then to stabilize the modified system of manufacturing.

In this way all of the team members are involved, there is adequate time for discussion, adjustment, and learning, and the organization is making constant productive progress. It is important to recognize, although change brings uncertainty and a temporary lowering of operating confidence, it ultimately ensures greater competence and experience. ***What are the benefits of education and learning?***

Knowledge is Power!

"There is no knowledge that is not power."
Ralph Waldo Emerson

What are the benefits of committing to daily education and building a learning organization?

➔ *To anticipate and solve problems*
➔ *To reduce frustration and stress*
➔ *To gain leverage and influence*
➔ *To improve our professional value*

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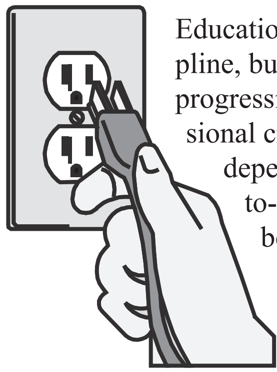
➔ *To increase job security*
➔ *To take productive action*
➔ *To simplify complex tasks*
➔ *To gain competitive advantage*
➔ *To gain respect, appreciation and praise*
➔ *To share knowledge and skill with our colleagues*
➔ *To build a more productive future*



Education is not a static, esoteric discipline, but it is about action, change, and progressive improvement. As a professional craftsman or woman our future depends upon our ability to be up-to-date, to be innovative, and to be productively flexible. It is our most important asset. If it is so critical to individual, to team, and to company success, what goals should we be pursuing in expanding our knowledge and our skill?

Personal Goals for the Master Crafts Person

"You are your first product, so positioning yourself in the market as an individual is extremely important." Portia Isacson

What are the goals you should be considering as you begin using this manual or committing to productive improvement? These could be:

➔ *To develop an effective career and job strategy*
➔ *To develop technical competence and confidence*
➔ *To define current knowledge limits and potential for improvement.*
➔ *To consolidate, organize, and energize your skills*
➔ *To be the very best you can be*
➔ *To develop a knowledge and technical information network*
➔ *To develop reference resources and data outlets*
➔ *To be less frustrated, more proficient, faster & better*
➔ *To gain recognition from peers, company & industry*
➔ *To leverage more money and gain greater job security.*

You should reorganize, modify, and augment this list to reflect your own ideas and your specific goals. A good piece of advice is to start keeping a daily record of activities,

actions, and results. Therefore, it is vital you begin keeping a daily journal, to record your ideas, to collect information, to brainstorm, to make notes, and to remain focused upon your goals.

If these are your personal goals, what are the professional aspirations you should become dedicated to?

Professional Goals for the Master Crafts Person

"Acquire new knowledge whilst thinking over the old, and you may become a teacher of others." Confucius

What are the goals you should be considering in terms of your career as a Master Craft Professional? These could be:

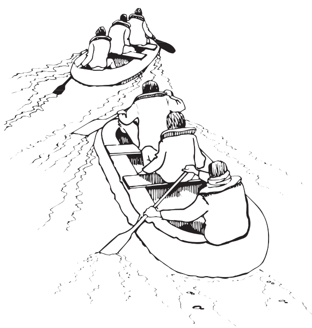
➔ *To create an effective plan of action*
➔ *To close the knowledge and skill loop*
➔ *To evaluate current methods and practices*
➔ *To find simpler, faster, and better methods*
➔ *To learn how others solve key problems*
➔ *To evaluate your knowledge, skill and ability*
➔ *To improve career prospects and opportunity*
➔ *To eliminate specific technical issues and bottlenecks*
➔ *To understand the science and the underlying theory*
➔ *To develop mastercraft status and recognition*

No matter what your position, what your do, or your current status, developing master craft ability, or optimal professional skill, should be a by-product of every daily activity. However, you are not isolated and you work in and with a team of people, who may need your help, who may seek your guidance, and who may need your leadership.

In reality you should be a positive and productive force in all of the teams you participate in, however, to be a great team player, it is obviously important to have a professional foundation of integrity, of openness, and as part of the team, dedicated to being the best you can be.

What are the appropriate goals for the Production Team?

"You should have enough education so that you will not have to look up to people; and then more education so that you will be wise enough not to look down on people." M.L. Boren



What are the goals you and the production team should be considering, in terms of your work together in a professional team? These could be:

- ➔ *To work safely, at higher speed, with better quality, and lower cost*
- ➔ *To accelerate knowledge and skill development and to learn from each other*
- ➔ *To resolve technical disputes and unify the best methods*
- ➔ *To align the best techniques, methods, and procedures*
- ➔ *To generate the best ideas, best practices, and best performance*
- ➔ *To create a technically balanced professional work team*
- ➔ *To create a vibrant technical partnership*
- ➔ *To create an effective training program*
- ➔ *To build an industry library and reference foundation*
- ➔ *To create a world class manufacturing team*

Good teamwork begins with good communication. Try to involve the entire team, at some level, in brainstorming, in discussion, in determining technical changes, and in making important decisions. A great quote from Hamilton Barksdale illustrates the challenge of building an effective team; ***"The whole object of the organization is to get cooperation, to get to each individual the benefit of all of the knowledge and all of the experience of all of the individuals."***

Successful manufacturing relies upon powerful people, who cooperate and work for each other, who put each other first, and who are committed to teamwork. Manufacturing is generally a team sport, and it is impossible to make it to the World Series without a great team.

We have discussed personal, professional, and team goals, but what of the organization who is making all of this possible, and who is investing in your success. What are company goals?

Goals for the World Class Converting Organization

"The magic formula that successful businesses have discovered is to treat customers like guests and employees like people." Thomas J. Peters

It is obvious there is intense competition in the Converting Industry. This is driven by over capacity, by competitive innovation, by speed of response, by the quality and the consistency of output, by economic fluctuation, and by the cost of manufacturing. Companies are striving to create a world class manufacturing organization, which is equally adept at competing regionally, nationally, and internationally. The over riding mission statement of an effective manufacturing organization is ***Safety, Speed, Quality, and Cost. See below.***

This demands an effective, innovative, and well-organized operation, driven by a motivated team of technically gifted individuals who are accurately aligned with company goals and aspirations. What are the goals of your organization who is making an investment in your technical education?

- ➔ *To build a World Class organization*
- ➔ *To develop the best system of manufacturing*
- ➔ *To develop a fast cycle "learning" operation*
- ➔ *To develop procedural uniformity and performance parity*
- ➔ *To generate optimal and consistent output quality*
- ➔ *To maximize output speed and yield*
- ➔ *To eliminate errors and mistakes*
- ➔ *To reduce waste and develop the lowest cost of manufacturing*
- ➔ *To accelerate changeover and competitive performance*
- ➔ *To create a World Class manufacturing Team*

So far we have examined potential personal, profession al, team, and company goals, but what other elements of manufacturing are critical to success. In essence all types of manufacturing are about the movement of information and material. Therefore, it is important to gain knowledge about the importance of developing a comprehensive information management system for converting manufacturing. It is vital to integrate the discipline of time management, statistical evaluation, and of establishing benchmark standards for key activities.

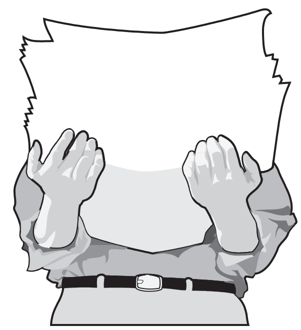
Finally, it is critical to set up an effective system of performance measurement, to ensure all the changes and upgrades and improvements are delivering the productive output they promise. Therefore, what are your team, and your company goals in terms of developing a greater use of valuable information resources?

Information Management: The Keys to the Kingdom

"If you get all the facts, your judgment can be right; if you don't get all the facts, it can't be right." Bernard M. Baruch

What are the essential goals of creating an effective technical, commercial, and performance information system?

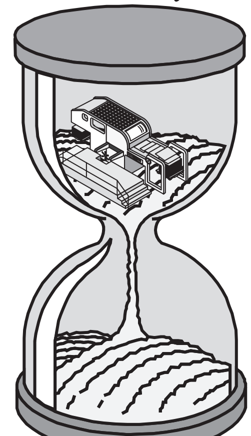
- ➔ *To understand the role, the power, and the value of information*
- ➔ *To develop an understanding of how accurate information drives manufacturing success*
- ➔ *To develop information collection and management systems*
- ➔ *To find and define all current information sources*
- ➔ *To collect and collate all current information*
- ➔ *To determine what information is currently missing and incomplete*
- ➔ *To develop a technical internal & external information resource*
- ➔ *To develop a scientific approach to manufacturing*
- ➔ *To educate the organization about information management*
- ➔ *To develop accurate terminology and precise communication methods & practices*



It will take time for everyone to understand the role, to understand the importance, and to understand the value of good information. To build a world class organization, it will be necessary to patiently educate every key player about how a comprehensive technical data system is essential for productive converting. As Claude Bernard noted, ***"A fact in itself is nothing. It is valuable only for the idea attached to it, or for the proof which it furnishes."***

Why is Time Management so Critical to Manufacturing Success?

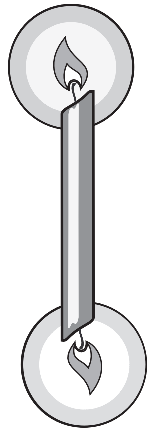
"A sense of the value of time—that is, of the best way to divide one's time into one's various activities—is an essential preliminary to efficient work; it is the only method of avoiding hurry." Arnold Bennett



In manufacturing time is at once the most valuable and the most poorly utilized resource. Every element of the process hinges on prudent time management. Therefore, time management is one of the most important creative disciplines in building and maintaining a productive production process. How should time management be used?

- ➔ *To determine how time is consumed in the manufacturing operation*
- ➔ *To establish current* ***"baseline"*** *performance standards*
- ➔ *To find the fastest, the simplest and the safest way to do things*
- ➔ *To establish clear, fair, and acceptable performance benchmarks*
- ➔ *To establish a priority for analytical and remedial action*
- ➔ *To evaluate competing procedural options and practices*
- ➔ *To organize* ***"just-in-time"*** *efficient work areas*
- ➔ *To focus upon and eliminate non-value added activity*
- ➔ *To create an understandable and fair system of measurement*
- ➔ *To reduce stress, physical exertion, and fatigue*

Time management is the most important discipline in manufacturing, as it is in life. We have a limited number of hours to accomplish things and the universal drive is to make the most of our time. As Peter Drucker observed; ***"Time is the scarcest resource, and unless it is managed nothing else can be managed."***

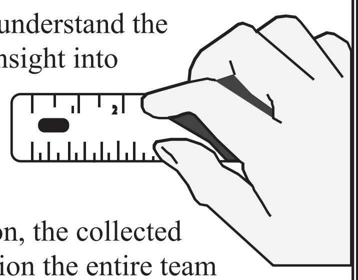


To repeat, time is our most valuable and yet most volatile resource. We must manage it effectively or it will manage us!

Why is Process Measurement so Critical to Manufacturing Success?

"The real contest is always between what you've done and what you're capable of doing. You measure yourself against yourself and nobody else." Geoffrey Gaberino

It is important to establish a fair, an understandable, and an effective system of measurement. Therefore, the goal is to create a system of measurement which enables the person collecting the data to understand the information, to gain a fresh insight into what is happening, to be able to act upon the information, and to make productive changes based upon greater knowledge. In addition, the collected data should provide information the entire team and the entire organization can use to consolidate expertise, to improve productive throughput, and to increase converting product quality.



A good performance measurement system should enable the team:

➔ *To determine what must be measured and why*
➔ *To determine what is currently happening and why*
➔ *To determine and define current performance parameters*
➔ *To establish current performance benchmarks*
➔ *To integrate statistically based graphic key result analysis*
➔ *To establish baseline performance bottlenecks and standards*
➔ *To prioritize the development of measurement techniques*
➔ *To analyze success, errors, and opportunities*
➔ *To set a course for achievable productive improvement*
➔ *To increase productivity and improve product quality*

The goal of an effective system of measurement is to educate, to expand knowledge, and to find easier, faster, and better ways to do things. Good measurement is an important tool in building a more productive operation.

What is the most effective approach to using this manual productively?

"Knowledge is of two kinds; we know a subject ourselves, or we know where we can find information about it." Samuel Johnson

The power of ongoing education is it enlightens, energizes and expands current knowledge. By combining these new techniques and manufacturing concepts with your existing knowledge and experience, unique new methods and practices will emerge. The challenge of new information and ideas is they should act as a catalyst, they should fill knowledge gaps, and they should inspire the work team to higher levels of competence and performance. Therefore, it is important to integrate these ideas carefully.

➔ *Share the information and cautiously discuss the ideas and concepts*
➔ *Break each section/discipline into separate binders*
➔ *Collect and document every piece of existing data about each discipline*
➔ *Test and evaluate new techniques and upgraded practices*
➔ *Brainstorm and integrate the best of the old with new techniques*
➔ *Assign responsibility for action on selected disciplines to work teams*
➔ *Test, evaluate, modify, and develop a consensus procedure*
➔ *Develop a new standard operating procedure for each discipline*
➔ *Develop new performance benchmark standards*
➔ *Implement a re-training program for each upgraded discipline*

It is vital to use the knowledge, the information, and the ground breaking concepts contained in this program as a positive catalyst to promote productive change. You will in affect become a teacher, a mentor, and a leader, as you make steady but cautious progress.

How to implement an Effective Plan of Action?

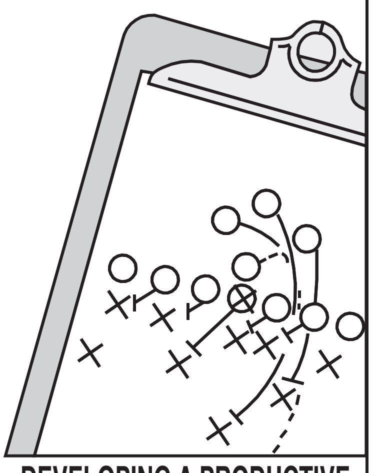
"Training is the teaching of specific skills. It should result in the employee having the ability to do something he or she could not do before." Mary Ann Allison

To implement an effective plan of action the following steps should be considered:

- ➔ *Make a presentation of the manual, program, and key concepts to the management and work teams*
- ➔ *Follow up with a brainstorming and discussion session with the work team*
- ➔ *Add team ideas, modifications, and suggestions*
- ➔ *Select and prioritize a number of key actions*
- ➔ *Assign team and/or individual responsibility*
- ➔ *Assign each team to develop and submit a consensus plan of action*
- ➔ *Document key steps, plan and schedule production testing*
- ➔ *Define measurement methods and criteria*
- ➔ *Implement upgraded practice and monitor results*
- ➔ *Complete team meetings to discuss results, to make changes, and retest*

Clearly the new procedure should be documented, even though it is likely existing practices and methods are poorly defined.

Eventually, the approved procedure should be videotaped, integrated into a Training Map, and used as the basis for individual training and certification.



DEVELOPING A PRODUCTIVE PRESS SET-UP STRATEGY

With this new information, your knowledge and experience, and with the ideas and suggestions of your colleagues, we can build a more productive system of converting manufacturing. Remember, whatever you decide it will be ultimately more effective, when the plan represents a team consensus, no matter how difficult that is to achieve. But we must begin, we must take action, and we must move forward.

A Path to a More Productive Future: Summary

"First study the science, and then practice the art which is born of that science." Leonardo de Vinci

Our current systems of diemaking, diecutting, and manufacturing are severely inhibited by a poor understanding of the principles of the process, and by disarray of poor and incomplete technical data. Further compounding the problem are inconsistently applied practices, inferior measurement methods, combined with poor time management and benchmarking. Finally, our greatest weakness is a failure to turn every production cycle into a learning opportunity.

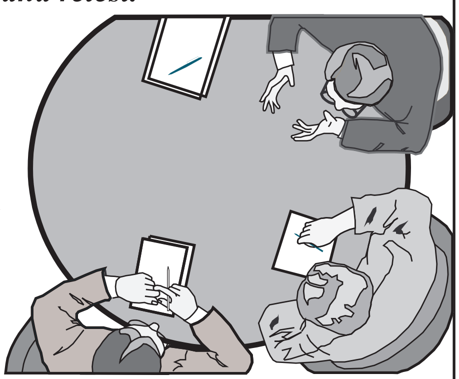
There are two quotes worthy of consideration here. The first is from Roger Von Oech when he stated; ***"Remember the two benefits of failure. First, if you do fail, you learn what doesn't work; and second, the failure gives you the opportunity to try a new approach."*** And the second quote is from Rudyard Kipling; ***"I keep six honest serving-men, They taught me all I knew; Their names are What and Why and When, And How and Where and Who."***

Therefore, with new information, your current knowledge and experience, and with the ideas and suggestions of your colleagues, we can build a more productive system of converting manufacturing. But we must begin, we must take action, and we must move forward.

Having invested valuable time in reading this technical report it is time to convert your education initiative into pragmatic action. What are basic steps you should consider?

1. ***Make a presentation of the manual, program, and key concepts to the management and team leaders.***
2. ***List, discuss and define the key points presented, & recommended action and priority.***
3. ***Follow up with a brainstorming and discussion session with the work team.***

4. Add team ideas, modifications, and suggestions.
5. Prioritize issues to be investigated & researched
6. Compare current practices with technical recommendations & elect and prioritize a number of key actions.
7. Combine & integrate new and established practices.
8. Prioritize actions and production testing & assign team and/or individual responsibility.
9. Define the number of tests, the key steps, & then plan and schedule production testing .
10. Define methods and criteria & determine key benchmarks for measurement.
11. Appoint test and documentation responsibility and a timeline to implement upgraded practices & monitor results.
12. Complete team meetings to discuss results, to make changes, and retest.



Clearly the new procedure should be documented as it is proven and approved, even though it is likely existing practices and methods are poorly defined. Eventually, the approved procedure should be videotaped, integrated into a Training Map, and used as the basis for individual training and certification. It is important to recognize the validity of this quote from Mary Ann Allison when you are assessing productive progress. ***"Training is the teaching of specific skills. It should result in the employee having the ability to do something he or she could not do before."***

One key error to avoid is working hard to create an effective plan of action, and then failing to be realistic about the implementation of the plan. Treat process improvement with the importance it deserves. For example, any process improvement action, task, or initiative should be scheduled just like any other production task or job! Most companies pay lip service to process improvement but work at it only when there is time or there is no production work. As a result process improvement is painfully slow and often is simply a plan of action gathering dust in some obscure filing cabinet. Process improvement is essential to gain time, to generate speed and throughput, and to energize productive potential. It is as important as any customer job, and your customers will repay your continuous performance improvement by loyalty and more work.

This is a great opportunity to start over and redefine the process with a fresh approach. Combining the best of the old with new ideas, improved techniques, and better methods. After you have had time to digest this information, collected your thoughts, and put everything together in an action plan, the team can make a new beginning. It is useful to create a ***"subject"*** book or manual, to make notes, record key information and tool parameters, and collect results.

But remember the challenge of productive change is as simple as it is powerful! Schedule process improvement as a vitally important change in the performance capability of the organization and not as a filler when and if time is available!

Also, it is useful to always remember mistakes are inevitable! However, if they are regarded as opportunities, as a way to eliminate another variable, as a tool to increase our understanding, and as a guide to change the way we do things next time. We will have made an important step forward. Make something productive happen. Be passionate, patient, relentless, fair, steadfast, open minded, and endlessly curious. And remember ***"Education is not filling the bucket but lighting a fire."*** *William Butler Yeats*

If you need technical assistance, advice, or recommendations, please call, we will be delighted to hear from you. Good luck with this project.

Chapter A:
A Path to a More Productive Future: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ Cautious skepticism represents a healthy outlook, but to be skeptical you have to listen to and to keep an open mind to new, different, or radical suggestions.

- ✓ Teamwork in manufacturing is the basis for productive success, and building effective team work is the most challenging task faced by the organization.

- ✓ Professional and personal success is a function of acquired knowledge and experience; knowledge and experience is a function of education and learning; and daily education and learning are the foundation for success.

- ✓ To be an effective well balanced team player you have to be an effective, well balanced individual. By setting and reaffirming personal goals you can develop your energy, your attitude, and your participation, to help yourself and the rest of the team you work with.

- ✓ As a professional craftsperson it is important to continuously define where you are, where you are going, and to have a plan of action to get there.

- ✓ To build a great team it is important to communicate openly and often; it is critical to discuss and consult; and it is vital to develop a vision and a mission, that the entire team can be inspired by.

- ✓ In becoming a professional crafts person and in building a great team approach to diecutting it is strategically important to recognize you are competing against other teams, in other organizations, in other parts of the world. Being the best you can be is not limited by geography.

- ✓ Information is the life blood of effective manufacturing, and it is important to strive to expand, to consolidate, to verify, and to distribute the information on a daily basis.

- ✓ Time is our most valuable and our most volatile resource, therefore, it is imperative to use time as a tool to guide, to measure, and to assess performance.

- ✓ It is said of manufacturing, if we are unable to measure something, it is impossible to manage it! Measurement is an information tool, it is an education tool, and it is an unbiased judge of progress.

- ✓ This manual and this program are a guide, and the goal is to compliment and augment your skills and ability and challenge your knowledge and experience. It is simply a tool for change, and a tool which you control.

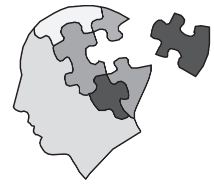
Chapter A:
A Path to a More Productive Future: Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ What do you think is the most appropriate reaction to new ideas and suggestions, particularly where they challenge or contradict current methods and practices?
- ✓ How would you organize the production team to focus everyone in diecutting manufacturing on a unified plan of action?
- ✓ Would you accept the statement that knowledge is power, and if so, how would you organize a daily education and learning program for your self and your colleagues?
- ✓ How would you describe your personal goals as a key member of the diecutting manufacturing team?
- ✓ In aspiring to be an effective, professional crafts person, how would you prioritize the goals a person in that position should be pursuing?
- ✓ If you were selected to lead the productive improvement initiative in diecutting, what goals do you feel are appropriate for the existing production team?
- ✓ How would you and how do your rate the competitive performance of other teams, in other operations, in other countries?
- ✓ Could you suggest three ways a more effective information management and collection system would improve diecutting manufacturing?
- ✓ Describe two areas of diecutting where you feel time management and just-in-time management would improve organizational performance?
- ✓ What do you think of current process measurement systems, how would you change them, and what would you add and why?
- ✓ What do you feel is the greatest impediment to making rapid performance improvement in diecutting manufacturing?
- ✓ Do you feel the organization is prepared for radical change of methods and procedures, and if not, how would you change things to make sure the organization is moving forward?

Brainstorming, Notes & Ideas

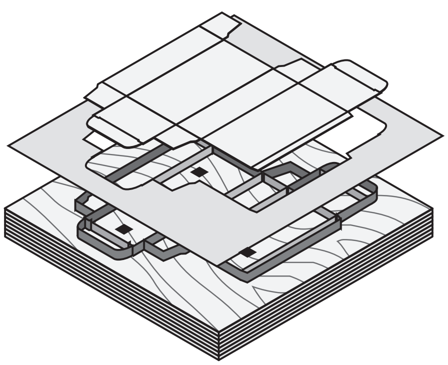
"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*



Chapter 1:
"The Goal of Effective Creasing"

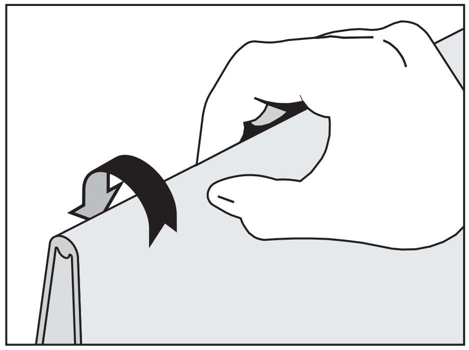
> *"Without a goal to work toward, we will not get there."*
> Natasha Josefowitz

Before even beginning to think about the goal of effective creasing, it is important to understand the dynamic of the converting industry. This means considering the constant change, which impacts every design, and manufacturing decision we make. It is vital to recognize the rapid and almost daily change in materials and in the technology of fabricating paperboard and fluted materials, which demand job to job vigilance. It is also important to accept the responsibility to educate, to teach and to train the workforce to have greater folding and creasing knowledge and skill.



As a result, one of the by-product of each converting manufacturing cycle, should be the consolidation of a growing database of cutting, creasing, and diecutting converting parameters. This should focus upon but not be limited to paperboard, tooling, tool-settings, tool materials, the impact on creasing on the rest of the diecutting process, and the relationship between the design and the type of creasing method selected.

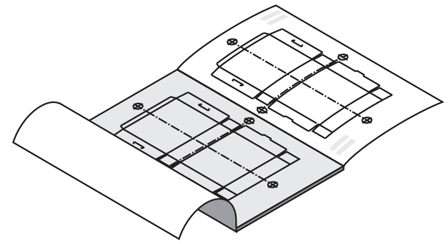
With this overall understanding of the responsibilities of the designer/toolmaker, it is possible to concentrate on the specific technical needs of the design to be creased and folded.



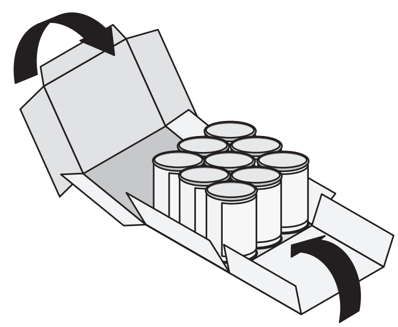
In creating a controlled failure in a paperboard or a fluted material it is important to understand the role of the crease and the attributes it must have to succeed.

The general assessment of a crease is derived from folding the panels through 90 and then 180 degrees and then by examining the spine or outer surface of the crease to see if there is any surface fracturing or splitting. See illustration.

Although this is certainly one of the requirements of an effective crease



crease this is only one element of a hinge performance which must provide 10 key attributes to the container and to the packaging process. Therefore, the creation of an effective crease ***must*** provide the attributes listed at the bottom of the middle column:



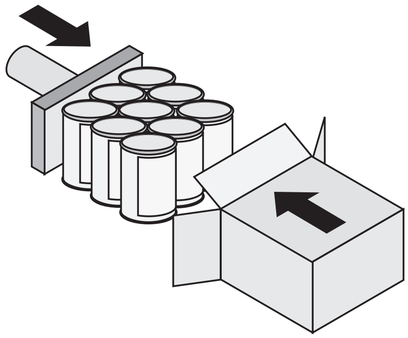
All of these attributes must also be based upon each individual material, on the design of the carton, and on the application the container is being used in. For example, there is considerable difference between the folding needs of a container which is being hand erected and filled, compared to a container which is being machine erected and filled.

Furthermore, the speed of cartoning, how the carton is erected, and the type of contents being packaged, impact the demands on crease/folding - hinge/rotation performance.

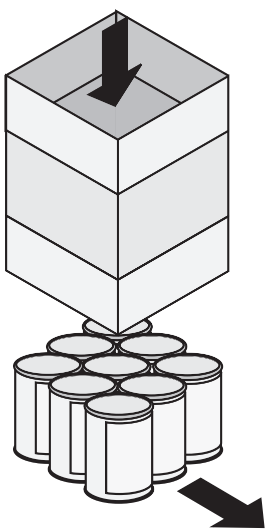
Key Crease Attributes

- ➔ *A Resilient "Power" Hinge*
- ➔ *Crease by Crease Predictable Folding Force*
- ➔ *Crease by Crease Predictable Opening Force*
- ➔ *Square Aligned Folding*
- ➔ *A Smooth Spine Profile*
- ➔ *Die Station to Die Station Repeatability*
- ➔ *First to Last Diecut Sheet Repeatability*
- ➔ *Optimal Speed in Gluing & Finishing*
- ➔ *Optimal Cartoning/Packaging Speed*
- ➔ *A Long Shelf Life*

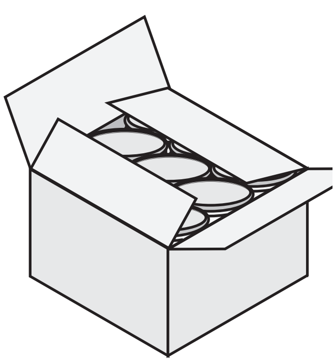
  Contact Kevin - kevin@dieinfo.com



In designing an effective folded container and in specifying and designing the tools used to covert the product in diecutting, it is important to regard the carton as an ***"engineered container"*** rather than just a simple ***"box."***

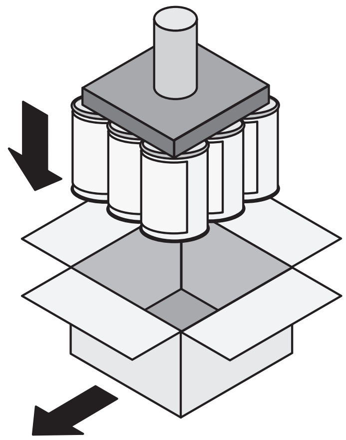


As creasing and folding paperboard is the core discipline of container manufacturing, it is important to understand the principles and practices of ***"traditional"*** creasing.



A Critical Crease Design Discipline

One of the most important practices in designing the ***"engineered"*** container is to examine the role of each crease individually, and to develop a precise understanding of the role the crease will play in the packaging process.



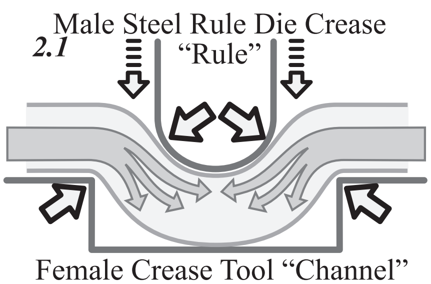
It is a mistake to make all creases in a design identical. Each crease has a distinct role to play in the folding process, and to use the same creasing rule, and counter/matrix parameters for every crease/fold is a mistake, This practice, consistently undermines the manufacturing and the performance of the folding carton or the fluted container.

It is vital to examine the structural design; evaluate the toolmaking, diecutting, and finishing process, factor in the cartoning process and the container application before choosing the best hinge parameters.

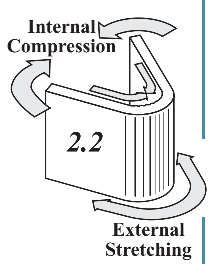
Your knowledge, skill, and technical expertise will increase, the cost of manufacturing will be reduced, and the quality of the finished folding container, will be optimized.

Chapter 2:
"The Principles of Traditional Creasing"

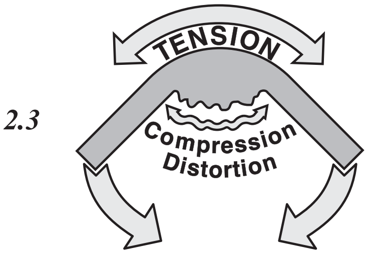
A "crease" is a controlled failure, generated in paperboard by trapping and pinching the material between the upper corners of a female "channel," mounted on the press cutting anvil, and the twin faces of a male creasing "rule," mounted in an inverted steel rule die. ***See illustration 2.1***



In forming a paperboard crease, it is useful to recognize the stress generated in any material as it is folded. ***See illustration 2.2***.



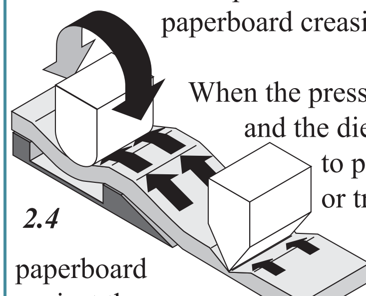
As the container or folding carton panels are rotated around the connecting central "hinge" the outside of the material is stretched and elongated, and the inside surface at the bend



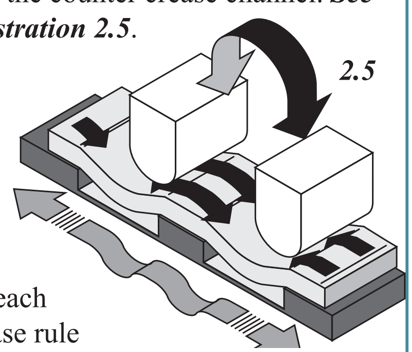
point is compressed and distorted. ***See illustration 2.3*** This potential distortion problem represents one of the key challenges in creating an effective paperboard or fluted hinge.

Folding a material successfully requires controlling the degree of outside stress, so the material does not split and fail, and by redirecting inner surface material compression, which could result in bead binding and add to the tensile stress on the outer surface of the paperboard.

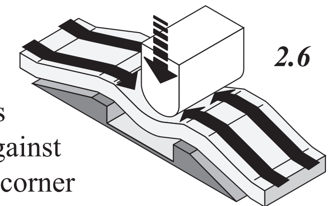
How is this accomplished in paperboard creasing?

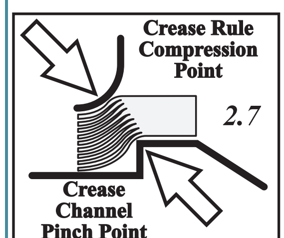


When the press closes and the die begins to pinch or trap the paperboard against the cutting plate or anvil, the surface of the material is subjected to high levels of both compressive and tensile or lateral stress. As the knife edge begins to create a valley in the material and the crease rule begins to drive the material into the counter or matrix channel, ***see illustration 2.4***, they are in fact competing with each other and this effect is called ***"draw"*** in platen diecutting. This same type of tensile competition also exists between creases as they each "***stretch***" the material around and into the counter crease channel. ***See illustration 2.5***.

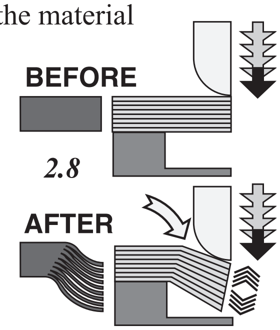


As each crease rule drives the paperboard into the counter channel, it is stretching, drawing, and pulling the material toward and punching it into the female channel. ***See illustration 2.6***. As the press continues to cycle shut, the underside of the material is trapped against the upper corner of each channel by the compression pressure of the male creasing rule. ***See illustration 2.7***.





Because the upper layers of material are driven downward and laterally, and the lower surface of the material is trapped, the internal stress of this action causes the material to shear and delaminate into separate layers. ***See illustration 2.8***.

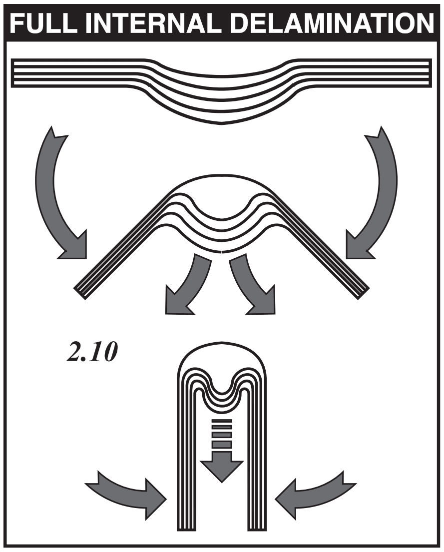


This is called ***<u>Partial Internal Delamination</u>***. ***See illustration 2.9***. This partial internal layering or induced failure of the paperboard in the raised ridge called the "***crease bead,***" is critical to the

formation of the crease and to the effective folding action of the hinge mechanism.

The controlled failure or partial

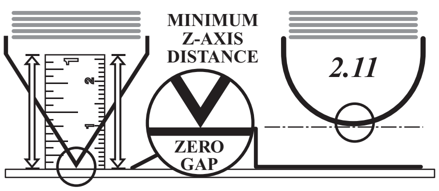
internal delamination of the paperboard is converted to ***Full Internal Delamination*** by the stress



2.10

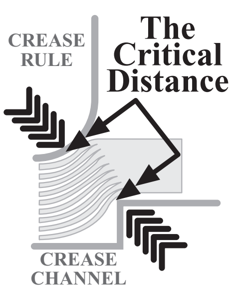
generated by folding the material through 90 and then 180 degrees. ***See illustration 2.10***.

This optimal degree of delamination is achieved when the male crease rule, set in the inverted steel rule die, and the female crease channel, mounted on the lower cutting plate,



2.11

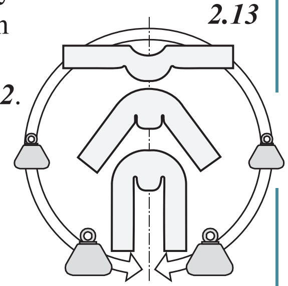
are fully closed. This means the press is on impression, and it has reached the minimum Z-Axis Distance. ***See illustration 2.11***.



2.12

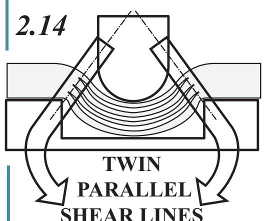
When the upper and lower press tools are in their closest position, the distance between the outer faces of the male creasing rule and the upper corner of the channel wall, will regulate the degree of internal delamination.

This is called the Critical Distance in creasing and it is the most important and consistently overlooked measurement in creasing. ***See illustration 2.12***.



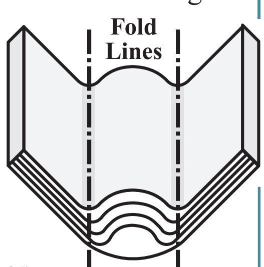
2.13

The Critical Distance sets the degree of pinching and shearing force, which is required to cause a specific amount of internal delamination, which in turn controls the degree of force required to fold a material from 0 to 90 degrees, and then onto 180 degrees. ***See illustration 2.13***.



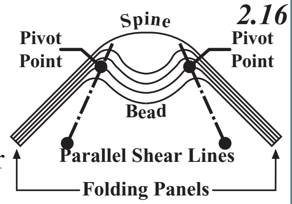
2.14

One of the critical mistakes in creasing paperboard is the perception that a crease is a ***single fold***! In fact a crease is a ***double fold,*** because the act of converting paperboard into a hinge or crease, creates twin parallel lines of shearing failure. ***See illustration 2.14***. It is along these shear lines or pivot points the crease is folding. ***See illustration 2.15***.



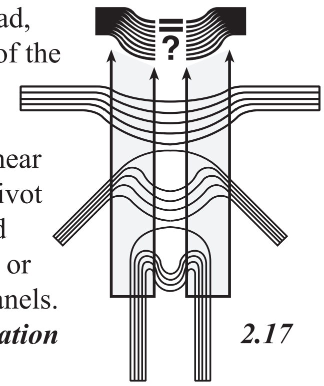
2.15

The paperboard crease has distinct components, which impact performance in the same way a mechanical hinge has individual components, all designed to play a different, but integrated role.



2.16

There are four key elements or parts of a paperboard crease. The Crease Bead, the Spine of the Crease, the Twin Internal Shear Lines or Pivot Points, and the Levers or Folding Panels. ***See illustration 2.16***.



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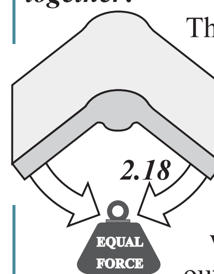
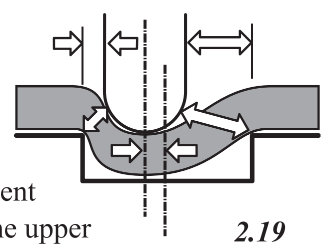
How do these components work together?



2.18

The role of the shear line in creasing, is to cause the paperboard to fold along this line of failure, without the inner or outer surfaces of the material rupturing. It is of course important that each shear line fold is delaminated to the same degree, ***see illustration 2.17***, and both sides fold with the same degree of force. ***See illustration 2.18***.

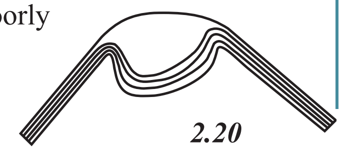
This is why precise alignment of the male creasing rule, mounted in the upper inverted steel rule die, and the female matrix/counter tool, mounted the surface of the lower press cutting plate, is so critical.



2.19

Any lateral misalignment between the upper crease rule and the lower crease tool channel, will result in unbalanced shearing. This means there would be excess shearing/pinching on one side of the fold centerline, and insufficient shearing/pinching on the other side of the centerline. ***See illustration 2.19***.

This type of male/female tool and subsequent crease bead misalignment, is the most common, if often poorly diagnosed failure, in creasing and folding paperboard. This is referred to as ***"One Sided Creasing"***, ***see illustration 2.20***, as tool-to-tool alignment, bead formation, and the folding action of the panels is off center, the crease/fold will perform poorly.



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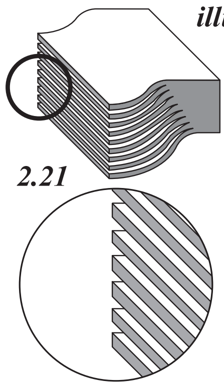
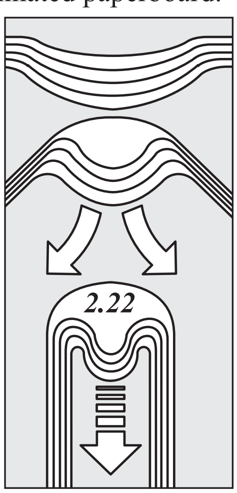


2.21

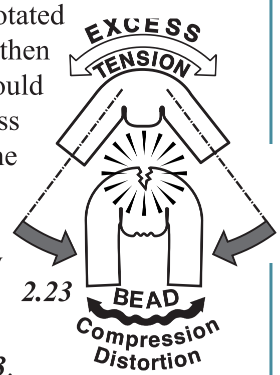
The role of the bead in creasing is to act like a shock absorber or a flexible connector which holds the folding panels together, and forms the engine room of the crease. Although the bead looks like a solid welt of material it is actually made from several layers of internally delaminated paperboard. ***See illustration 2.21***.

These separated resilient layers enable the bead to collapse outward and inward as the crease/panels are folded through 90 and 180 degrees. ***See illustration 2.22***. If the bead did not have this ability to flex and move out of the way, two critical problems would arise.



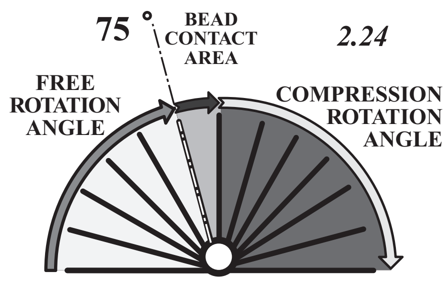
2.22

The first is the lack of flexibility of the crease bead. An inability of the bead to flex out of the way and to absorb the inevitable compression of the inside of the paperboard as the panels are rotated through 90 and then 180 degrees, would transfer the stress to the outer spine of the crease. This will almost certainly result in spine fracturing. ***See illustration 2.23***.



2.23

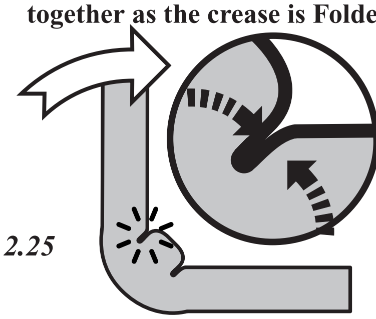
The second problem is an inflexible bead will generate a problem called bead binding. In folding a paperboard crease, particularly for the first time, partial internal delamination is being converted into full internal delamination; in addition there are different degrees of force generated in this formation action. Most panels connected by a crease will fold through approximately 75 degrees without a great deal of resistance. ***See illustration 2.24***.



2.24

This is called the ***Free Rotation Angle*** of the crease. As the crease goes beyond 75 degrees the bead is beginning to distort and further internal shearing is taking place. From 75 degrees to 180 degrees of folding is called the ***Compression Rotation Angle*** of creasing. However, if the bead does not delaminate properly and become flexible enough in the process to get out of the way, the inner wall of the folding panel and the inner wall of the bead will bind with each other. ***See illustration 2.25***.

The Inner Bead Wall & the Inside of the Panel BIND together as the crease is Folded.



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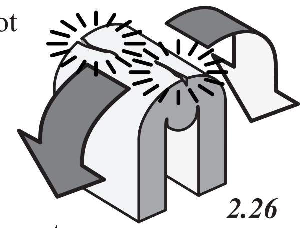
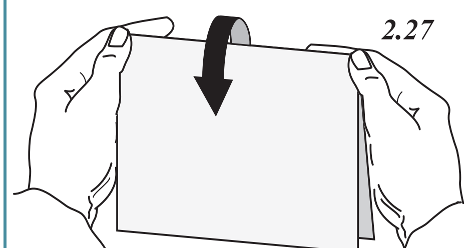


2.26

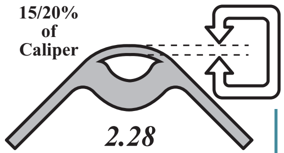
Bead Binding will, of course, change the opening and closing force of the crease and the container, and it will undoubtedly generate excess spine stress and failure. ***See illustration 2.26***.

In assessing the performance of a crease most diecutters will fold the paperboard crease intersection through 180 degrees, ***see illustration 2.27***, and examine the spine for fracturing or for crazing of the print or coating film. In practice this cursory visual inspection of the crease spine, and a simple test of folding squareness are the only qualification procedures the crease/fold will be subjected to. And although the spine is a reasonable indicator of the health of the crease/hinge, it is not the most effective method of determining the key attributes of a crease/fold.



2.27

The spine of the crease is the outer cover of the mechanism and is generally evaluated on an aesthetic impact. If it is not split or fractured the container/fold is acceptable, however, if there are cracks or crazing in the spine, the crease is rejected. In creasing, the spine is an elastic outer skin of the crease mechanism, which almost plays the role of a door closer!



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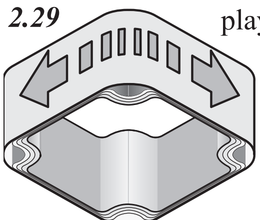
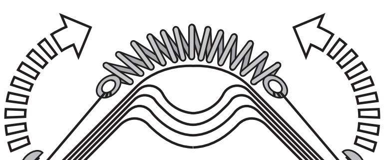
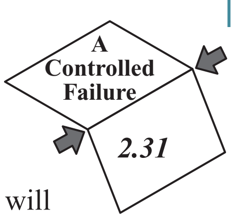

2.29

When a crease is formed and then folded, only a small proportion of the total thickness of the paperboard is used in the spine of the crease. ***See illustration 2.28***. Although this may seem to make this already stretched out material more susceptible to failure, if too much material were allocated to the spine of the crease the material would lose elasticity. This means the spine would neither have the ability to stretch around the folded crease, ***see illustration 2.29***, nor act as an elastic assist device for pulling the panels


2.30

open after folding. ***See illustration 2.30***. Therefore, the correct formation of the spine in creasing is important as it plays a key role in closing and reopening the paperboard hinge. In creasing paperboard or fluted material we are clearly generating a controlled internal failure of the material, which will form a hinge point at the junction between the two connected panels. ***See illustration 2.31***. The focus of much of the attention is on the bead of the crease, which is correctly identified as the engine room of the folding action. However, the length and proportion of the connected panels, ***see illustration 2.32***, not only influences the parameters of the bead, they directly affect the bead formation.



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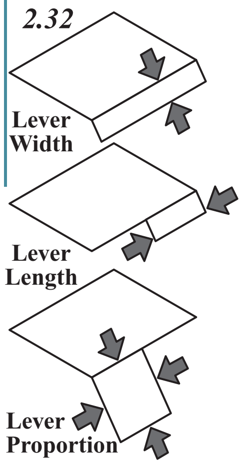
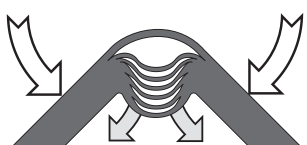


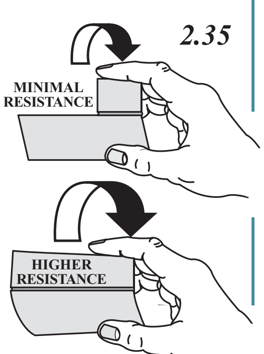
2.32

It is important to recall an earlier description, which stated that when the crease bead is converted, it is only the first stage of crease formation, as at this stage the bead is only partially internally delaminated. ***See illustration 2.33***. And this is important. It is actually the stress on the bead caused by folding the panels through 90 and 180 degrees, which convert partial internal delamination into full internal delamination. ***See illustration 2.34***.


2.33


2.34

It is also important to recognize that this conversion of partial internal delamination into full internal delamination, generated by folding the panels, will meet with some resistance. For example, as the length of the folding hinge/lever increases, the resistance to folding also increases. ***See illustration 2.35***.



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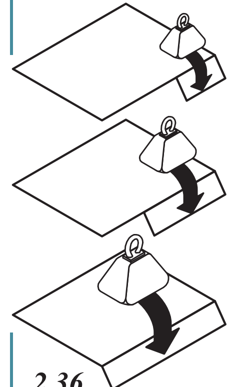
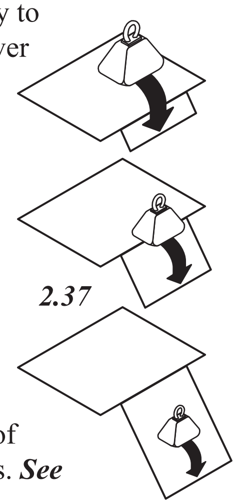

2.36

For example, a very short lever length will be easy to fold, but as the lever length increases, the degree of resistance to folding increases. ***See illustration 2.36***. Using the same principles the resistance to folding of a very short lever will fall, as the width of the lever increases. ***See illustration 2.37***.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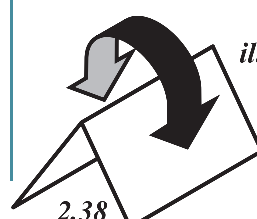
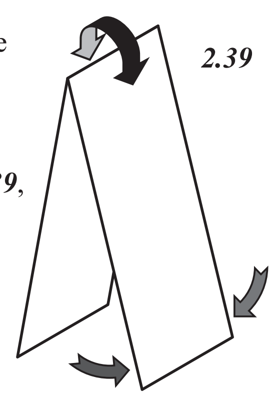

2.38

To reinforce this important principle, a small rectangle of paperboard creased through the middle will fold with relative ease and squareness because the degree of folding control and leverage are relatively high. ***See illustration 2.38***.

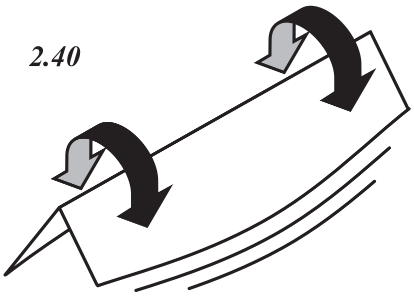
However, if the lengths of the levers were increased, ***see illustration 2.39***, the degree of control and the squareness of the folding action would


2.39

certainly be difficult to control, even though folding would require minimal leverage effort.

Again using a similar example, if the length of the connected levers in the previous example, were significantly

2.40



increased, the degree of resistance to folding would be high, and the panels would certainly bow and distort. ***See illustration 2.40***.

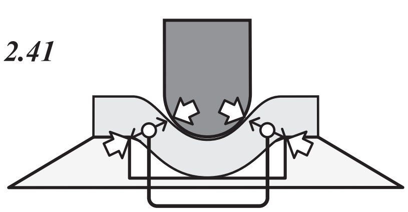
How do these key factors, lever width, lever length, and lever proportion, change the selection of "**standard**" crease tool parameters?

When designing a engineered folding carton or a fluted container, it is critical to adjust the crease tool parameters based upon the leverage properties of the connected panels. This will ensure optimal crease formation, it will ensure balanced folding force, it will eliminate folding failure, and it will provide a container, which will perform flawlessly.

What are "Standard-Traditional" Crease Tool Parameters?

The formation of the paperboard hinge is made possible by trapping and pinching the material between

2.41

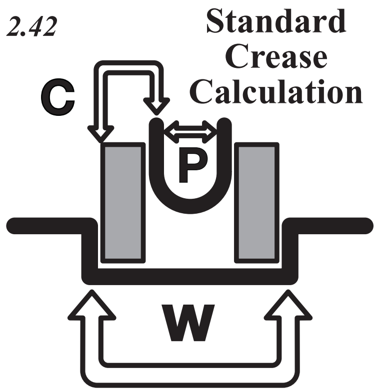


The Critical Pinch Points in Crease Formation.

the steel rule die crease rule and the upper corners of the channel in the female matrix/counter plate. ***See illustration 2.41***.

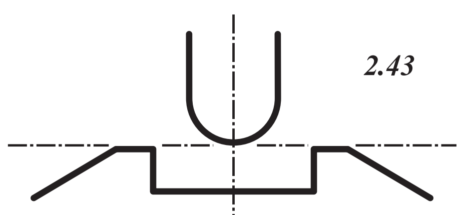
The parameters of this interaction, and the relative sizes and relationships of the tool components, were determined more than eighty years ago. In practice, the width of the counter channel in traditional creasing is arrived at by doubling the caliper of the paperboard and by adding this total to the thickness

2.42



Channel Width: W
Equals Twice the Caliper: C
Plus One thickness of
Crease Rule: P

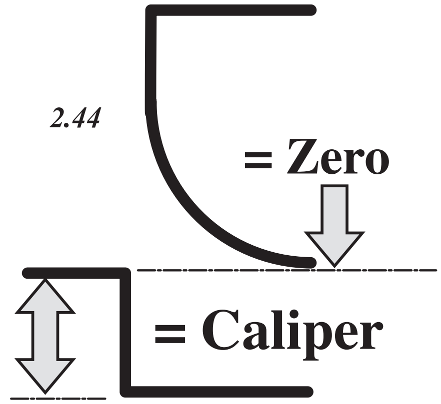
or the pointage of the crease rule selected for the dieboard. ***See illustration 2.42***.



2.43

The thickness of the female creasing tool, is also based upon the caliper of the paperboard being processed, and the height of the creasing rule is designed to cause the tip of the metal crease to align with the surface of the counter, when the platen is full closed. ***See illustration 2.43***.

2.44



The thickness of the counter/matrix female crease tool in traditional creasing and/or the depth of the crease channel is set to the caliper of the paperboard being converted. ***See illustration 2.44***.

There are many problems with this over-simplistic formula and there are many reasons why this traditional approach to creasing generates such inconsistent and variable performance.

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Chapter 2:
The Principles of Traditional Creasing - Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ A Crease is a ***"Controlled Failure"*** of the paperboard or fluted material.
- ✓ Crease formation uses a combination of vertical stamping pressure and lateral shearing stress.
- ✓ The generation of lateral tensile stress by the crease, the knives, and the other steel rule die components, are referred to as "draw" in platen diecutting.
- ✓ Immediately, the paperboard is diecut and before the crease is folded, "Partial Internal Delamination" of the material forms the crease bead.
- ✓ The Partial Internal Delamination of the crease bead is converted to "Full Internal Delamination" by the stress generated by folding the hinged panels through 90 and onto 180 degrees.
- ✓ Paperboard internal delamination is generated by trapping and pinching the material between the face of the crease rule, mounted in the steel rule die, and the upper corner of the channel in the female crease tool, mounted on the press cutting plate.
- ✓ The optimal setting for the pinching distance between the steel rule and the upper channel corner is called the "Critical Distance" in creasing.
- ✓ A crease is ***NOT*** a single fold but a ***DOUBLE*** fold, as it hinges on the twin parallel shearing lines which define the crease bead.
- ✓ There are four key components in a paperboard hinge mechanism. These are the ***Spine*** of the crease, the crease ***Bead***, the ***Twin Pivot Points/Shear Lines***, and the ***Folding Panels or Levers.***
- ✓ The bead is obviously not a solid welt of paperboard but it is a flexible, shock absorber, with multiple internal layers.
- ✓ As the panels are folded, the bead flexes inward and compresses to minimize stress on the spine, and the pivot points of the crease.
- ✓ As a crease is folded approximately through the first 75 degrees of rotation, this is called the ***Free Rotation Angle***, as the resistance to folding is relatively low.
- ✓ As the crease is folded from 75 degrees through 180 degrees of rotation, this is called the ***Compression Rotation Angle,*** as resistance begins to increase.
- ✓ When a poorly formed, inflexible bead is folded, it is unable to relieve the folding stress by compressing and changing shape, and resistance to folding climbs dramatically. This causes ***"Bead Binding"*** at the base of the bead wall and the inside junction of the folding panel.
- ✓ In crease formation less than 20% of the caliper of the material is used to form the spine of the crease.
- ✓ It is vital to factor in critical design features, ***Lever Width, Lever Length and Lever Proportion***, into the specification and design of the male and female crease tools.
- ✓ As the length of a crease lever increases, the degree of force required to fold it increases proportionately.
- ✓ As the width of a crease lever increases, the degree of force required to fold it decreases proportionately.
- ✓ The ***formula*** for calculating standard crease channel parameters is to double the caliper of the paperboard and add the thickness of the creasing rule being used.
- ✓ The ***formula*** for calculating the thickness of the female crease tool, or to set the depth of the channel, is to make it identical to the caliper of the paperboard.

Chapter 2: The Principles of Traditional Creasing - Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ How is full internal delamination of the bead achieved in creasing and folding?
- ✓ What is the Compression Rotation Angle?
- ✓ What is the Critical Distance in creasing, and why is it important?
- ✓ What are the shear lines or pivot points in creasing?
- ✓ How is the width of the female channel calculated?
- ✓ With the press on impression, where should the tip of the crease rule be in relation to the female crease tool?
- ✓ What is the purpose of the bead in creasing?
- ✓ Why do the Length, the Width, and the Proportion of the folding panels/levers impact tool design?
- ✓ What is Bead Binding and what effect does it have on folding?
- ✓ What are the stresses, which affect a material as it is folded?
- ✓ What are the two major forces used in crease formation?
- ✓ What is the approximate thickness of the spine of the crease?
- ✓ What is a One-Sided crease and why is it a disadvantage?
- ✓ What are the construction characteristics of the inside of the crease bead?
- ✓ What are the important properties of a crease spine?
- ✓ How do creases compete with one another?
- ✓ What is a source of spine fracturing stress?

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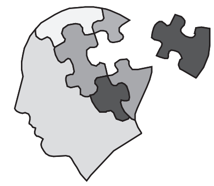
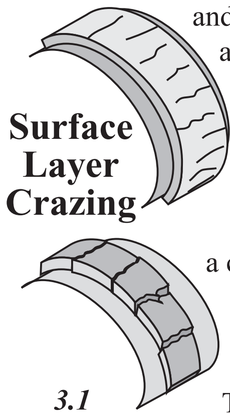
Brainstorming, Notes & Ideas

"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*



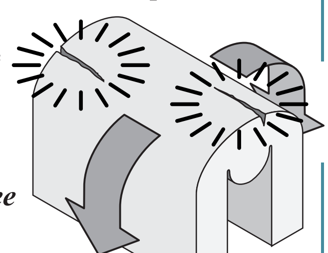
Chapter 3: "How & Why the Traditional Specification Fails?"

It is obviously important to recognize every container as a powerful display and promotional tool, and therefore, the condition of the outer and usually printed surface of each crease spine is a critical factor in evaluating crease performance.



3.1

There are several types of spine failure, which will cause a carton to be rejected. The first is print film and/or paperboard coating crazing. This is simply caused by the layer of ink/varnish, and/or surface/filler material fracturing as it is stretched around the periphery of the folded crease. ***See illustration 3.1***. The second type of common failure is spine splitting along the crown of the spine, where the surface layer of the material develops a stress fracture. ***See illustration 3.2***. This generally occurs on the 180-degree folds or the working creases of the folded container. ***See illustration 3.3***. And as the opening action in cartoning will actually reduce spine pressure and to a certain extend close the split, the greatest danger is the aesthetic impact of the print film splitting to expose the innards of the paperboard. ***See illustration 3.4***. All of these problems are obviously caused by excess tensile stress in the spine as it is folded. ***See illustration 3.5***. Most mistakenly view spine splitting as the result of excess pressure, however, in the majority of failure, it is a ***lack of pressure*** which causes incomplete bead delamination. As a result, the bead is unable to ***"get out of the way"*** as the panels are folded and the compression and bead binding translate into excess spine stretching and failure. ***See illustration 3.6***. The solution is to increase delamination force by reducing the width of the channel and/or by increasing the pointage or thickness of the creasing rule in the steel rule die. ***See illustration 3.7***.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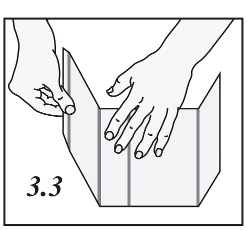
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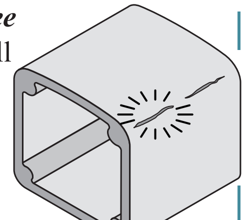
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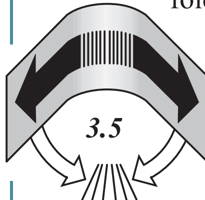

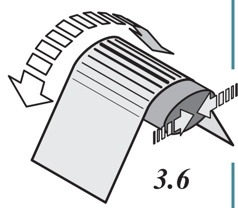
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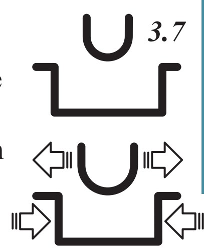
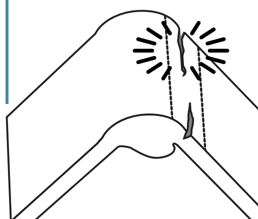

3.7

A more serious spine failure is called one-sided splitting, in which the fracture in the spine material is on one side of the crease or the other. ***See illustration 3.8.*** This generally means the degree of failure is so severe, the functionality of the carton is compromised and the container is rejected. This is caused by a misalignment between the crease rule in the steel rule die and the counter channel mounted on the cutting plate. ***See illustration 3.9***. The resulting formation of the crease has insufficient deformation on one side of the crease, but excess shearing on the opposite side of the crease. ***See illustration 3.10***. Even if the spine does not fracture the resulting off center folding, may cause cartoning problems, as the shape and size of the container is changed. ***See illustration 3.11***. The solution to this problem is to check steel rule die and counter/matrix channel alignment every time the die/chase or the cutting-plate/lower sliding platen bed is pulled out from the platen well for adjustment.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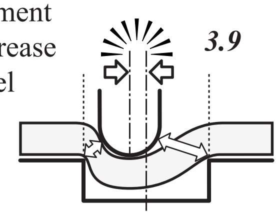
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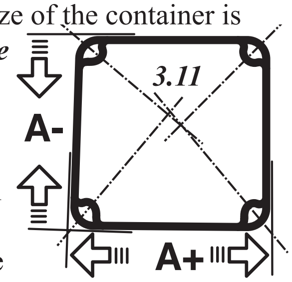
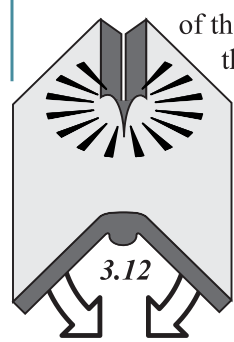
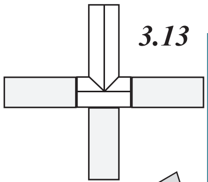


3.11

A very common problem is crease end splitting, where the spine of the crease fractures at the intersection of the crease/fold and the cut in a carton, generally at right angles to the paperboard grain. ***See illustration 3.12***. The most effective and widely practiced


3.12

solution to this problem is to add a ***"T-Knife"*** at the intersection, ***see illustration 3.13***, or a ***"J-Knife"*** in the same position. ***See illustration 3.14***. Both of these devices are isolating the splitting force of the knife from the stretching action of the spine and work by diverting the splitting force of the cut at right angles to the crease and parallel to the paperboard grain. ***See illustration 3.15***.



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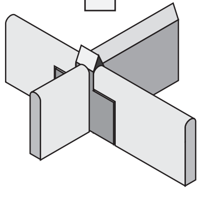
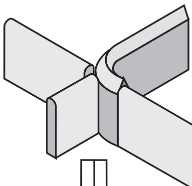
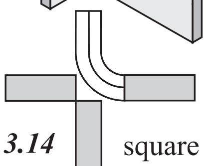
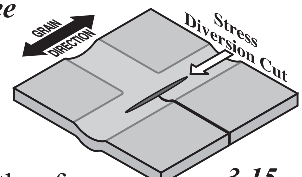






3.14

A perennial problem in generating a square fold in paperboard is the use of a Cut/Crease or a Cut-Score combination of crease and knife. ***See illustration 3.16***. Although the insertion of short lengths of knife are designed to lower folding resistance, they can create severe spine splitting problems. As with crease end splitting the intersection of the cut with the highly stretched spine often generates a rupture of the ends of each crease fold. ***See illustration 3.17***.



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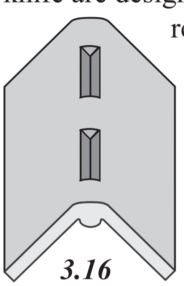
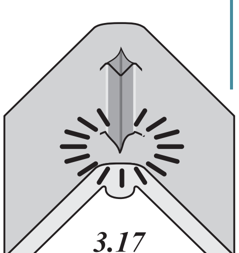


3.16

The solution is to reduce the width of the channel, to use a higher pointage of crease and to use the lowest bevel angle/pointage of knife possible to minimize the displacement action. ***See illustration 3.18***. To use a round top crease rather than a square ground profile crease; to modify the ends of the cut to a "J" profile, and or to back bevel the ends of each knife. ***See illustration 3.19***.



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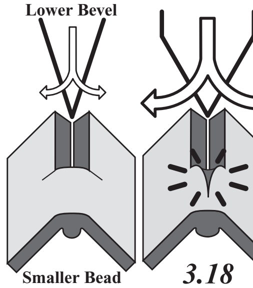
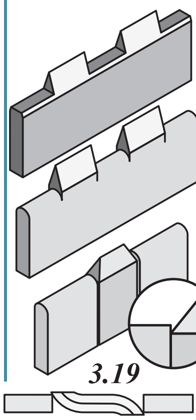


3.18

Once all of the spine problems have been dealt with, the most common problem in creasing is folding alignment, folding force, and off square folding caused by poor bead formation. A very common folding problem is often referred to as a rolling fold because of insufficient internal delamination, which causes the bead to collapse as the panels are folded. ***See illustration 3.20***. This is most common parallel to the paperboard grain and is primarily caused by the increased elasticity of the paperboard parallel to the grain. This elastic quality of the material, caused by shrinkage during papermaking, makes effective delamination very difficult.



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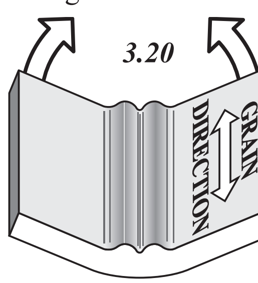
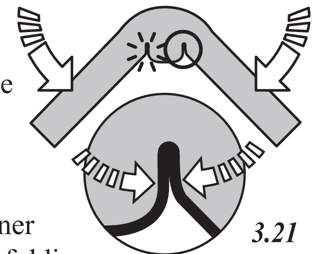


3.20

A frequently overlooked folding failure is caused by folding problem, called Bead Binding. Bead binding is caused because the bed is improperly formed with poor internal delamination into individual fiber layers. As a result when the panels are folded, the bead does not spring out of the way but acts like a nut in a nutcracker, and binds with the inner wall of the folding panel. ***See illustration 3.21***. This is particularly prevalent in fluted creasing and is noticeable as the panels are folded through 75 degrees, ***see illustration 3.22***, when the degree of force required to continue folding climbs to unacceptable levels. ***See illustration 3.23***.



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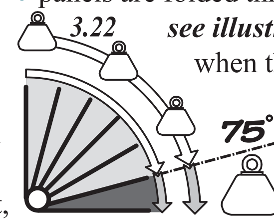
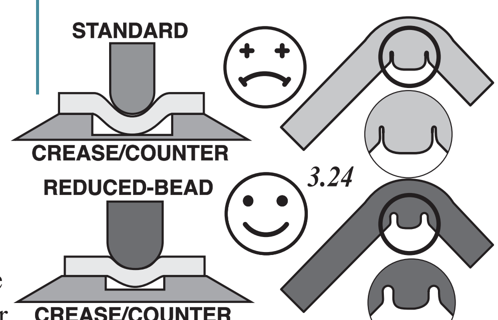


3.22

3.23

In the majority of instances, increasing the delamination/shearing pressure applied to the paperboard during crease formation can eliminate these problems.

This simply requires either reducing the channel width and/or increasing the pointage of the creasing rule ***see illustration 3.24***, to increase the pinching pressure on the material at the shear lines of the crease.



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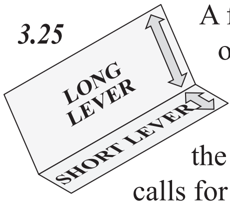
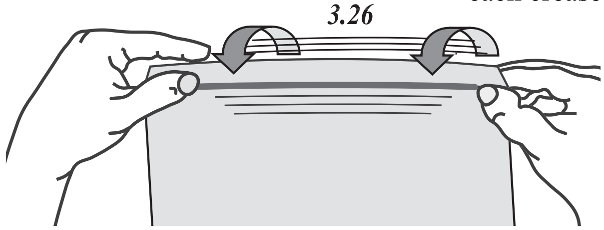


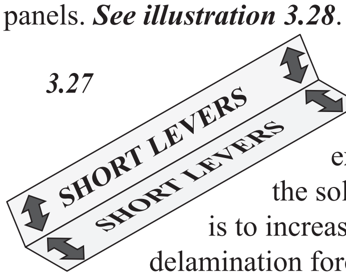
A frequently overlooked problem in folding is when the carton design calls for a configuration which has a large panel or lever on one side of the crease, and a narrow lever or panel on the other side of the crease. ***See illustration 3.25***.
This makes it very difficult to fold because insufficient leverage or unbalanced leverage reduces the ability of the panels to complete the full internal delamination of the bead necessary for balanced folding. ***See illustration 3.26***.

3.26

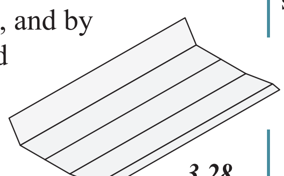


These same problems arise when the panels are very long, ***see illustration 3.27***, or in a carton with very narrow panels. ***See illustration 3.28***.

3.27



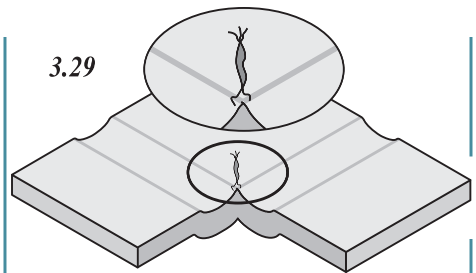
As in earlier examples the solution is to increase the delamination force on the bead, and by making the bead much smaller; the degree of delamination and therefore folding force is reduced.



3.28

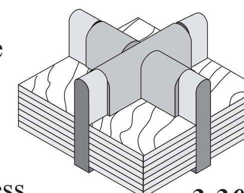
One final common problem in creasing is bursting or checking of the surface of the material, generally at multiple crease intersections. ***See illustration 3.29***. This is caused by the difficulty of attempting to drive all of the paperboard into the intersection channels at the same time using tool parameters, which render the effort virtually impossible.

3.29



The paperboard has insufficient elasticity to accommodate this degree of concentrated tensile stress and the surface of the board ruptures at each crease intersection. The solution to this problem is to increase the pointage of the crease rules at the intersection, ***see illustration 3.30***, and/or to reduce the width of the counter channel at the intersection. ***See illustration 3.31***.

It is also possible to minimize the stress by simply machining down the thickness of the counter at the intersection, ***see illustration 3.32***, thereby reducing the degree of stretching stress.



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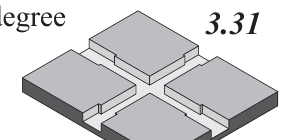
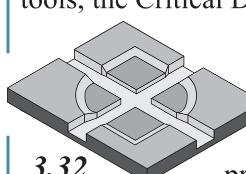
3.31

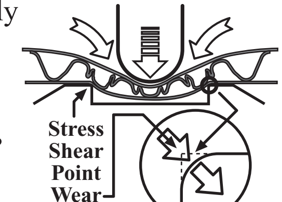


The greatest challenge in converting paperboard to generate cartons or containers with both predictable and consistent performance parameters, is the rapid wear of the most vulnerable feature of the creasing tools, the Critical Distance.



3.32

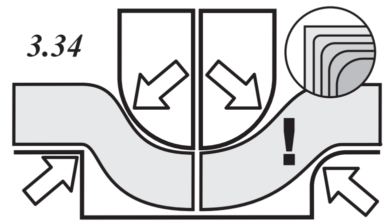
Because traditional creasing is primarily achieved through lateral draw, or by driving material toward and into the counter channel, the stress on the upper corner of each channel is severe. ***See illustration 3.33***. Because paperboard is very abrasive the combination of lateral drag and compressive pressure causes the upper channel corner to become rapidly abraded. ***See illustration 3.34***.



3.33

At the beginning of the production run the critical distance was originally set with the

3.34

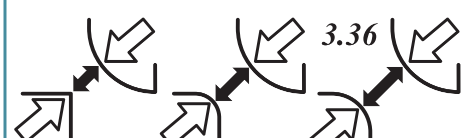


optimum gap to generate the correct degree of internal delamination by pinching the material between the crease rule and the upper channel corner. ***See illustration 3.35***.

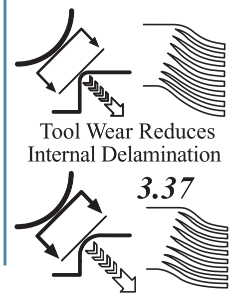
3.35

Unfortunately, incremental abrasion of the upper corner of the channel gradually increases the critical distance. ***See illustration 3.36***.

3.36



As a result the internal partial delamination of the bead is gradually reduced, ***see illustration 3.37***, as the upper corner of the crease channel is abraded away.



3.37

Naturally, a

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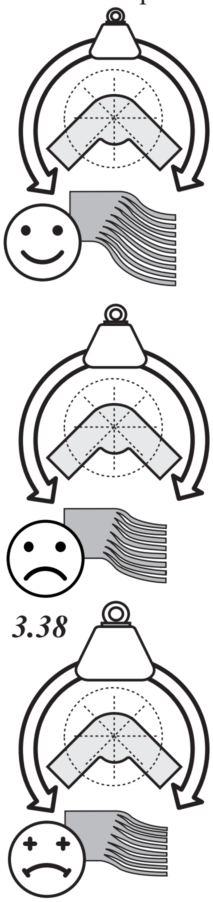
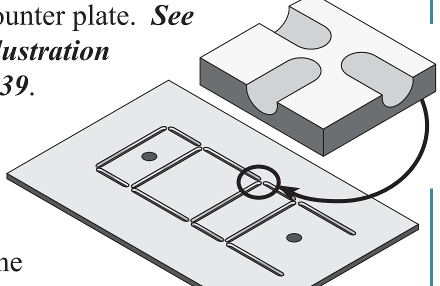
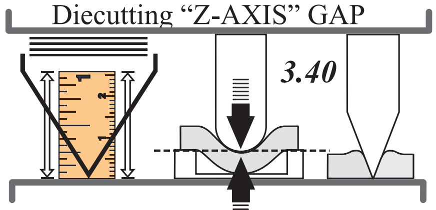
reduction in the degree of internal delamination of the bead increases the force required to fold the carton. ***See illustration 3.38***. This upper channel corner wear and resulting change in the Critical Distance, changes the folding performance of every carton, impression by impression!


3.38

In practice this means the folding performance of a carton from the first impression of the production run is very different from the folding performance of a carton taken from the last sheet of the production run. This is not what the customer has been sold or is expecting. The solution to these problems is to use reduced bead creasing, outlined in a subsequent chapter, or to move to a channel material which is resistant to abrasion, such as a steel counter plate. ***See illustration 3.39***.

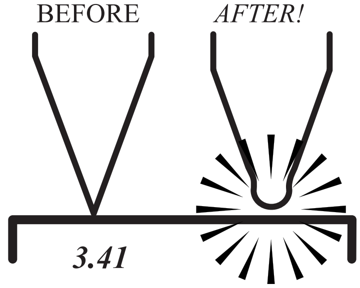

3.39

The second factor, which severely undermines crease performance and contributes to the abrasion of the upper corner of each channel, is poor control of pressure or tonnage in diecutting. At the beginning of the production run the "Z-Axis" gap of the tooling is set so



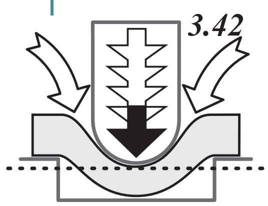
3.40

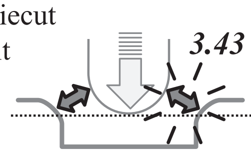
the tip of the creasing rule intersects with the plane formed by the top of the counter material. ***See illustration 3.40***.



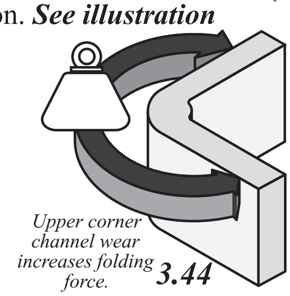
3.41

Unfortunately as pressure is increased to compensate for knife tip compression, ***see illustration 3.41***, the platen gap is reduced, and the tip of the creasing rule is now penetrating below the top of the counter material. ***See illustration 3.42***. This increases tensile stress on the diecut sheet, (which is often why more nicks are needed and flaking or chipping of the diecut edge increases), it abrades the upper-channel corner more rapidly, ***see illustration 3.43***, and it changes the folding performance of the crease/carton. ***See illustration 3.44***.


3.42

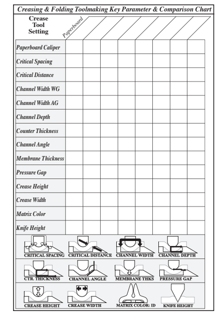

3.43

The solution is to calibrate the press, to calibrate the steel rule die, and to pre-calculate diecutting pressure to use the minimal amount of tonnage and/or change in tonnage, from the first impression to the last.

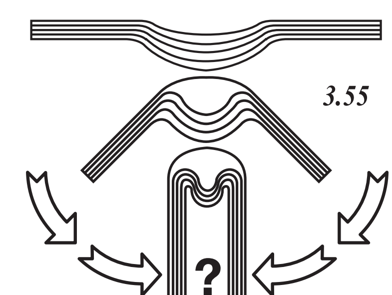


3.44

One of the common mistakes in creasing is to begin with an incorrect or incomplete tool specification. This can mean selecting incorrect counter parameters, choosing the wrong height and thickness of creasing rule, or by simply failing to specify a key ingredient, such as the calculation of the vitally important critical distance. ***See Chart above and on next page***. This chart shows all of the key factors, which should be considered in analyzing the application, in specifying the tool parameters and in designing the counter/channel tool and the steel rule die.



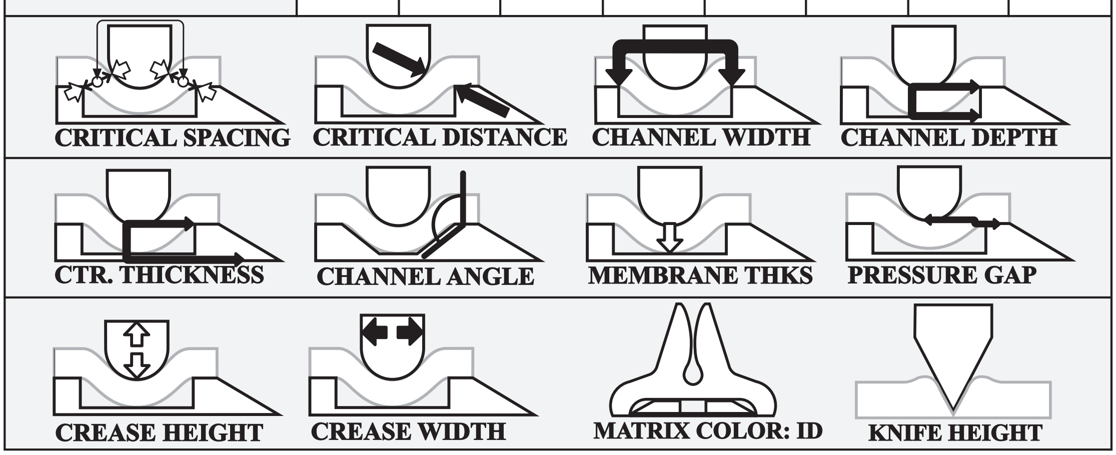
In setting the folding parameters for a specific paperboard or for a carton design, there are some key performance characteristics which continue to cause set-up problems in production. The most obvious of these is specifying and designing the creasing tools so the degree of force required to fold the crease through 90 and then 180 degrees falls within very specific parameters. ***See illustration 3.45***. Why is this such a perennial problem?



3.45

Creasing & Folding Toolmaking Key Parameter & Comparison Chart

Crease Tool Setting	Paperboard							
Paperboard Caliper								
Critical Spacing								
Critical Distance								
Channel Width WG								
Channel Width AG								
Channel Depth								
Counter Thickness								
Channel Angle								
Membrane Thickness								
Pressure Gap								
Crease Height								
Crease Width								
Matrix Color								
Knife Height								



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Chapter 3:
How & Why Traditional Creasing Fails - Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ The most common form of folding failure is crazing, splitting, and fracturing of the outer spine of the crease.
- ✓ Although the source of crease spine failure would appear to be excess pressure, in practice the problem is caused by insufficient pressure.
- ✓ One of the more serious types of crease formation and folding failure is caused by a misalignment between the male and female tooling, generating an off-center fold, which is called a one-sided crease.
- ✓ A common source of crease spine failure occurs at the ends of 180-degree folds at right angles to the paperboard grain. Inserting “T” knives and/or “J” knives usually eliminates this form of crease end splitting.
- ✓ An effective method of preventing crease spine fracturing at the intersection of the cuts in a cut-crease fold, requires increasing the pointage of the male creasing rule, reducing the channel width of the female counter, and using a lower bevel angle cutting knife.
- ✓ Shrinkage of the cross machine direction web, parallel to the paperboard grain, during papermaking increases the elasticity of the material, which makes forming a consistent parallel grain crease more difficult than a cross grain crease.
- ✓ Bead Binding during folding is an often overlooked critical failure in carton and container manufacturing, which generates spine splitting, fold misalignment, and it significantly increases the degree of folding force.
- ✓ One of the most critical aspects of forming effective folds is the impact of the length, the width, and the proportion of the panels the crease hinges, have on final delamination of the bead during folding.
- ✓ The critical distance is the key measurement in crease formation, which is often rapidly undermined by abrasion of the upper corners of each female crease channel.
- ✓ To ensure precise and consistent crease formation it is essential to calibrate the steel rule die and calibrate the diecutting press.
- ✓ To develop creasing and folding consistency it is essential to collect current tool parameters and to set-up a data base of crease tool settings.

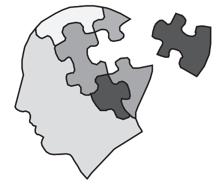
Chapter 3:
How & Why Traditional Creasing Fails - Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ Identify two common forms of crease spine failure?
- ✓ What role does pressure play in crease spine failure?
- ✓ What is one-sided creasing?
- ✓ What causes a one-sided crease?
- ✓ How will a “T” knife solve a critical crease spine failure problem?
- ✓ What is a typical crease fold failure, parallel to the paperboard grain direction?
- ✓ What is crease-folding force, and why is it important?
- ✓ What does Bead Binding describe in crease folding?
- ✓ Why is Bead Binding such a critical failure in folding?
- ✓ How do the width and the length of the creased panels impact folding force?
- ✓ Why is the Critical Distance so important in creasing?
- ✓ Why is abrasion of the upper corner of each crease channel a problem in crease formation?

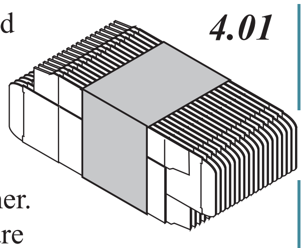
Brainstorming, Notes & Ideas

"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*



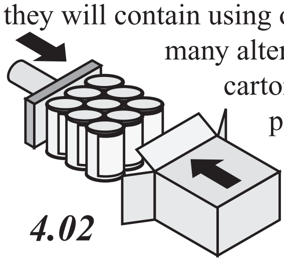
Chapter 4:
How to Control Crease Folding & Opening Force?

The majority of cartons are delivered pre-folded and glued, ***see illustration 4.01***, in a protective fluted container.

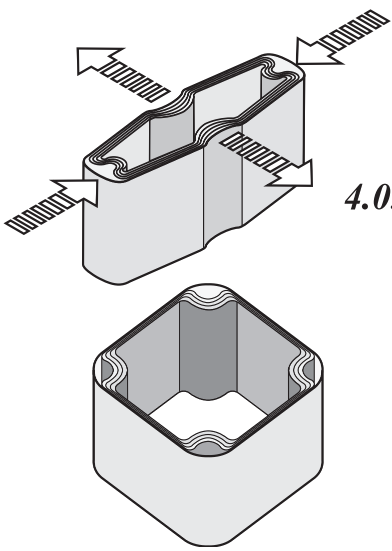


4.01

The cartons are integrated with the product they will contain using one of the many alternative cartoning/ packaging techniques. ***See illustration 4.02***. This process requires wrapping the carton around the product or inserting the product into an opening in the carton.



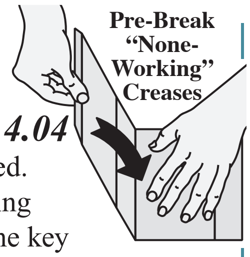
4.02



4.03

To achieve consistent high speed insertion into the carton requires the creases folded through 180 degrees to have a degree of resiliency or a property often defined as ***"fluff." See illustration 4.03***.

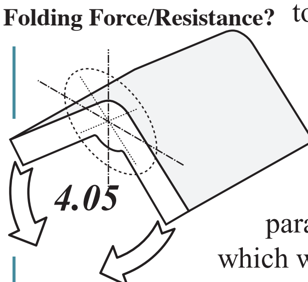
This simply means the creases have retained a degree of fiber resiliency or "***memory***", which causes the crease to try to unfold and partially ***"open"*** once clamping pressure is removed. As part of the gluing process some of the key creases are "***broken***" or partially pre-folded, prior to machine gluing. ***See illustration 4.04***.



4.04

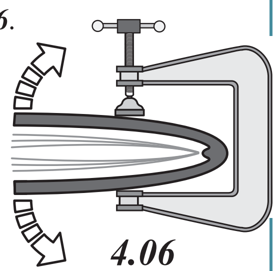
However, all of this presupposes the toolmaker and the diecutter have worked together to set up tool/crease parameters, which will produce a fold with a specific amount of force or with a specific degree of resistance. ***See illustration 4.05***. Setting the tool parameters also requires the knowledge and the experience to design a crease with sufficient resiliency, which will cause the crease to try to unfold once clamping pressure is removed. ***See illustration 4.06***.

Folding Force/Resistance?



4.05

To control the degree of folding force in a crease hinge and to set the required degree of resilient opening or unfolding force, the ***Critical Distance Measurement of the Crease*** must be precisely adjusted and carefully controlled. The critical distance in crease formation is the gap or the pinching distance the paperboard must be subjected to, to cause internal lateral shearing or delamination of the material into separate layers, to form the flexible crease bead. ***See illustration 4.07***.



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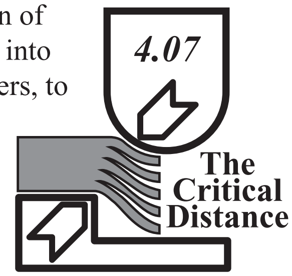
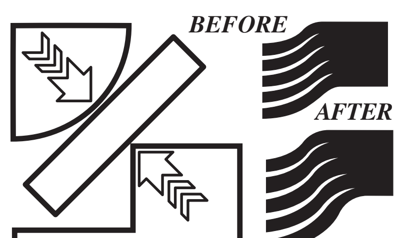


4.07

Adjusting the critical distance is not generally the focus of the specification and design of the male and female creasing tools, which is one of the reasons folding force is considered a ***"difficult"*** issue. In practice controlling folding force in creasing requires controlling the degree of pinching pressure between the crease rule in the steel rule die, and the upper corner of the female channel mounted on the opposing anvil or cutting plate.



4.08

For example as the level of shearing or compression force acting on the paperboard increases, (the pinching distance between the upper corner of the crease channel and the face of the crease is narrower), the degree of internal delamination/fiber separation increases. ***See illustration 4.08***.

However, if the critical distance is increased the degree of shearing force acting on the paperboard decreases, (the pinching distance between the upper corner of the crease channel

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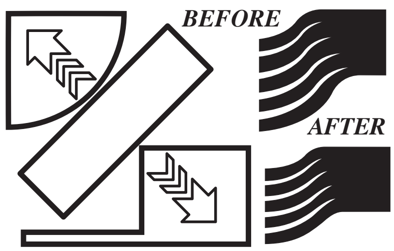
and the face of the crease is wider), the degree of internal delamination/ fiber separation decreases. ***See illustration 4.09***.

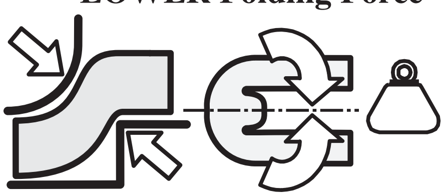
4.09



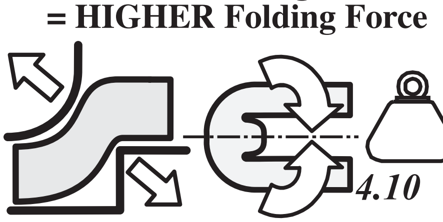
The specific relationship between the ***Critical Distance & Folding Force*** is that if the degree of delamination is increased by narrowing the critical distance, the degree of the pressure or force required to fold a paperboard hinge through 90 degrees is reduced.

Conversely, if the degree of delamination is reduced, by increasing the critical distance, the pressure or force required to fold a paperboard hinge through 90 degrees is increased. ***See illustration 4.10***.

Increased Pinching Pressure = LOWER Folding Force



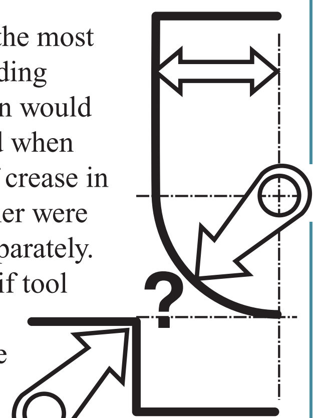
Decreased Pinching Pressure = HIGHER Folding Force



4.10

Naturally, the caliper, the fiber type, the grain direction, the density, and the stiffness of each material are factors, which impact the selection of the optimal critical distance for the crease.

This is why the calculation of the Critical Distance either before or after the production run is complete is so important. Each paperboard material and each carton design should have a specific critical distance measurement defined as the degree of pinching pressure which is required to cause this material to fold with a specific and optimal degree of force. ***See illustration 4.11.***



4.11

In practice, the most effective folding carton design would be generated when each type of crease in each container were classified separately. In addition, if tool parameters for each type of crease were based on the role of the hinge in the finished carton/ container, many creasing and folding problems would be eliminated.

This approach would require a system of crease specification, which although not complex, would require specifying and forming each type of crease based upon its role in the complete carton design.

Although setting the most effective critical distance to control folding force is essential, the size, the shape, and the proportion of the crease bead play a major role in folding performance.

As defined, setting the critical distance, the gap between the face of the crease rule and the upper corner of the channel, the degree of pinching force driving internal shearing of the paperboard generates a specific amount of internal delamination. ***See illustration 4.12.***

The Critical Distance (1)

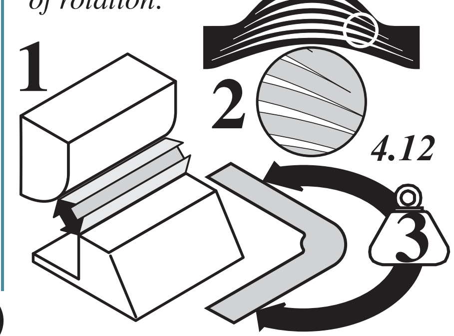
controls the degree of

Bead Delamination (2)

which generates the

Level of Force (3)

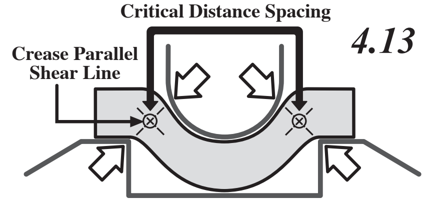
required to fold the connected hinged panels to a specific angle of rotation.



4.12

However, the distance between each parallel shear failure line, ***see illustration 4.13***, controls the size and shape of the bead. The greater the gap, in proportion to the caliper of the material, produces a shallower, a wider, and a less well defined crease bead.

Critical Distance Spacing

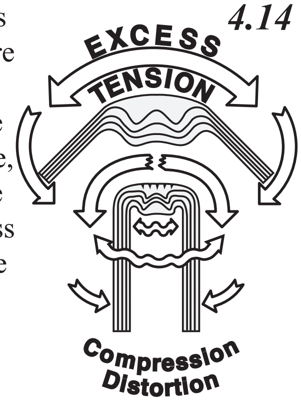


4.13

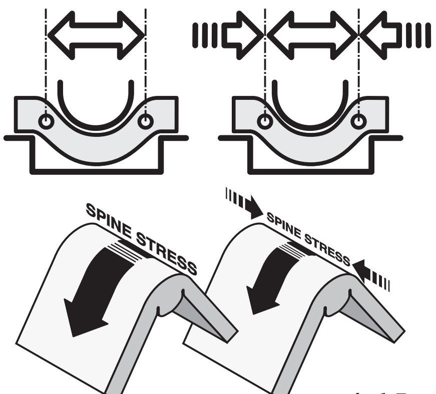
The **Gap** between each **Crease Parallel Shear Line** is called the **Critical Distance Spacing**, which controls the overall size of the **bead** and **force** required to fold.

If the gap or the ***Critical Distance Spacing*** is too wide the resulting bead has a far lower degree of internal delamination, which translates into bead ridging and collapsing as the panels are folded. This will increase folding force, and generate greater stress on the crease spine. ***See illustration 4.14***.

4.14



These crease setting attributes are clearly defining the optimum distance between each crease failure/fold point for each type of material and for each folding application. As the ***Critical Distance Spacing*** between the ***Crease Parallel Shear Lines*** is reduced, the proportionate size of the bead is reduced, the degree of internal delamination increases, the degree of force required to fold the crease is reduced, and the amount of tensile stress acting on the crease spine is minimized. ***See illustration 4.15***.



4.15

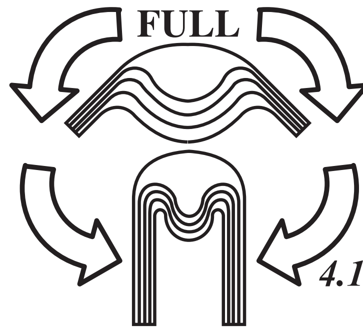
Therefore, the smaller the bead, proportionate to the caliper, the more effective the crease will hinge and pivot, and it will do so with greater consistency and with greater predictability.

4.16

Internal Delamination

The impression taken on press creates partial internal delamination in the crease bead, which is the first step in crease formation. ***See illustration 4.16***.

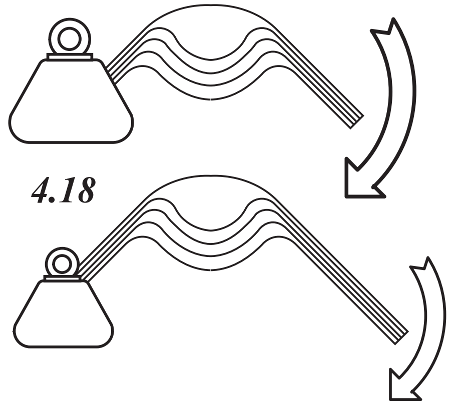
However, it is the action of folding the attached panels or levers, through 90 and then 180 degrees, which converts the partial internal delamination into full internal delamination, which in turn completes the formation of the paperboard hinge. ***See illustration 4.17***.



4.17

Internal Delamination

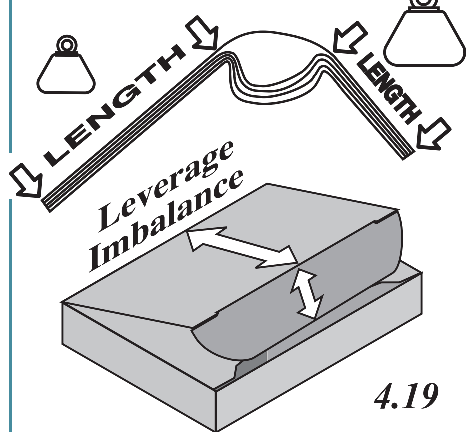
There are two additional factors to consider here. The first is the length of the panels/levers. The longer the lever the less force is required to fold the crease, and obviously the shorter the lever, the greater the force required to fold the panels through the required arc. ***See illustration 4.18***.



4.18

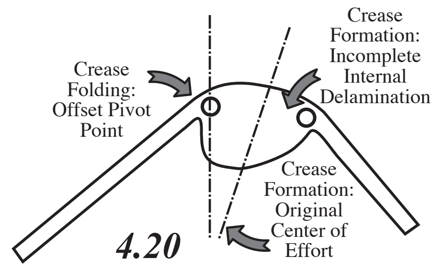
The second is unbalanced leverage. In this example, if one lever is shorter than the other the degree of force required to fold the shorter lever is greater than the degree of force required to fold the longer lever. ***See illustration 4.19***.

As the illustration shows this leverage imbalance can cause a key panel or carton feature to fold out of position. As a result of the uneven leverage, and the impact on the conversion of partial internal penetration to full internal penetration, the crease fold points are not aligned with the center of crease formation. ***See illustration 4.20***.



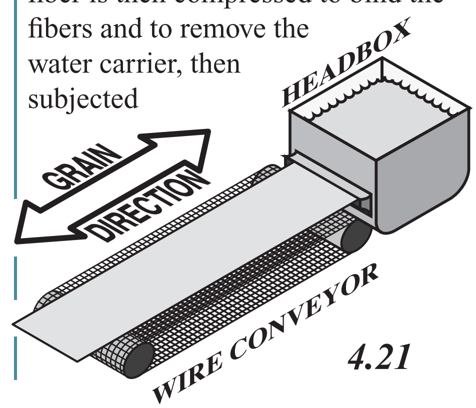
4.19

The solution to this potential problem is to increase the pinching force during the formation of the bead so the levers have less work to do to turn partial internal delamination into full internal delamination.



4.20

It would be impossible to discuss paperboard creasing without discussing the impact of grain direction on the formation of a crease bead. As paperboard is formed and extruded from the head box in a paperboard machine, it is gradual converted from a slurry of pulp, into a spongy matte of fiber. This matte of fiber is then compressed to bind the fibers and to remove the water carrier, then subjected



4.21

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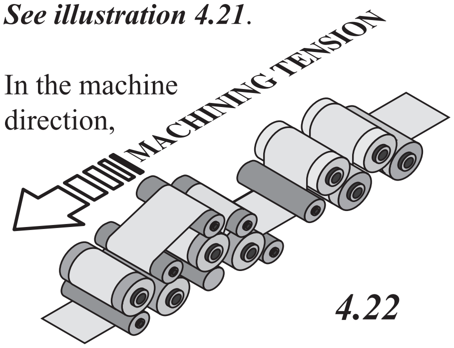
to heat and pressure to complete the paperboard manufacturing process. ***See illustration 4.21***.

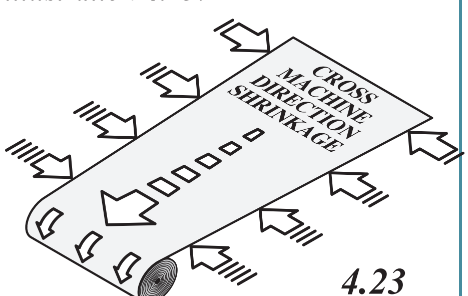
In the machine direction,



4.22

running from the Pulp Headbox to the winding of paperboard reels, the web of pulp is under considerable tension control, as it is pulled through each section of the papermaking machine. ***See illustration 4.22***.

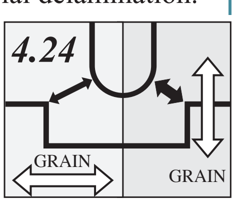
However, the cross machine direction there is no restraint on the material in any way. As the paperboard is formed, from the wet end, to the press, to the drier, the width of the web of pulp shrinks as the moisture is removed from the material. ***See illustration 4.23***.



4.23

The significance of this in terms of creasing paperboard, is when a material shrinks it becomes more elastic & elasticity in paperboard is the enemy of material delamination.

4.24

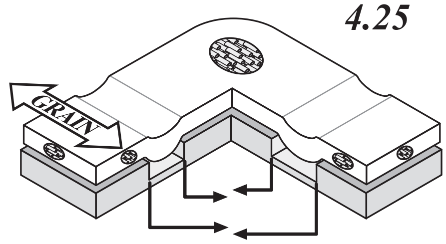


Therefore, more force, or more accurately, a narrower critical distance is needed to cause an effective bead to be formed when creasing parallel to the paperboard grain. ***See illustration 4.24***.

Not only should the critical distance be reduced in comparison to the setting for creasing at right angles to the grain, but the size of the bead should also be smaller. ***See illustration 4.25***.

This is important because it is

4.25

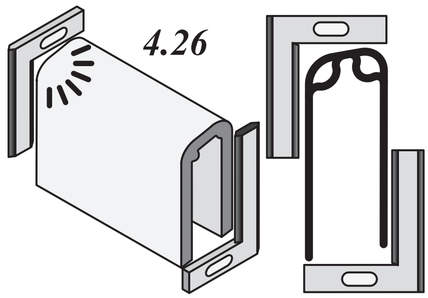


It is necessary to ***reduce*** the ***Critical Distance*** when creasing ***parallel to the grain***. This will both generate a ***narrower channel*** and a ***narrower/smaller bead***.

difficult to generate the same degree of delamination with a material which is very elastic. However, the other side of the issue is that although it is more difficult to fold creases as crisply parallel to the grain, the elasticity of the paperboard generally eliminates any splitting caused by excess spine tensile stress.

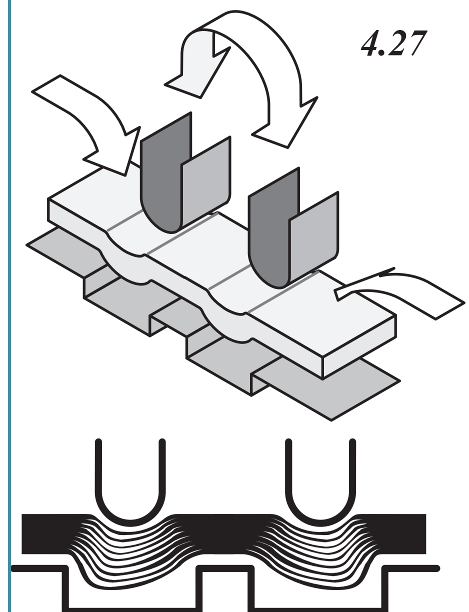
One of the most frustrating challenges in folding carton and in fluted container construction is to achieve balanced and square-folding in parallel, close proximity creases. ***See illustration 4.26***.

4.26



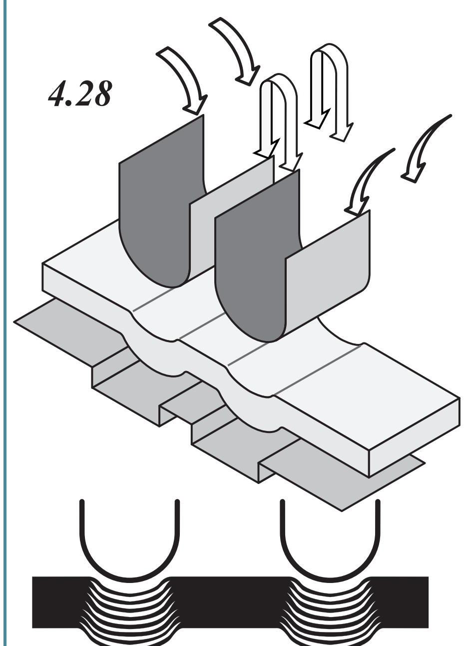
The primary problem is driven by the difficulty of achieving balanced bead formation as the standard draw crease, which is 75 percent lateral draw and 25 percent compression force, is competing with its neighbor for the same area of material. As a result the paperboard between the creases is unable to stretch and deform sufficiently so both parallel creases can achieve balanced internal delamination. ***See illustration 4.27***.

4.27



This problem is simply resolved by converting the standard crease to a Reduced Bead Crease, in which the lateral draw force is less than 25 percent and the compression force is 75 percent. As there is minimal competition between the parallel creases they can be formed and folded with precision. ***See illustration 4.28***.

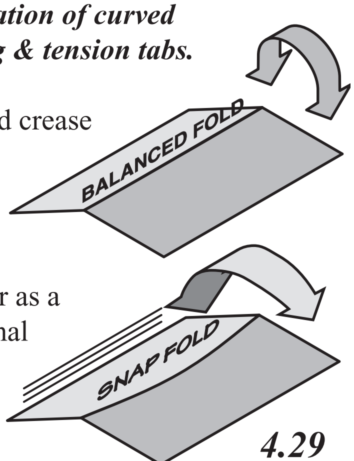
4.28



This eliminates the difficulty of the two creases competing with each other as they attempted the impossible, to force the same material into both channels simultaneously. However, it still left an underlying problem. How to get both creases to fold in a balanced fashion without one crease folding well and the other badly, or not at all!

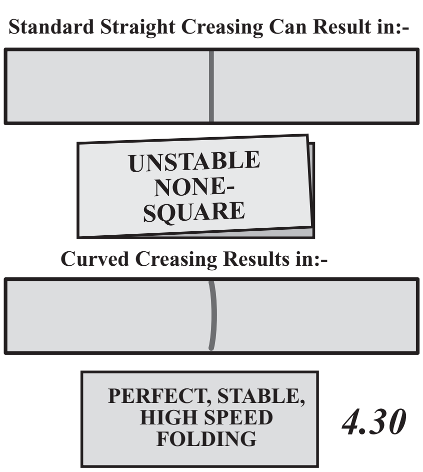
One effective solution is a combination of curved creasing & tension tabs.

A curved crease is often referred to as a snap crease or as a directional fold as these are two important characteristics of adding even a slight curve to a crease. It is called a snap fold because the curvature of the crease changes the balance of folding force from one side of the crease to the other, with the result the stronger side dominates and forces the other side to collapse first. ***See illustration 4.29***.



4.29

The curved crease is also called a directional fold as a normal crease



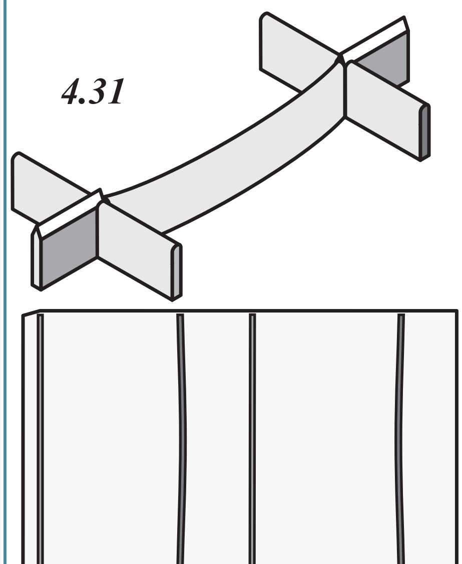
4.30

intersection can fold out of square in either direction, particularly when the leverage of long panels is acting upon the crease intersection. ***See illustration 4.30***.

However, the introduction of a curved crease with the directional bias forces the panel to fold in alignment with minimal variation. It is in reality very difficult for the crease to fold even slightly out of alignment with the centerline formed by the crease intersection.

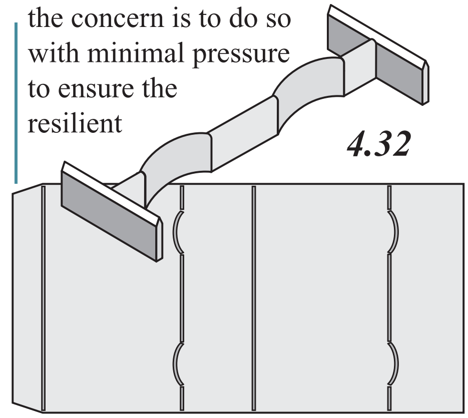
Using curved creases in carton and container manufacturing is one of the most overlooked techniques which can transform both the precision of folding and the degree of force generated by the opening and closing of the paperboard hinge. ***See illustration 4.31***

4.31



Another important technique is the insertion of short curved creases into a standard straight crease. ***See illustration 4.32***. These are called ***Tension Tabs***.

The tension tab in creasing is primarily directed at controlling ***Opening Force*** as opposed to ***Folding Force***. For example, in gluing a folding carton or container, the concern is to do so with minimal pressure to ensure the resilient

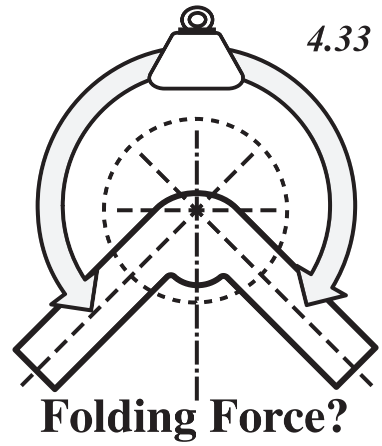


4.32

nature of the cellulose, the material, and the bead/hinge, are not crushed. This is often referred to as ***"fluff."***

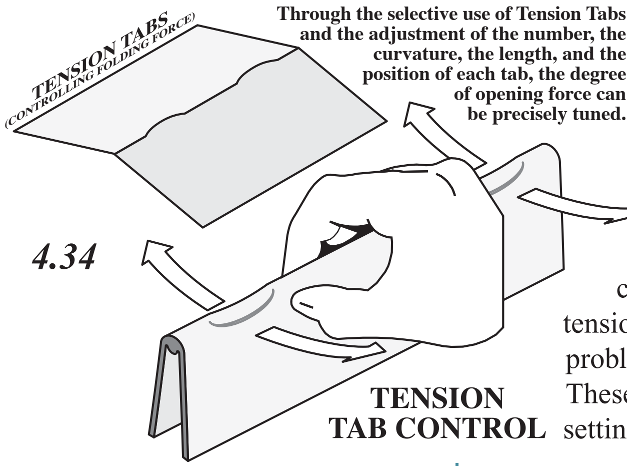
In reality the goal is to deform or delaminate the material with sufficient pressure in forming the bead to cause the panels to fold with a specific degree of rotational pressure. ***See illustration 4.33***.

4.33



The tension tab is designed to apply a controlled amount of reverse tension to the folding sequence. If a crease is folded with a specific amount of force, the integration of a slightly curved section into the standard straight crease, will build in a degree of resilient resistance which is used to add fluff or a ***"unfolding"*** force to the container during the erection-cartoning process. ***See illustration 4.34***.

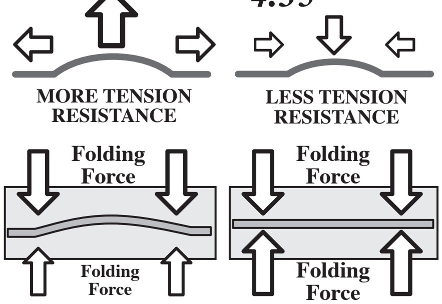
This resistance is insufficient to prevent the carton from folding



4.34

however, it integrates a predictable and controllable degree of opening force to ensure the product packaging sequence can proceed at maximum speed.

In both the Curved Crease and the Tension Tab, which is effectively a small curved crease, the degree of tension control is a function of the curvature and the proportions of the curved section of the crease. ***See illustration 4.35***. This means the body of the crease or the straight parts of the crease control the degree of folding force, and the curved section/tension tabs control the opening force of the folded panels.

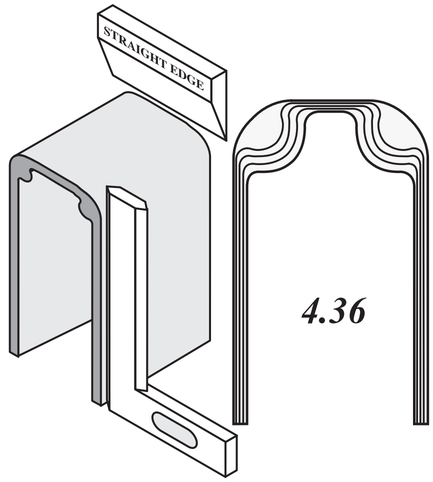


4.35

For example, a crease can be modified from a straight crease to a full curve or to a partial curve. A partial curve of a crease could obviously be defined as a partial curved crease or a large tension tab!

To return to the earlier parallel creasing/folding problem, the solution is to use this curved crease and/or tension tabs to control the formation of a square folded profile. ***See illustration 4.36***.

There are several methods of using curved creases and tension tabs to solve problems in parallel folding. These could include setting the creases with the curvature outward, with a full or partially curved crease section. ***See illustration 4.37***. As we have stated many times this is not an experiment to be conducted on-press, but as a research project to be conducted using a sample making table, in the CAD CAM area, or using a hand fed clam shell platen.



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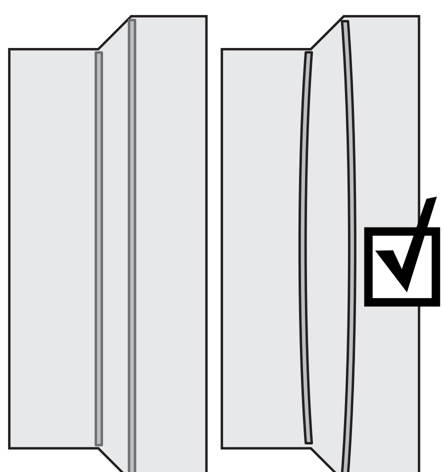

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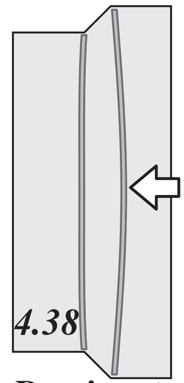


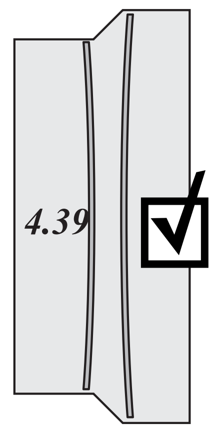
4.38

Dominant Fold

The curves can be slightly different, ***see illustration 4.38***, with the greater curvature of crease being the dominant fold!

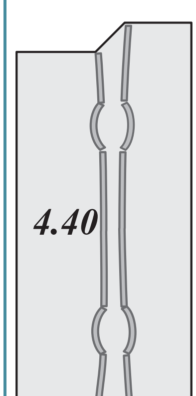
The degree of curvature is varied to reflect the caliper of the material, the type of paperboard, the grain direction, and the features of the design.

The creases can be curved in the other direction, ***see illustration 4.39***, which is excellent if a number of flaps have to be folded in the gap between the creases. Naturally, the tension tabs can be integrated into the crease to add another degree of control and resistance, ***see illustration 4.40***, and these can be varied in the same way the curved creases were manipulated.



4.39

In attempting to create a more precise ***"engineered paperboard container"*** it is essential to reexamine the cellulose hinge mechanism which is at the heart of an effective folding carton. Unfortunately, the standard traditional crease formulation does not offer the degree of control flexibility nor the formation or a reliable hinge.

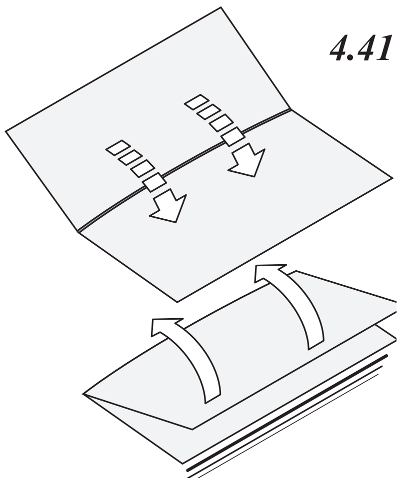


4.40

It is useful to understand the weaknesses of this ***"traditional"*** form of creasing.

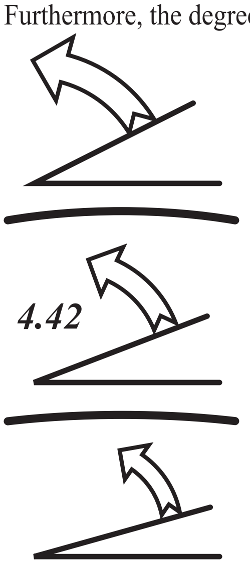
Curved creases or crease sections provide multiple folding benefits and solutions to perennial cartoning problems in folding carton and container manufacturing. In terms of specifically controlling and regulating folding and opening force, a curved crease or the use of tension tabs can be included in the specification of creasing to add resistance and resiliency to folding.

4.41



Even though the degree of curvature is so slight it is virtually impossible to detect, the impact on folding performance is measurable. Even the slightest degree of curvature will add a degree of resilient flexibility to a folded crease intersection, which will induce a positive unfolding action when clamping pressure is removed. ***See illustration 4.41.***

Furthermore, the degree of opening force can be regulated by changing the curvature of the crease and/or the inset tension tabs. ***See illustration 4.42.*** With so many positive attributes, which improve creasing and folding performance, it is important to begin experimenting with these techniques.



4.42

In addition, to changing the ***Critical Distance***, to using ***Reduced Bead Practices***, and to using ***Curved Creases*** and ***Tension Tabs***, there is a method of controlling folding and opening force, which is very successful. This technique is called ***Combination Creasing.***

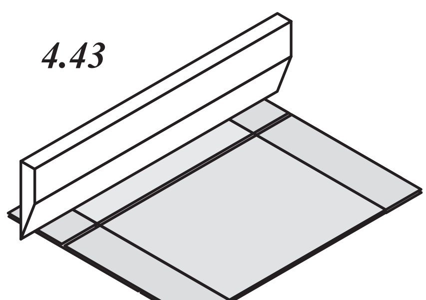
Using Compound Creasing to Control Folding & Opening Force

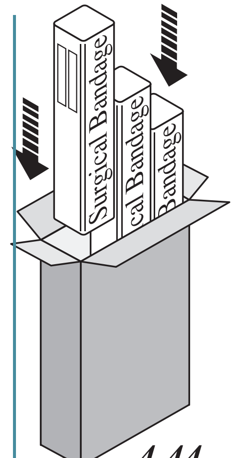
As we have read one of the radical methods of changing the folding properties of a paperboard hinge is to ***Curve the Crease*** and/or to add short lengths of a reverse curve crease, called ***Tension Tabs***, into a single fold. This technique is designed to regulate the resistance to folding, or the "***Opening Force***" of the fold. A very effective alternative, which achieves exceptional results, employs the use of ***"Combination-Multi-Featured Creasing."*** Before we describe this technique we should both examine the problem and redefine the goal of these techniques.

What is the Goal of Combination Creasing?

The goal of creasing is to create a paperboard hinge, which will fold through 90 and 180 degrees and unfold, without fracturing the outer spine of the fold or the inner bead of the crease. However, as the folding carton and fluted container are regarded as an "engineered" container, and the contents are generally inserted into the carton in an automated high-speed packaging or "***cartoning***" line, the folding and unfolding properties of the hinge are critical to an effective marriage of container and product contents. As most "***folding***" cartons are delivered pre-folded and glued "***flat***", ***see illustration 4.43***, to be ***"opened"*** for product insertion, ***see illustration 4.44***, or are delivered unglued and unfolded, ***see illustration 4.45***, to be "***wrapped***" around the product, ***see illustration 4.46***, the resistance and resilient flexibility of the hinge are important.

4.43





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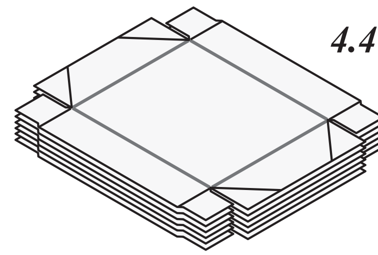
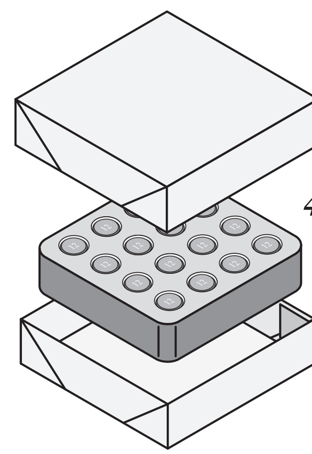


A consistent oversight in the carton and container industry is the practice of largely ignoring the cartoning process in the design and specification of diecutting-converting tools. This dangerous practice is extended into diecutting manufacturing and the examination and final qualification of the product. There are important advantages in examining the product packaging line to look for problems, to detect anomalies, and to discover op-

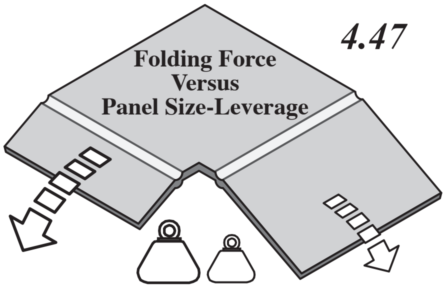


4.46

portunity to design and fabricate a more effective carton or container.

The degree of folding force in a paperboard hinge is a function of many parameters, including the proportion and leverage of the attached panels. ***See illustration 4.47.*** In principle the amount of force required to fold a crease through 90 and 180 degrees is related to the degree of double parallel pinching of the material and the degree of internal delamination of fiber, which creates the central flexible bead. ***See illustration 4.48***.

4.47



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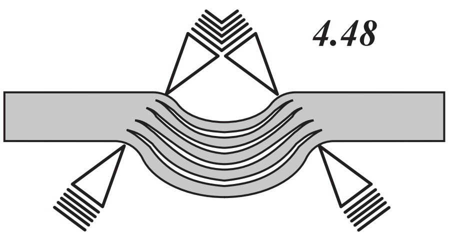
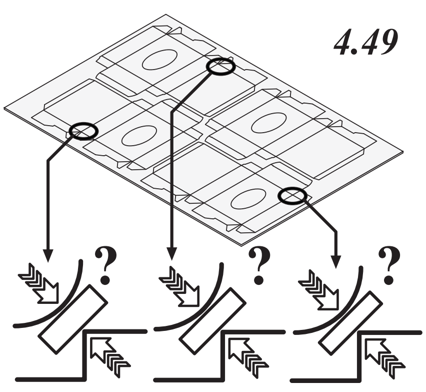


However, this is by no means a precise science. Key variables include the setting and the consistency of the pinching gap between the male and female tooling.

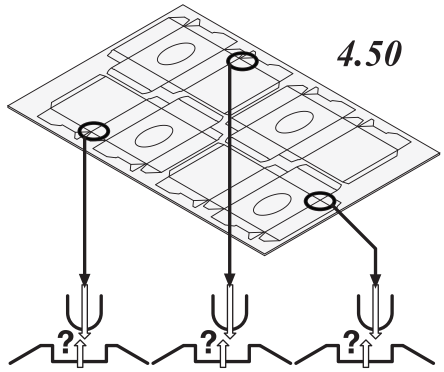
4.49



See illustration 4.49. This is not an unusual variable, as the spacing between the male crease and the female channel, from crease to crease, can be caused by an uneven cutting make-ready and an uneven press!

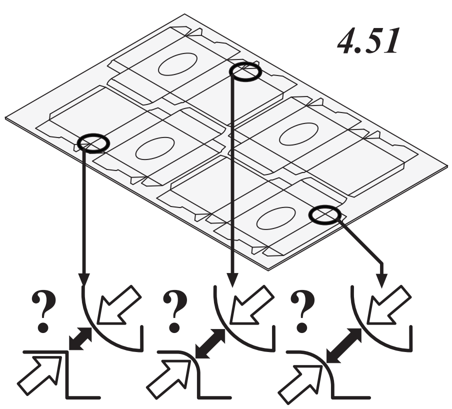
Another common source of misalignment, is the chase or lower platen being seated and locked incorrectly into the press after an adjustment, undermining the precise alignment of the male and female tooling. ***See illustration 4.50.*** This can also be the result of excessive tool machining and continuing progressive shrinkage of an improperly prepared and protected steel rule dieboard.

4.50



A constant source of variation is the result of the degree and the speed of progressive wear on the key upper corners of the female channel. ***See illustration 4.51.*** This rapid wear of the critical upper corner of each crease channel can be caused by the pressure imbalance and the tool-to-tool misalignment previously illustrated, and/or by choosing the incorrect counter/crease rule parameters. Finally, variation can be caused by the moisture content, caliper and the fiber content of the material at the hinge point.

4.51



Having set up the parameters and made the press ready for production, the degree of folding force is measured, and the degree of resistance and/or the lack of resistance, is adjusted using limited means. In the majority of manufacturing operations, this simply means adding or reducing pressure on the crease rule in the steel rule die to control the critical distance. This change in pinching force regulates the degree to which the crease or ***"controlled failure"*** resist folding.

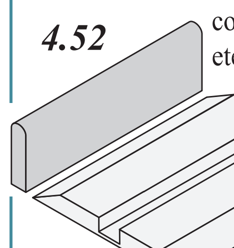
The disadvantage of this approach, is the adjustment described has regulated the folding stiffness of the hinge, however, the inherent resiliency of the fold, or the degree to which it will unfold after being folded, compressed and stored under pressure, for a short or a long period of time, is a function of the mix and the characteristics of the fiber in the hinge and in the bead between the twin shear lines of the crease.

This lottery like approach to manufacturing converting is far to unpredictable for high-speed packaging, and given the inherent variation in key paperboard characteristics, it is essential to add techniques to more accurately regulate and control, both folding force and opening force. One very effective technique, which is simple to understand, easy to execute, and not complicated to manage, is the Combination Crease method.

How Does Combination Creasing Work?

The singular difference between combination creasing and standard creasing, is using combination creasing, a single fold, is not simply a single set of parameters. The practice of using a single male crease rule and a single width of female channel, ***see illustration 4.52***, is replaced with a combination of parameters, which integrates different widths and heights of crease, combined with different widths of

4.52



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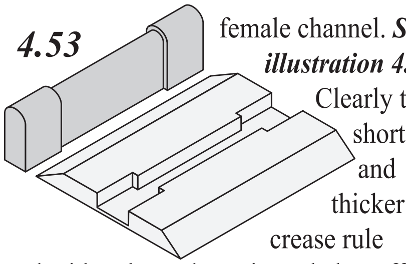
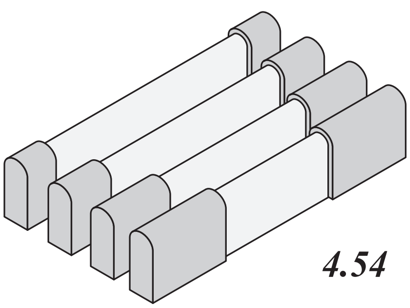


female channel. ***See illustration 4.53***. Clearly the shorter and thicker crease rule and wider channel, are intended to offer higher resistance to folding, than the majority of the crease, which is formed using standard crease parameters.

The reason this is so effective, is rather than trust to chance, by adding a mechanically different section of hinge, with different folding properties, into a standard crease/fold, both folding force and opening force can be individually adjusted. The range of adjustment possibilities is unlimited.

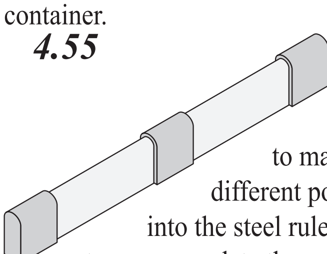
For example, a standard crease could be modified with two higher pointage creases, and the proportion of the higher resistance crease to the lower resistance crease, can be adjusted in several ways. ***See illustration 4.54***. In addition, the



4.54

number of higher resistance crease can be adjusted, ***see illustration 4.55***, to reflect the specific needs of the fold and the container.

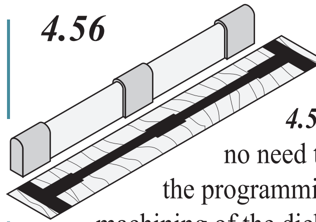
4.55



It is obviously not necessary to machine different pointages into the steel rule die board to accommodate these different pointages. See illustration 4.56.

By using 3-point crease rule on a 2-point crease body, and 4-point crease rule on a

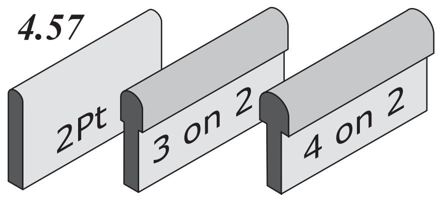
4.56



2-point body crease, ***see illustration 4.57***, there is no need to change the programming and the machining of the dieboard.

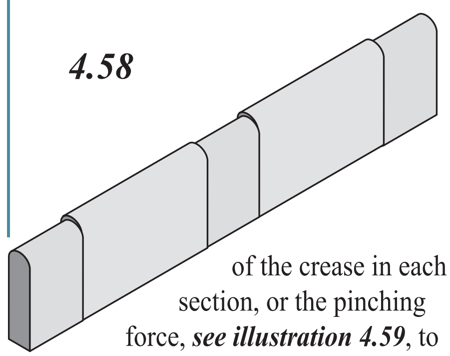
Even simpler, a combination crease can be made from the same pointage of crease rule, but the degree of resistance

4.57



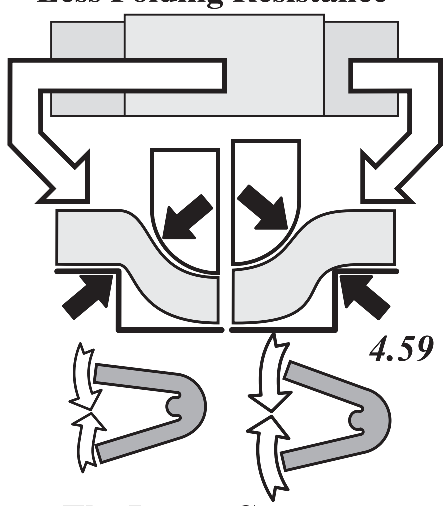
or resiliency adjusted by increasing or reducing the height of the short crease sections. ***See illustration 4.58***. This method is adjusting the critical distance

4.58



of the crease in each section, or the pinching force, ***see illustration 4.59***, to give greater control of the folding and opening force of the crease.

The Higher Crease = Less Folding Resistance



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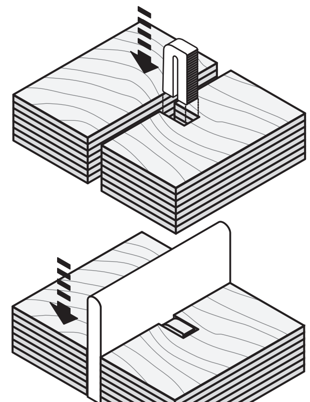
The Lower Crease = More Folding Resistance

The technical breakthrough with this approach is to integrate ***"adjustable"*** sections of crease parameters into a standard crease, to enable greater control of critical folding and unfolding parameters.



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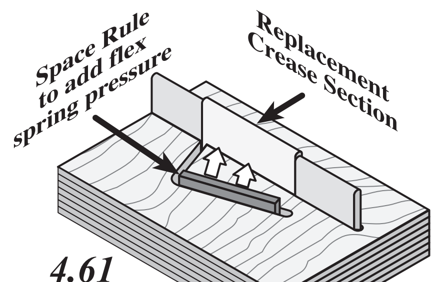
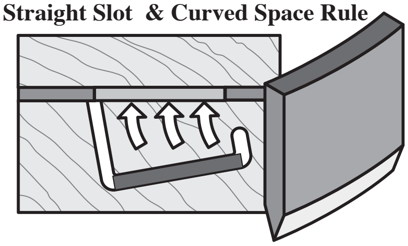
To simplify, initial adjustments using this technique, the dieboard is made with provision for Kerf Locks, ***see illustration 4.60***, or Dieboard Locks. ***See illustration 4.61***. Both of these methods enable easy, fast and secure methods of changing short



4.61

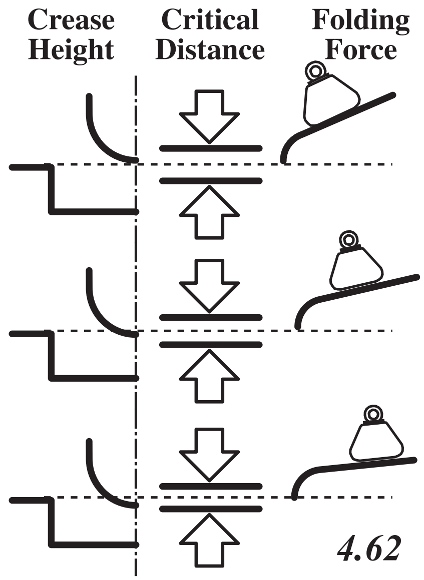
Straight Slot & Curved Space Rule



lengths of rule to eliminate technical difficulty with this approach. In reality a number of tests will determine the optimal setting, so this process will not have to be repeated, however, should a change to folding force become necessary, everything is in place to make the adjustment simple and effective.

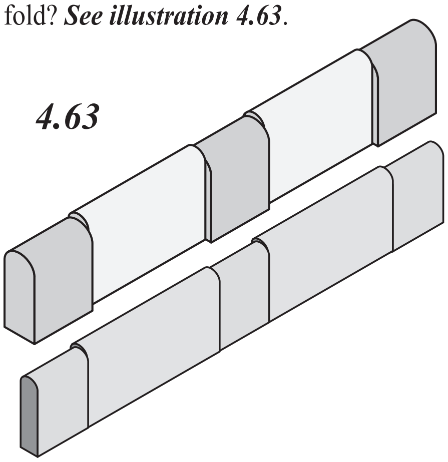
How Do the Different Crease Parameters Change Folding/ Unfolding Force?

It is obvious be changing the height of individual crease, the critical distance is changed, and the pinching force, and therefore, the folding force of the crease/ fold is modified. ***See illustration 4.62***.



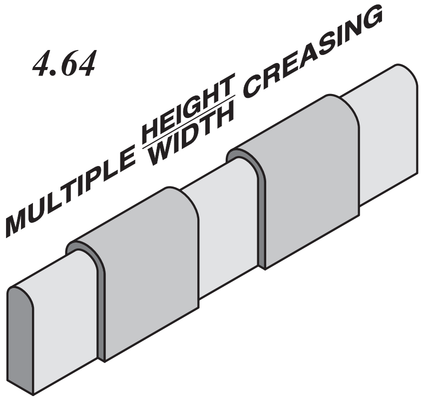
4.62

As this is the primary control of folding force in creasing, why is it necessary to add higher pointages of crease, wider sections of female channel, and generate two different proportions of bead in a single fold? ***See illustration 4.63***.



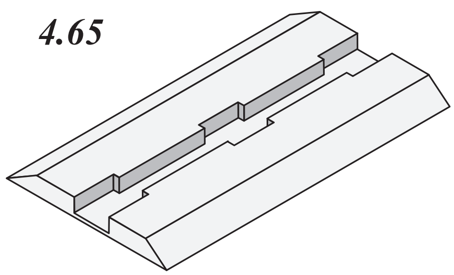
4.63

While the single pointage combination crease, with the ability to adjust individual sections of rule, ***see illustration 4.64***, and the elimination of a multiple width channel, ***see illustration 4.65***, is



4.64

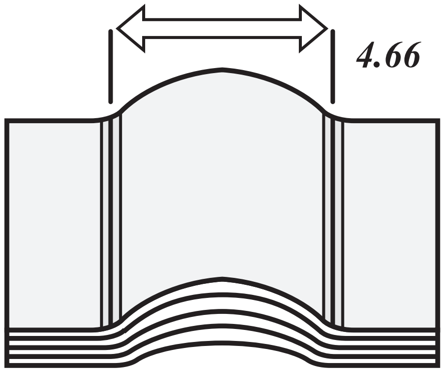
much simpler, the integration of different proportions/sizes of bead provides some additional advantages.



4.65

For example, even though the critical distance should be maintained at the optimal level for internal delamination, the increase in the Critical Spacing, the distance between the twin lines of

Critical Distance Spacing

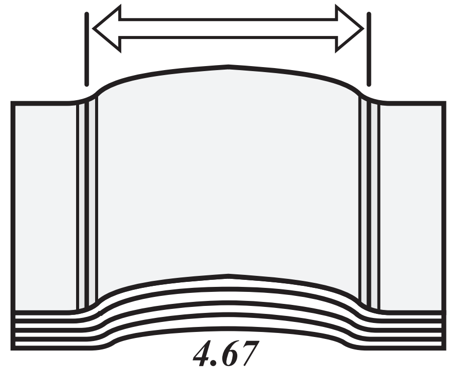


4.66

shearing effort, ***see illustration 4.66***, changes the degree of delamination in the central bead. ***See illustration 4.67***. As the Critical Spacing increases, ***see illustration 4.68***, the degree of bead delamination falls, and the resistance to folding increases. ***See illustration 4.69***.

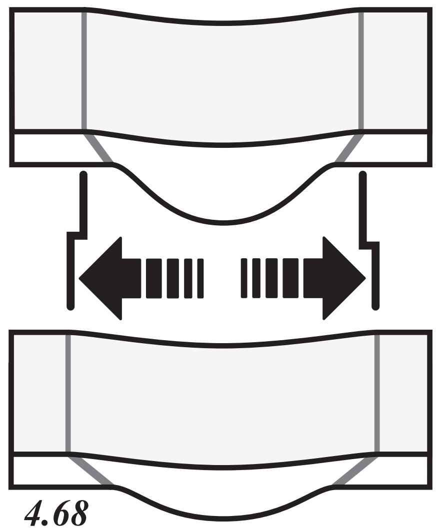
The wider bead, with lower internal delamination is less flexible and offers

Critical Distance Spacing



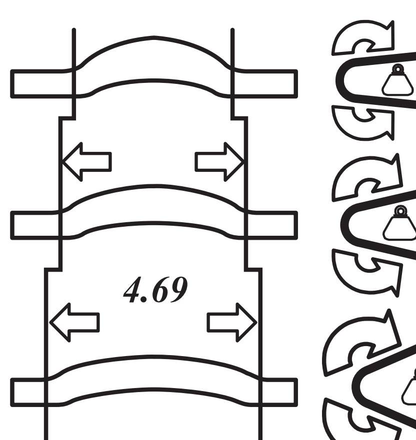
4.67

more resistance to folding. Naturally, if these parameters were used for the entire length of the fold, the increase resistance to folding would be unacceptable, and the probability of the increased folding stress



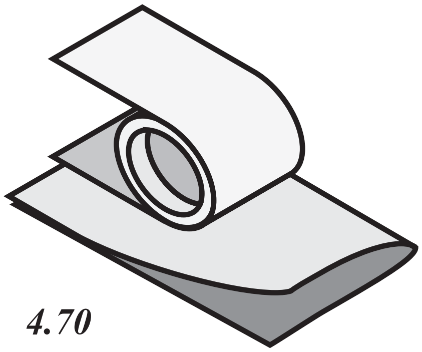
4.68

generating spine splitting could increase. However, given the short lengths of these higher resistance creases, there is insufficient folding stress to cause spine splitting. Apart from the advantage of



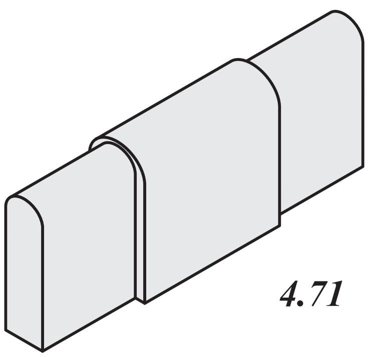
4.69

adding a specific and controllable degree of resistance to a standard crease, the increase in bead width protects the entire crease from being over-compressed in gluing. ***See illustration 4.70***.



4.70

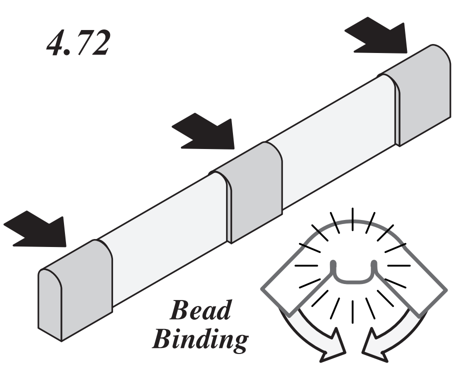
By regulating the channel width, and the height and the pointage of the short sections of crease, ***see illustration 4.71***,



4.71

the ***"problem"*** of bead binding can be selectively induced. ***See illustration 4.72***. When uncontrolled the bead binding ***"problem"*** would significantly increase folding force, and often lead to spine failure. However, in these short sections, the slight degree of bead binding, adds to the resilient resistance of the crease to folding, and will provide a small but critical resilient opening force when the carton is being erected.

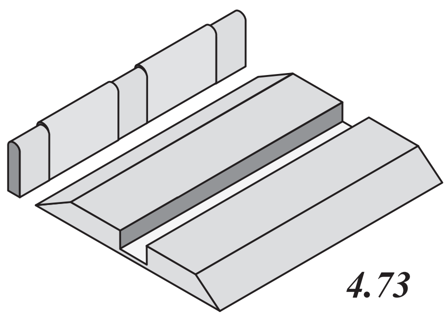
4.72



Combination Crease Summary

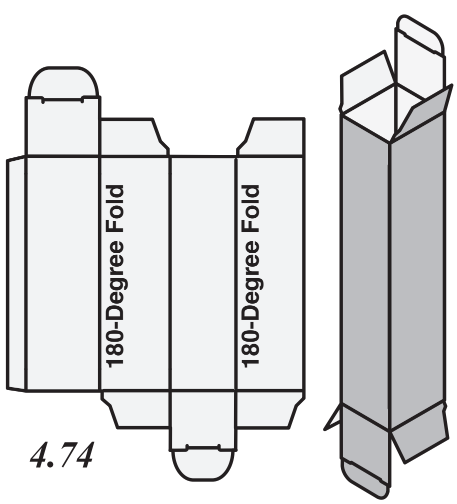
The technique of combination creasing is successful because instead of relying upon chance to control folding and opening force using standard crease parameters, the addition of a mechanism to add and regulate resilient opening force in the combination crease, more accurately balances the conflicting needs of folding in cartoning and automated packaging.

The most effective starting point to conduct experiments with this approach is by employing a single pointage, multi height combination crease, using a single width of counter/matrix channel. ***See illustration 4.73***.



4.73

There is certainly a learning curve in using this technique, however, as it is based upon making specific adjustments to key creasing and folding parameters, it takes a short time to build competence and expertise. In practice, combination crease is generally only used for the 180 degree fold in a carton or container, ***see illustration 4.74***, however, this technique has many attributes which can be used to solve problems and improve folding performance in many different carton and container applications.



4.74

Chapter 4:
How to Control Crease Folding & Opening Force: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

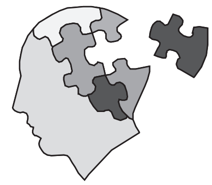
- ✓ A key ingredient of every crease is the amount of force required to fold the attached panels through 90 and then 180 degrees. Equally important is the amount of resilient opening force or "fluff" built into the fold hinge.
- ✓ The most important measurement in creasing is the Critical Distance, as this controls the degree of pinching force the paperboard is subjected to, and therefore, the amount of folding and opening force.
- ✓ The second most important measurement in creasing is the Critical Distance Spacing Gap, as this controls the degree of delamination and the flexibility of the crease bead.
- ✓ The length and the proportion of the panels attached to the central crease bead are important in creasing. A long lever results in lower folding force and a short lever results in higher folding force.
- ✓ A key attribute of paperboard is the inherent elasticity parallel to the grain caused by shrinkage of the paperboard in the cross machine direction.
- ✓ Excess crease-to-crease lateral draw competition using traditional crease tool parameters is the basic reason it is difficult to form effective parallel creases.
- ✓ A curved crease is a great innovation in creasing and folding as it adds or improves key properties of folding, without compromising the appearance or the functionality of the carton or container.
- ✓ Integrating short sections of curved crease rule, called Tension Tabs, into a standard crease/fold increases resistance to folding force and increases opening force resiliency.
- ✓ Combination creasing, or the integration of multiple heights and multiple pointages of crease rule and multiple widths of female crease channel in the same fold, is a powerful tool with which to control folding force.
- ✓ By integrating short sections of higher, but identical pointage crease, into a single fold, folding force is decreased and conversely, when a lower section of crease rule is integrated, the amount of folding force increases.
- ✓ It is possible to more accurately regulate folding and opening force in creasing by inducing the problem of "bead binding" in short sections of the crease/fold.

Chapter 4:
How to Control Crease Folding & Opening Force: Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ What does the term "fluff" mean in creasing and folding?
- ✓ How is the setting of the Critical Distance changed to, A; increase folding force; and B, to decrease folding force?
- ✓ What is the Critical Distance Spacing measurement in crease toolmaking, and how is it adjusted?
- ✓ What happens to folding force when the "pinching" distance of the crease tool setting is reduced?
- ✓ What happens to spine stress when the Critical Distance Spacing is reduced?
- ✓ How does the length/proportion of each panel attached to the central bead, impact folding force?
- ✓ Why is it necessary to use a narrower channel when creasing parallel to the paperboard grain, than when creasing at right angles to the paperboard grain.
- ✓ Why is a curved crease such an advantage in creasing and folding?
- ✓ How does the integration of Tension Tabs in a crease fold change the attributes of folding and opening force?
- ✓ What is a Combination Crease and what is the purpose of this crease/tool configuration?
- ✓ When a short section of a higher pointage crease is introduced into a lower pointage crease, how does the section of higher pointage crease impact the formation of the bead and the performance of folding and opening force?
- ✓ When short sections of crease rule are integrated into a single fold; how does a higher crease section impact folding force, and how does a lower crease section, impact folding force?

Brainstorming, Notes & Ideas



"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

Chapter 5:
What are the Disadvantages of Traditional Creasing?

The current standard methods for creasing and folding have remained virtually unchanged for more than fifty years, however, rapid and accelerating change in paperboard material, carton and container design, and in processing speed, have undermined their reliability. This chapter is a review of key weaknesses of traditional creasing, prior to describing more effective alternative methods.

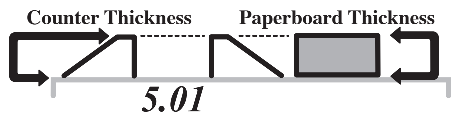
These issues include:

- ➔ *Spine Stress & Failure*
- ➔ *Single Specification Creasing*
- ➔ *Rapid Crease Tool Wear & Failure*
- ➔ *Ineffective Bead Formation*
- ➔ *Excess Draw: Flaking*
- ➔ *Excess Draw: Nicking*
- ➔ *Diecutting Pressure Resistance*
- ➔ *Unstable Diecutting Performance*
- ➔ *Crease-to-Crease Competition*
- ➔ *Ineffective Folding/Opening Force*
- ➔ *Diecut Part Marking/Shadowing*
- ➔ *Crease End Splitting*
- ➔ *Crease Intersection Bursting*
- ➔ *Bead Snagging*

Before we review these issues it would be an advantage to define how "***Traditional Creasing***" tooling is set-up.

What is Traditional Crease Tool Set-Up?

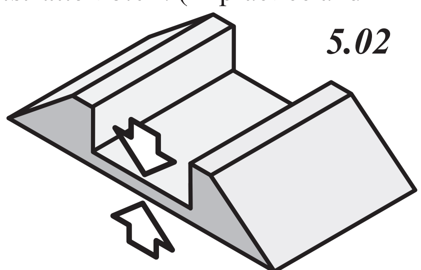
To begin the traditional crease set-up, ***the first step*** is to determine the thickness of the counter or female tool. The standard formula specifies the thickness of the female crease tool to match the thickness or caliper of the paperboard being converted. ***See illustration 5.01***. For the moment



5.01

we will ignore the membrane at the base of the channel, common to all fiberglass counters and used on some types of Crease Matrix. ***See illustration 5.02***. (In practice and in

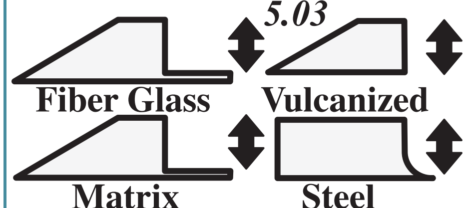
5.02



Channel Membrane

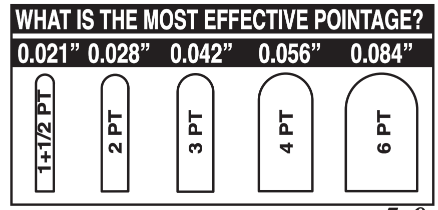
principle in all the four major female crease tool methods, Vulcanized Fiber, Matrix, Fiberglass Counters, and the Steel Cutting Plate, the depth of the channel and the caliper of the paperboard are identical. ***See illustration 5.03.***)

5.03



The second step in set-up is to select the pointage or thickness of the crease rule to be matched with the female counter. Crease rule is supplied in ***1.5, 2, 3, 4, & 6 Point***. ***See illustration 5.04***. However, the majority of carton and container converting tools are made using ***2, 3, and 4 point*** creasing rule.

Each organization has their own specific method of matching paperboard caliper with crease pointage, and, ***illustration 5.05*** shows a typical breakdown.



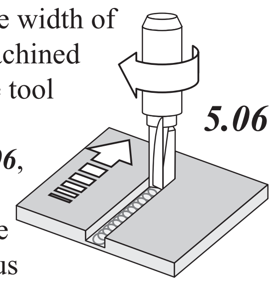
5.04

PAPERBOARD CLASSIFICATION : Solid Unbleached Sulphate (SUS)	
Caliper Range	**Pointage**
0.010 - 0.012 =	1+1/2 Pt
0.013 - 0.020 =	2 Pt
0.021 - 0.027 =	3 Pt
0.028 - 0.035 =	4 Pt
0.036 - 0.045 =	6 Pt
0.046 - 0.065 =	8 Pt

Example Only

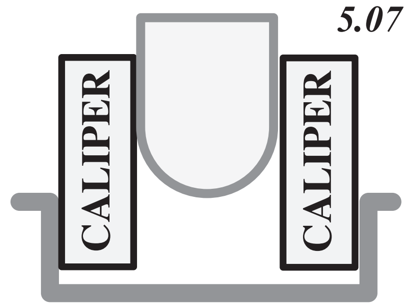
5.05

The third step is to calculate the width of the channel in the female crease tool. The width of the channel machined in to the crease tool materials, ***see illustration 5.06***, is twice the thickness of the paperboard, plus the thickness or pointage of the crease rule selected. ***See illustration 5.07***.

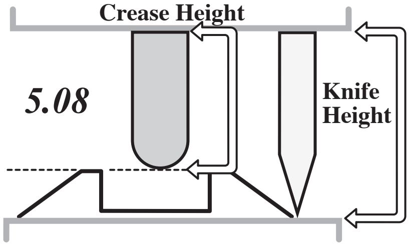


5.06

5.07



The fourth step is to determine the height of the crease rule in the steel rule die. In traditional creasing the standard set-up results in the tip of the crease rule being level with the

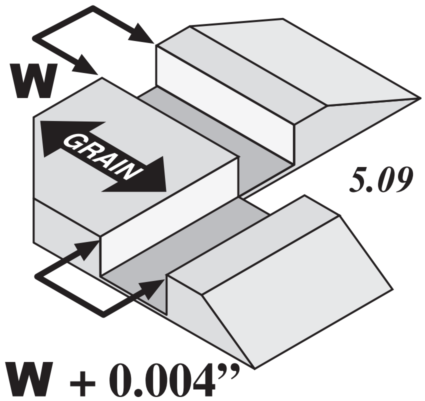


plane formed by the surface of the female crease tool, when the press is fully closed. ***See illustration 5.08***. Therefore, to calculate the height of the crease rule, the total thickness of the female tool is subtracted from the height of the cutting knife in use.

For example, if the caliper of a paperboard were 0.016”, the channel width calculation would be twice the caliper plus one thickness of crease rule. In this example that would be:

2 x 0.016” + 0.028” (2Pt) = 0.060”

This width would be used for channels parallel to the paperboard grain, and 0.004” added to the width of the Cross Grain Channels. ***See illustration 5.09***.



The thickness of the counter would be the same as the thickness of the material, which is 0.016.” Therefore the height of the crease rule would be:

0.037” - 0.016” = 0.921”

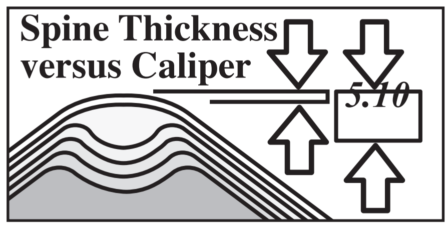
Naturally, if a fiberglass counter were being used, which had a 0.004” thick membrane the calculation would be:

0.037” - 0.020” = 0.917”

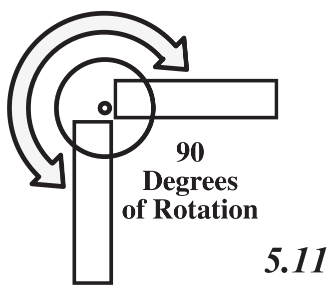
There are certainly variations on this method, however, this type of tooling calculation is fairly typical of traditional crease tool set-up.

Crease Spine Stress & Failure?

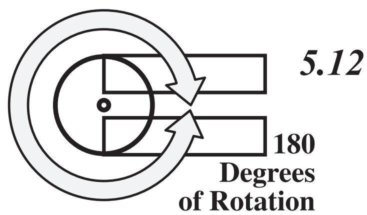
The Achilles Heel of the traditional paperboard crease is the thin membrane of material, which is stretched around the outside of the folded panels to form the face



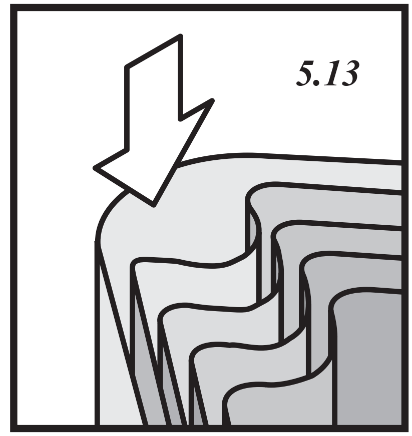
of the crease. ***See illustration 5.10***. Although the fold in most applications is only required to complete 90 degrees of panel rotation, ***see illustration 5.11***, certain



applications and particularly machine gluing and cartoning, require the panels to fold through a full 180-degrees. ***See illustration 5.12***.

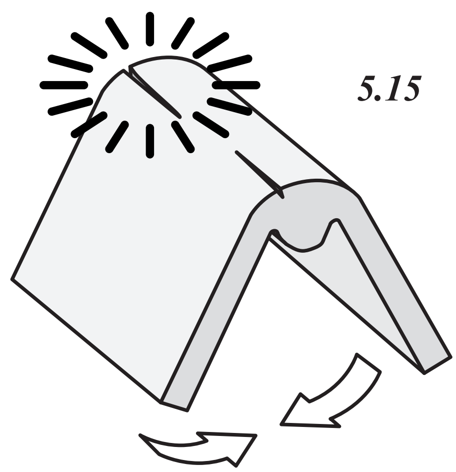


The spine of the crease is formed from delaminated layers, which are less than 20% of the caliper of the paperboard. ***See illustration 5.13***. This is necessary, so this thin layer of material will have the elasticity

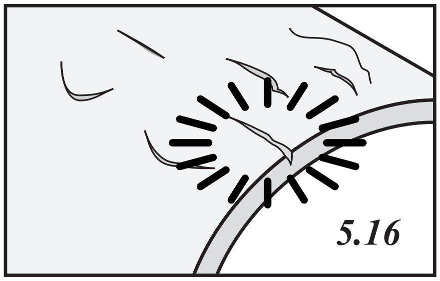


and resiliency to stretch around the outside of the folded panels. ***See illustration 5.14***. However, it is not surprising this is the first indicator

of a paperboard hinge and tooling problem, as the spine prematurely fails under excess tensile stress. ***See illustration 5.15***.

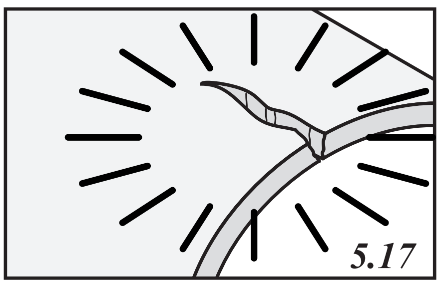


When the failure is a function of print or graphic finishing, the fracturing is generally limited to surface crazing and picking of the ink/varnish layer. ***See illustration 5.16***. Unfortunately,



5.16

if the hinge proportions are incorrect or improperly formed, the failure will be catastrophic and completely sever the spine layer. ***See illustration 5.17***. The problem, of course, is as the spine is under constant stress during formation and initial folding, any surface failure will spread and enlarge under folding tensile forces.



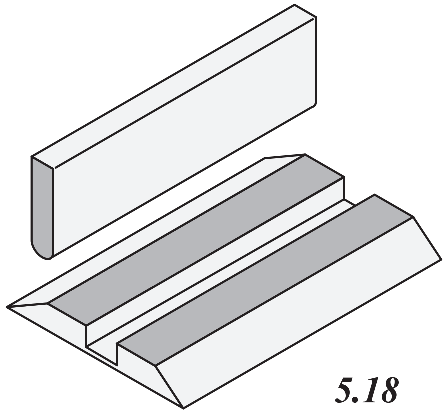
5.17

As paperboard and fluted materials are evolving, innovating, and diversifying, the critical multi-ply construction methods makes the material more stress sensitive if the paperboard hinge is not set-up or functioning effectively.

The traditional crease/tool set-up does not have the flexibility to accommodate many of these changes, and the standard parameters often generate poor folding performance and crease spine failure.

A Single Specification Crease & Fold

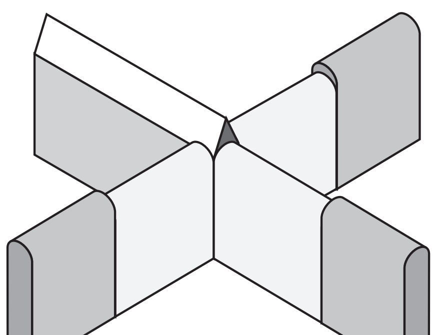
The traditional approach to creasing has always been to use a single specification for the entire length of the fold. For example, the fold would have a single height of crease, and obviously a single pointage, and the channel would be a single width and a single height. ***See illustration 5.18***.



5.18

Why is this a disadvantage? The problem with this approach is almost every crease has multiple folding needs along the length of the fold.

For example, where crease end splitting is a problem, or intersection surface bursting, the most effective crease would include three heights. ***See illustration 5.19***. The lower ends of the crease would generate a smaller bead which would minimize crease spine tensile stress at the end of each fold.

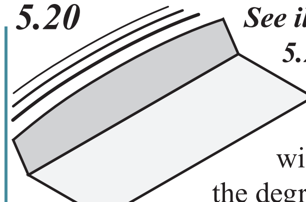


5.19

In a similar fashion, when a fold is a long and proportionately thin panel, it is not unusual to generate bowing in the center of the panel, where resistance is high. ***See illustration 5.20***.

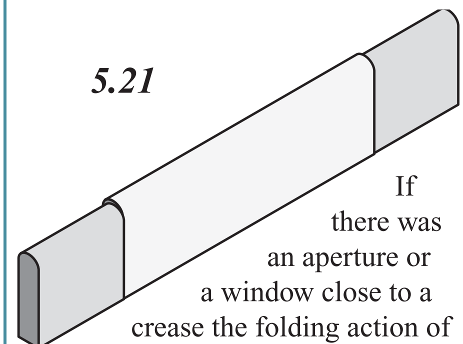
An effective solution is to have a crease with a higher central section.

5.20



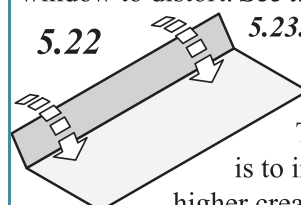
See illustration 5.21. The higher crease will increase the degree of delamination, increasing the flexibility of the bead, and reducing the folding force of the panel. ***See illustration 5.22***.

5.21



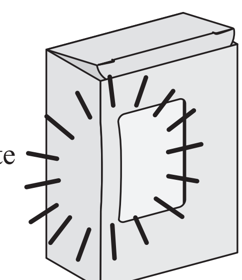
If there was an aperture or a window close to a crease the folding action of the crease causes the edge of the window to distort. ***See illustration 5.23.***

5.22



The solution is to integrate a higher crease rule into the fold, and align the crease with the window. ***See illustration 5.24***

This will eliminate and/or minimize the distortion of the edge of the window, by increasing the pinching pressure and reducing the force required to fold.



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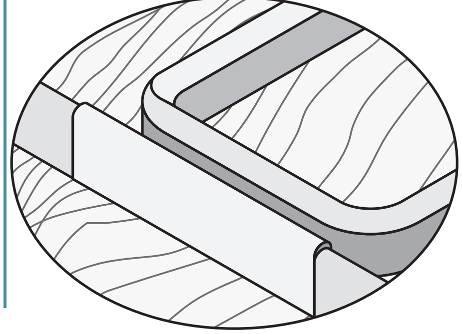
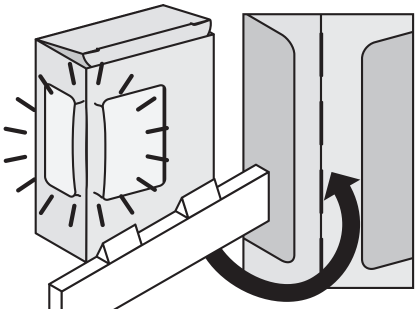
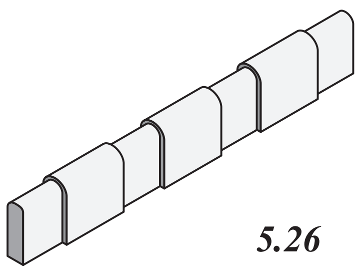
5.24





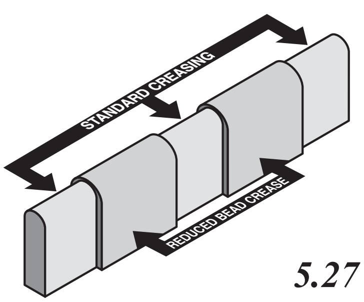
5.25 Cut-Crease

Many designers integrate cut-crease or score-crease, ***see illustration 5.25***, to reduce the folding resistance of the crease and to generate a square precise fold. Why not use all creases?



5.26

Simply use a higher crease and/or a higher pointage crease in the same method as cut-crease, but instead of the cut we are substituting a higher crease. ***See illustration 5.26***.



5.27

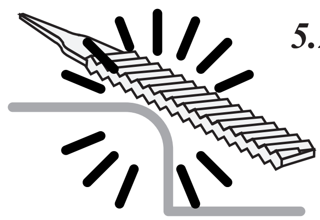
Finally, as specified in an earlier chapter, attempting to balance folding and opening force in a single specification crease, is an unnecessary gamble. The solution is to integrate multiple heights and multiple widths of crease rule, and when necessary multiple widths of channel, ***see illustration 5.27***, to create a hinge with multiple folding properties.

Realistically the single specification crease/hinge is perfect for more than 90% of folding applications. However, in those critical folds, which often make the difference between converting success and failure, the ability to manipulate key folding parameters of the crease is very important.

Rapid Crease Tool Failure!

When purchasing a carton or a container the customer is investing in quality, consistency and repeatability. Unfortunately, with the traditional crease set-up, the first impression starts a progressive degradation of creasing and folding attributes, which will ensure folding variation in every carton from every load. The problem is rapid and progressive wear of the upper corner of each crease tool channel. ***See illustration 5.28***.

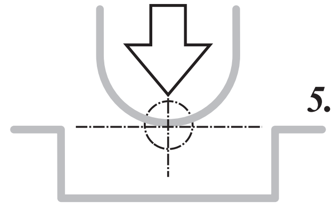
This gradual increase in the critical distance is caused by the shearing action between the face of the crease



5.28

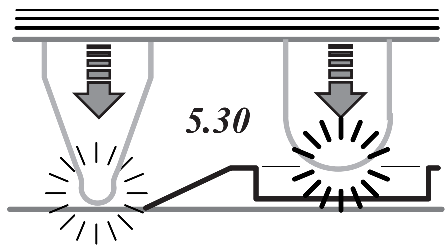
rule and the upper corner of the crease channel. Paperboard is an abrasive material and the repetitive compression and lateral movement of the material gradually rounds the corner of the channel, impression by impression.

There are several sources for this imbalance and a number of factors, which accelerate wear. This first is caused by a "***normal***" uneven make-ready, and the progressive reduction in the platen gap, as the production run progresses. If the setting is at the optimal distance, the tip of the crease rule would be level with the top of the channel. ***See illustration 5.29***.



5.29

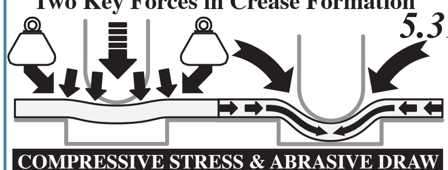
However, because of normal unevenness of the cutting impression, pressure is added through shimming, which simply means the gap between the tools is reduced. Unfortunately, knives which were once pristine and sharp suffer gradual compressive tip damage, and as adjustments are



5.30

made to compensate the tip of the crease penetrates further and further below the surface of the crease tool. ***See illustration 5.30***. The formation of the traditional crease involves

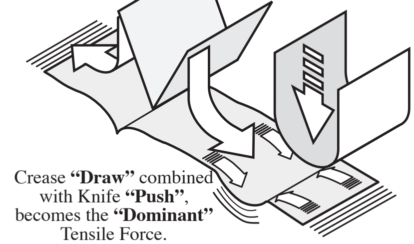
Two Key Forces in Crease Formation



5.31

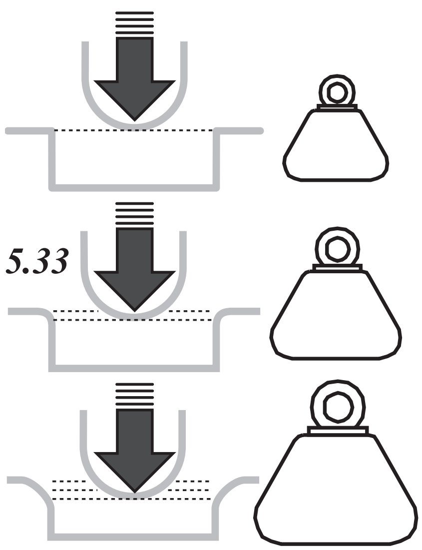
25% compression and 75% lateral draw of material toward and into the crease channel. ***See illustration 5.31***. If there are other knives and creases close by, they are also competing with the first crease to draw material toward their center of effort. ***See illustration 5.32***.

5.32



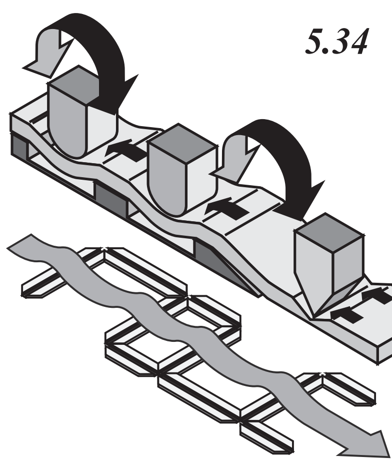
Crease **"Draw"** combined with Knife **"Push"**, becomes the **"Dominant"** Tensile Force.

This has three detrimental effects. First, it increases the stress on the corner of each channel, secondly, it prevents the crease bead from forming effectively, and third, it increases the stiffness of the material, which requires an increase in pressure to cut and to crease. ***See illustration 5.33***. Of course this problem is significantly complicated by the additional tensile stress generated by wrapping and stretching the paperboard around the crease tool. ***See illustration 5.34***.



5.33

In practice, the traditional crease specification results in an unstable cutting make-ready, rapid tool wear and degradation, and the quality, the consistency, and the repeatability of the folding carton or container is compromised.

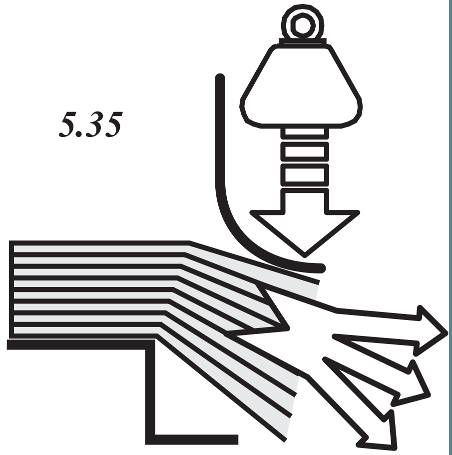


5.34

Ineffective Bead Formation

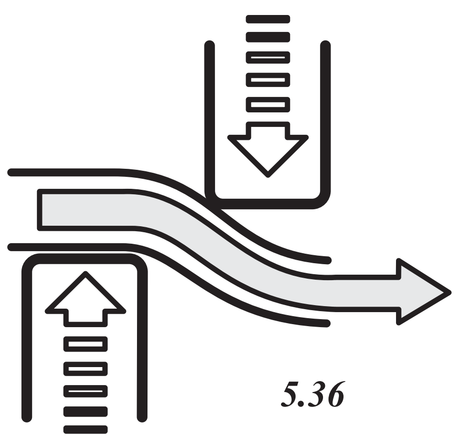
The traditional crease-bead formation formula is not so much wrong as it is outdated. The process, the tools and paperboard materials have

5.35



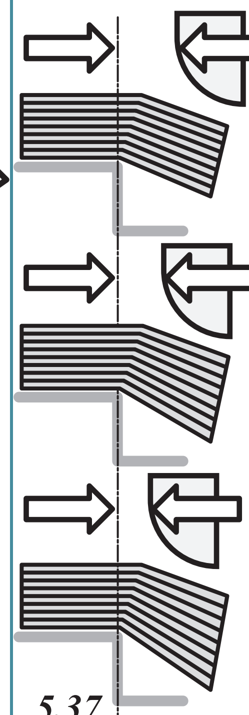
evolved, and it is necessary to modify the formulation to ensure greater predictability in diecutting, in gluing and cartoning, and in the use of the folding carton or container product.

The primary problem with the standard formula is it does not generate sufficient shearing force in the new paperboards to convert the bead into an effective, flexible shock absorber.



5.36

The bead is created by pinching pressure, which is a combination of vertical force and lateral draw. ***See illustration 5.35***. The problem with the current method is it relies too much on lateral pull and too little on compression. For example, shearing is caused by a material being trapped between two surfaces, which are moving in opposite directions. ***See illustration 5.36***. The further the surfaces are apart the greater the degree of lateral tensile stress and the closer the tools are together, the greater the degree of compression. ***See illustration 5.37***.



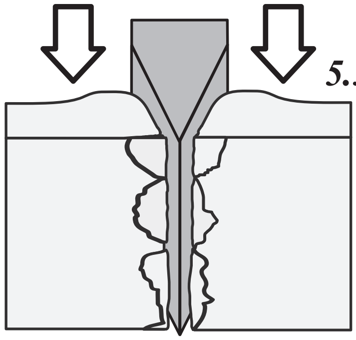
5.37

What is important when this is translated into paperboard creasing, is the shearing at the top of *5.37* generates significant draw, which we have learnt causes, rapid tool wear, poor crease-to-crease performance, excess edge chipping and flaking, and premature fracturing of nick/tags. The bottom diagrams in *5.37* utilize greater compressive force, which translates in extended tool life, minimal crease-to-crease impact, and minimal draw induced flaking or nick breaking.

Therefore, the future of creasing is to introduce tool parameters which increase compressive force; which generate a smaller but more proportionate bead, which provide greater stability and consistency in crease formation, which have minimal impact on surrounding crease and cutting activity, and which produce a more effective crease, with better folding performance in all key attributes.

Excess Tensile Stress: Flaking

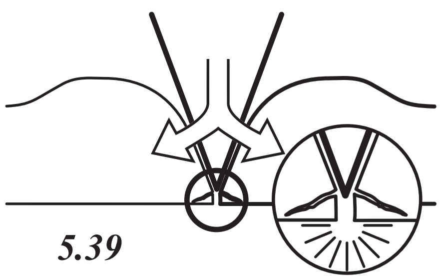
One of the perennial paperboard diecutting problems is chipping or flaking of the underside of the diecut edge. ***See illustration 5.38***. This is



5.38

particularly problematic when cutting at right angles to the paperboard grain.

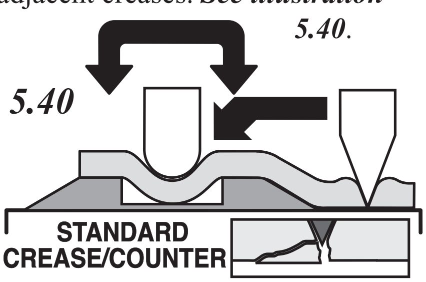
The failure is primarily caused by the displacement action of the knife /wedge, as it converts a vertical force into a lateral splitting action. ***See illustration 5.39***. This problem is exacerbated, when the paperboard is simultaneously subjected to high levels of tensile stress and stretching.



5.39

There are several source for this stress. These include other knives, blunt knives, improper ejection material selection and application, but the greatest culprit of all are adjacent creases. ***See illustration 5.40***.

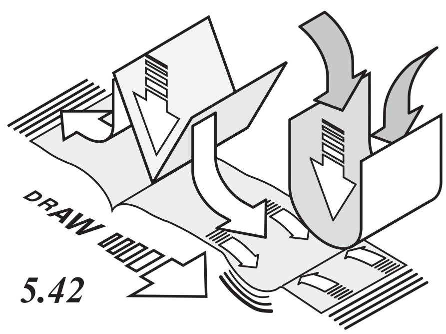
5.40



In the initial phase of diecutting, both the knife and the crease rule are competing with each other as they pull material toward their center of effort. ***See illustration 5.41***.

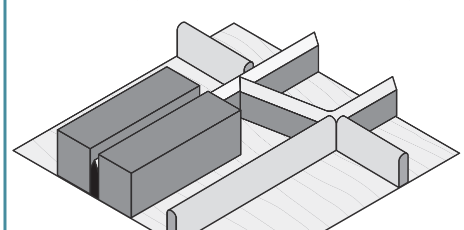
5.41

However, as soon as the tip of the knife has penetrated the surface of the material, the bevel edges of the knife, add their displacement push to the lateral pull of parallel creases. ***See illustration 5.42***.



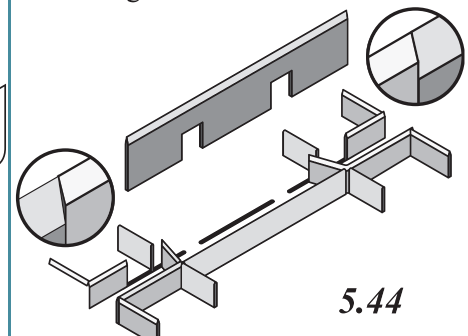
5.42

Attempts are made to isolate the knife and the crease by inserting denser rubber ejectors between the crease and cutting rule. ***See illustration 5.43***. And while this has some beneficial impact, the chances of marking the carton are very high!



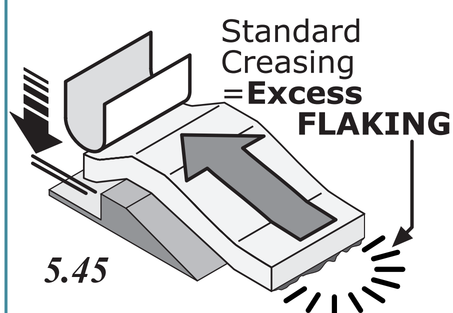
5.43

Rather than deal with the symptoms of the problem many diecutters minimize knife displacement force by substituting a lower bevel angle where the flaking occurs. ***See illustration 5.44***. However, the problems of traditional creasing overpower these band-aids and continue to generate flaking on the diecut edge.



5.44

The problem is, the high percentage of tensile draw using standard crease tool parameters; the problem of the material being wrapped and stretched around a very thick female creasing tool, and the inevitable problem of over-penetration of the crease, as pressure is added to compensate for incomplete knife cutting. ***See illustration 5.45***.



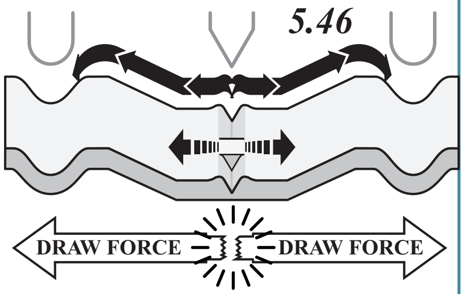
5.45

The problem is particularly acute because of the shearing action of creasing. The surface of the material is stretched the most by the formation of the crease, and this adds to the problem of premature separation or lateral shearing of the paperboard, immediately prior to full knife penetration.

In this scenario the competing needs of the knife and the crease rule are unbalanced in favor of the crease, because of the parameters of traditional crease tools.

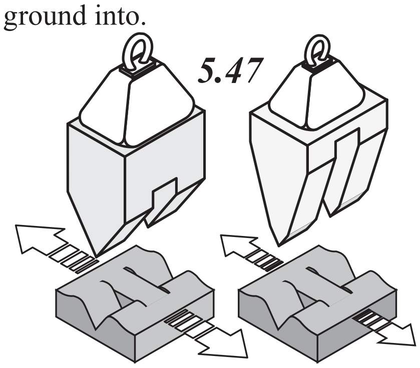
Excess Tensile Stress: Nicking & Sheet Break-Up

Many of the problems defined in the ***Flaking,*** described in the previous section, have an almost identical negative impact on the formation of effective nick/tags. ***See illustration 5.46***.



5.46

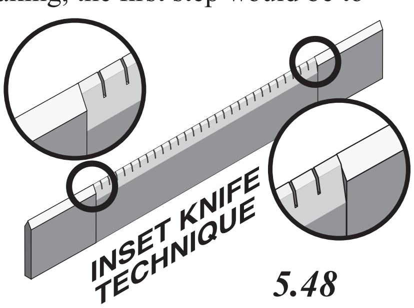
As with flaking the primary threat to the integrity of the nick/tag is the bevel angle of the knife the nick is ground into.



5.47

Note: Lower Bevel Angle Knives require less pressure to diecut, displace less material, and therefore, produce stronger nicks!

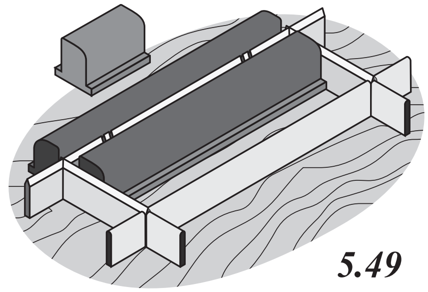
The wider the bevel angle, the weaker the nick/tag, and the narrower the bevel angle, the stronger the nick tag. ***See illustration 5.47***. And as with flaking, the first step would be to



5.48

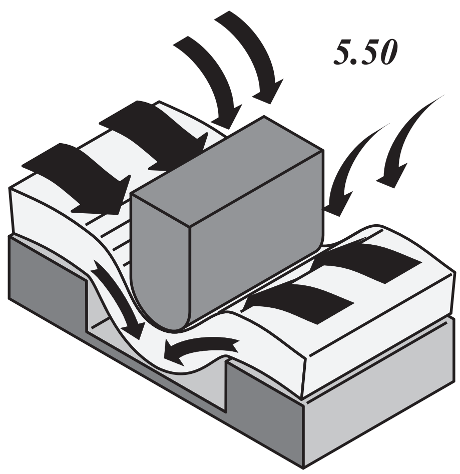
substitute a lower bevel angle knife where nicks are to be added to the steel rule die profile. ***See illustration 5.48***.

As with flaking special rubber is added to protect the nick/tag from the high level of draw forces in diecutting converting. ***See illustration 5.49***.



5.49

However, the primary source of tensile stress and paperboard stretching, is caused by the excess thickness of crease tool, the wrap around effect of crease formation, and the over-penetration of the crease rule down into the crease channel. ***See illustration 5.50***.



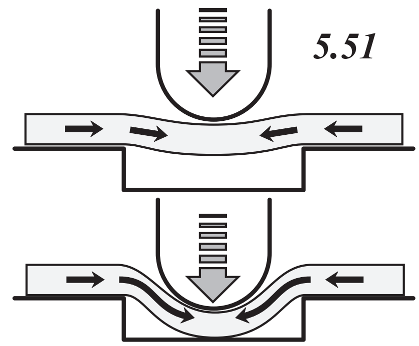
5.50

Unfortunately, the underlying problem is the degree of competitive draw generated by the traditional crease/tool specification. When using traditional crease tool parameters, more nicks will be needed, and they will have to be wider than would normally be acceptable!

Diecutting Pressure Resistance?

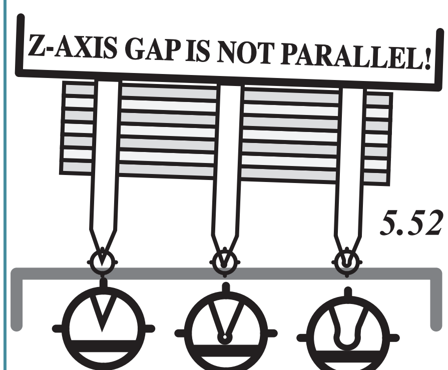
A critical weakness of the traditional crease-tool set-up is it is designed for a perfect world with no margin for error. Of course when the inevitable variables are added to the complexity of platen diecutting, crease folding performance is compromised, and even more important the crease tool parameters undermine other key converting activity.

The standard set-up has the tip of the crease level with the surface of crease counter, when the press is full closed and "***on***" impression. ***See illustration 5.51***. In a "***normal***" press



5.51

make ready some of the knives are not making contact with the cutting plate, and other areas of the die, the cutting edges are compressed and damaged, by heavy contact with the cutting plate. ***See illustration 5.52***.

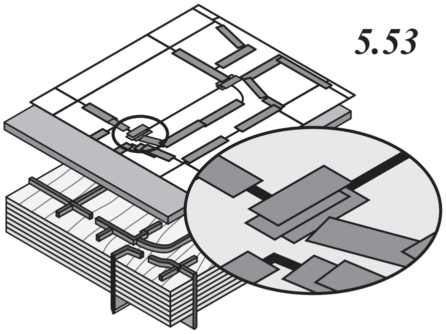


5.52

This is not an unusual scenario, and to compensate for the resulting incomplete cutting, the back of the die is "***shimmed***" with strips of tape to push the steel rule closer to the cutting plate. ***See illustration 5.53***.

This is a common sequence of activity, and several rounds of "***patch-up***" may be required

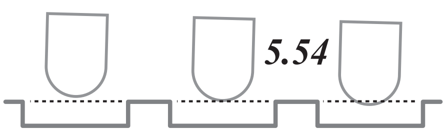
5.53



during make ready, and adjustment shimming and increments of pressure may be added as the production run continues.

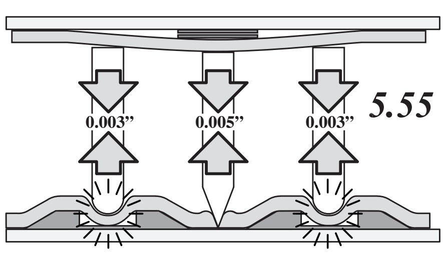
The problem for the "***invisible***" role of creasing during make ready is the fold was designed with an optimal relationship between the male and female crease tool. If some of the creases are not reaching the optimal setting on full press closure, or they are driving too deep into the crease channel, ***see illustration 5.54***, there are three areas of concern.

5.54



The first obvious problem, is we are converting cartons in a layout with multiple die stations, and in which the performance of individual creases will vary from fold to fold. This inconsistency is not what the customer invested in, as the customer expectation is folding uniformity and repeatability from die station to die station!

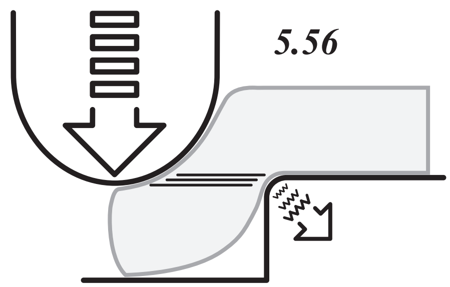
5.55



Patch-Up Impacts Creases To!

The second problem is, the pressure imbalance, set up by the uneven cutting make-ready. Obviously, the operator concentrates on the primary problem, of getting every cut to completely penetrate the substrate. However, his or her actions are also impacting the relationship between the male crease rule and the female

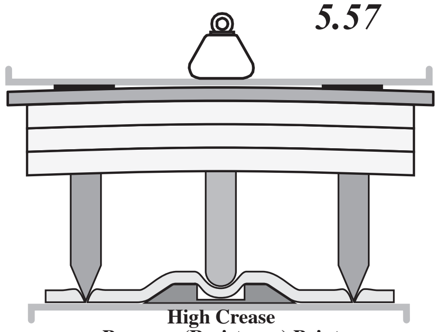
5.56



counter. ***See illustration 5.55***. It is obvious that driving the tip of the crease too deep into the crease channel, will stress and abrade the upper corner of the channel, ***see illustration 5.56***, but this does not happen immediately!

As the shimming and reduction of the Z-Axis is gradually implemented, the crease is driven deeper and

5.57



High Crease Pressure (Resistance) Point

deeper into the channel, but the resulting abrasion does not happen immediately. In reality the paperboard is highly resistant to this increased level of pinching pressure, at the Critical Distance. Which means as cutting "***pressure***" is increased the paperboard fights the added compression, with the result a "***resistance***" point is created in the layout. ***See illustration 5.57***.

This appears to the operator that there is insufficient pressure or patch-up on the surrounding knives, so more patch-up is added. These "***false-pressure images***" cause the operator to add far more patch-up than would be necessary. However, the crease counter has not had time to adjust to the added force by abrading the upper corners of each over pressurized channel.

As a result, the make-ready is inaccurate, it damages and causes rapid wear to the knives, and it causes rapid wear to the crease-tool set-up, and inevitably the folding performance of the finished product is variable and uneven!

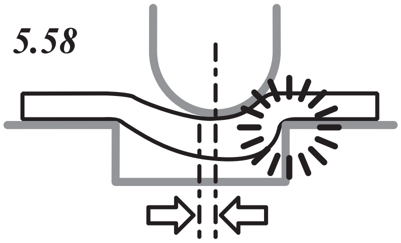
An Unstable Cutting Make-Ready!

As we have discussed, a normal diecutting press make-ready using a non-calibrated press and a non-calibrated steel rule die, employing the "***standard***" crease tool configuration, is inherently unstable. Cutting will be uneven and unstable and excess pressure adjustment will frequently be required. Creasing will be inconsistent, and rapid and unbalanced crease tool wear, will further destabilize the cutting impression. Inevitably creasing and folding performance will vary from die station to die station, and from impression to impression!

There is no margin for error in the standard crease set-up! Instead of designing for an impossible perfect world, it is essential to use our experience and design for the reality of platen diecutting.

Common factors of male-female crease tool misalignment such as lateral variation between the male and female tool are inevitable, ***see***

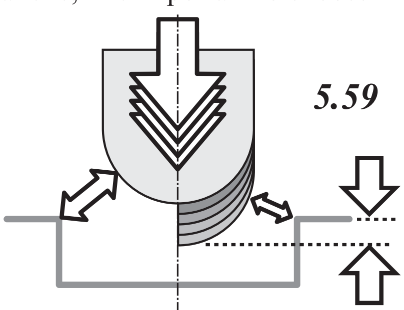
illustration 5.58, and uneven over penetration of the crease rule into the



Male-Female Missalignment

crease channel an unavoidable fact of life. ***See illustration 5.59***.

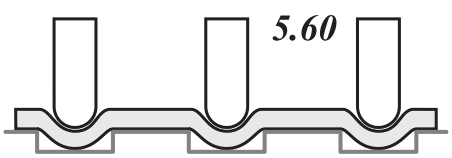
It is vital to calibrate the press and the tools, and to calculate pressure with a degree of precision, which will reduce and hopefully eliminate key variables in platen diecutting. However, to be practical and to be realistic, it is important to choose



a method of creasing, which compensates for and somewhat accommodates normal variation.

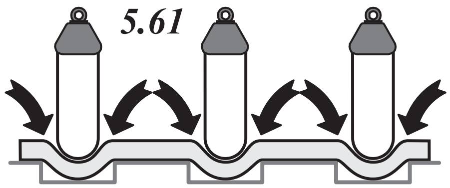
Crease-to-Crease Draw Competition!

The traditional set-up for crease tools relies heavily on tensile stress of a lateral pull toward the crease to generate bead delamination & bead formation. These forces do not act in isolation, and they obviously impact knives and other creases in the die



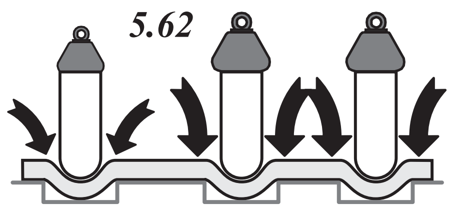
layout as they pull, stretch and draw the substrate in every direction.

The reason this effect is so important is how pressure and tensile stress change based on the distance between knives and creases. For example, if three parallel creases are spaced an equal distance apart, ***see illustration 5.60***, lateral draw and compressive pressure are evenly balanced. ***See illustration 5.61***. These creases will also demonstrate consistent crease formation and folding performance,



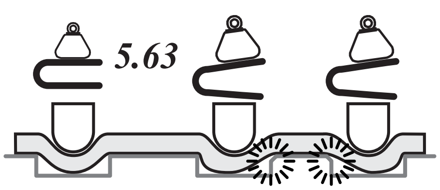
and progressive wear will be identical, and therefore, the level of performance will remain in balance.

However, if one of the creases is moved closer to one of the others, pressure and lateral draw is unbalanced. ***See illustration 5.62***.



In addition, female tool wear is unbalanced and folding performance is different from crease-to-crease-to-crease! ***See illustration 5.63***.

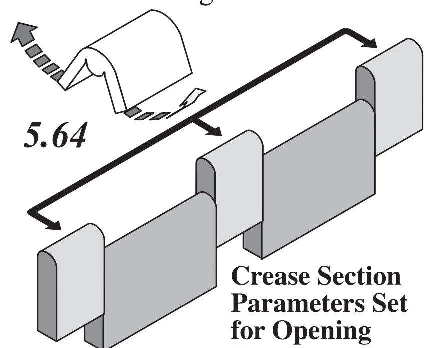
As there is rarely any control of the design of a diecut part and the



arrangement of knives and crease rules, it is vital we recognize the potential problem, and use tool set-up to compensate for the potential imbalance. If the standard crease set-up is applied in this type of common situation, we are simply setting up the press operator to fail, and the customer to struggle with a variable and inconsistent folding carton and container product.

Inconsistent Control of Folding & Opening Force

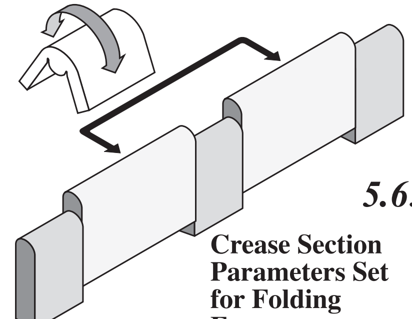
As discussed in the previous chapter, the standard crease tool configuration is poorly designed to control and regulate both folding and opening force, even if the diecutting platform and the diecutting tools were stable.



Crease Section Parameters Set for Opening Force.

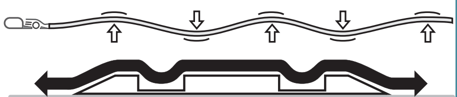
Therefore, by recognizing all of the inherent variability of the process, and by assessing the impact of progressive tool wear, from the first impression to the last, it is obvious that controlling folding and opening force using current methods, is a concept rather than a practical reality.

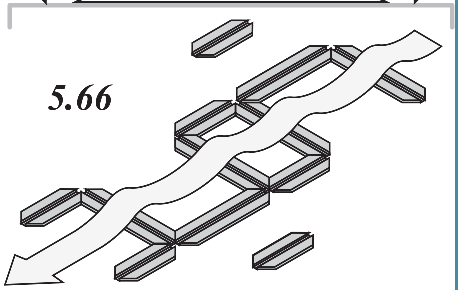
It is obviously more effective to separate folding and opening force in a single fold, and to set one or more sections of the fold and the crease tool parameters to generate a specific degree of opening force.



Crease Section Parameters Set for Folding Force.

See illustration 5.64. This would also by default, result in setting the remaining sections of the fold, and the crease tool parameters, to accommodate the folding force requirements of the hinge in the design. ***See illustration 5.65.***



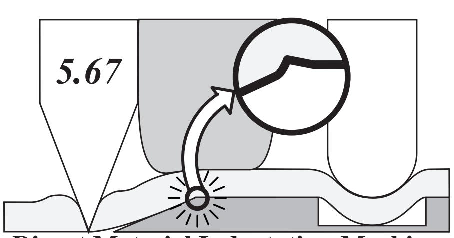


By adjusting individual crease tool parameters within single key folds, and by measuring the results, it is possible to develop a chart of settings which will provide specific degrees of folding force and specific degrees of opening force.

This logical practice is basically the combination of different fold parameters in a single crease, using simple and non complex methods.

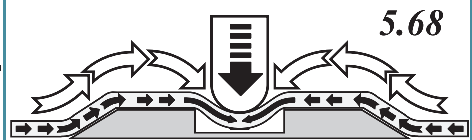
Marking of the Diecut Parts

Vulcanized Fiber, Matrix Strips, and Individual Fiberglass Counters all share one major disadvantage. They all protrude above the surface of the anvil, the knife will cut onto or into. ***See illustration 5.66***.

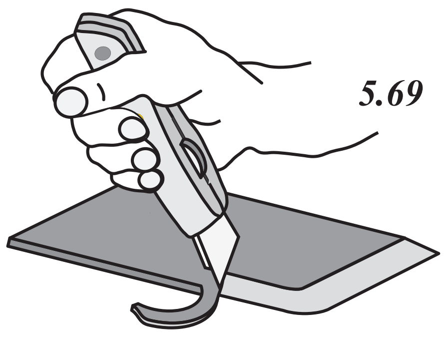


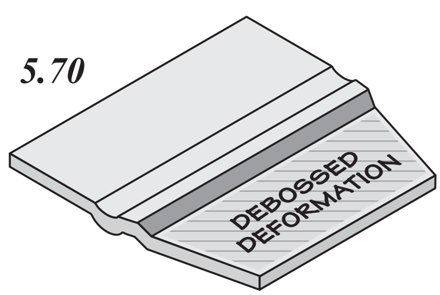
Diecut Material Indentation-Marking

This inevitably results in the paperboard or fluted material being trapped and pinched, between the edges of protruding crease tool profile and the ejection material mounted in the steel rule die. ***See illustration 5.67***.

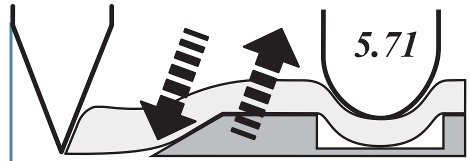


Compounding this potential problem is the necessity of the paperboard being compressed onto, and stretched around the profile of the female tool. ***See illustration 5.68***. Under these circumstances, even with extraordinary beveling of the counter profile, ***see illustration 5.69***, and the use of softer ejection material, it is difficult to avoid the crease tool profile indenting the face of the carton or container. ***See illustration 5.70***.

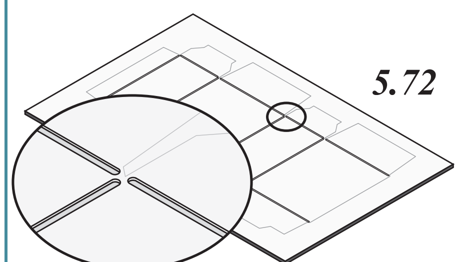


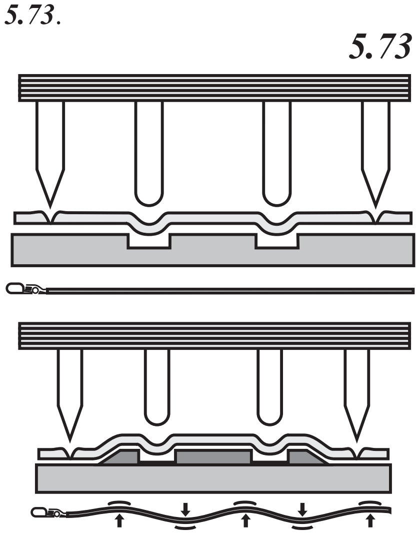


As inevitably parts of the design require knives and creases in close proximity, the shearing effect between the die and the crease tool is difficult to eliminate. ***See illustration 5.71***. Therefore, the traditional crease formula, which mistakenly ties the caliper of the paperboard to the thickness of the crease tool, makes a complex process that much more complex.



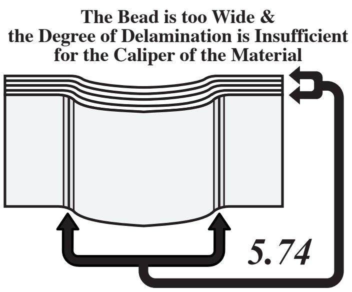
Conversely, the alternative steel counter plate, is a "***flush***" creasing and cutting anvil combination. ***See illustration 5.72***. The comparison between the shape of the sheet using this tool, as opposed to the shape of the diecut sheet using a protruding alternative, demonstrate clearly the scale of the problem. ***See illustration 5.73***.





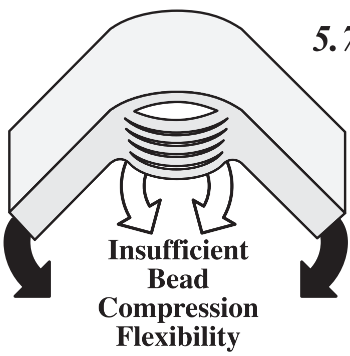
Bead Binding

In essence, the bead generated by traditional crease set-up is too wide, and also the degree of internal delamination, ***see illustration 5.74***, which ensures the bead has its essential flexibility, is far from complete.



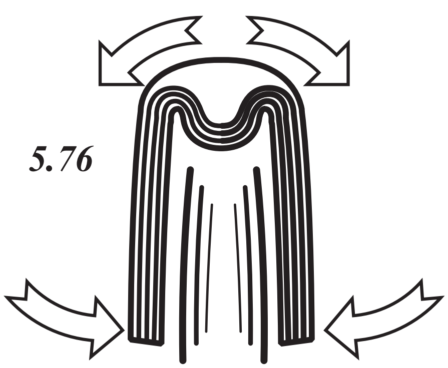
5.74

As a result, when the panels are folded, the bead has insufficient flexibility to compress, and to partially collapse, which is essential to prevent excess folding stress being transferred to the spine of the crease.

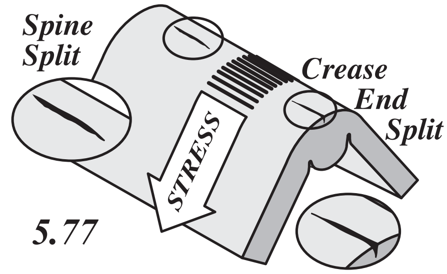


5.75

See illustration 5.75. In addition, the partial internal delamination, generated by the converting action of the press is inadequate and as a result, the folding action of the panel/levers have difficulty converting the partial internal delamination, into full internal delamination. ***See illustration 5.76***.



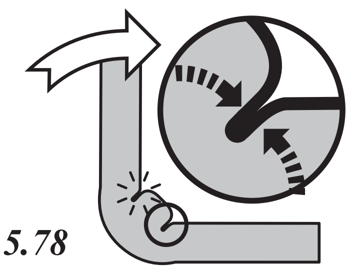
5.76



5.77

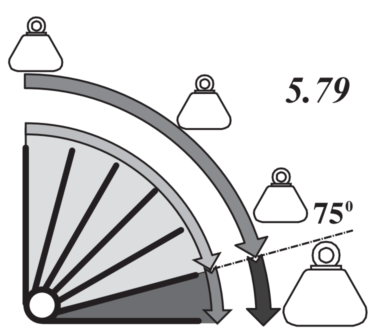
This has several negative consequences which undermine the folding performance of the crease. The first, is because the bead formation is only partially complete, folding transfers the stress normally absorbed by a flexible bead, to the spine of the crease, with obvious results. ***See illustration 5.77***.

Inner Bead Wall & Inside Panel Surface Intersection Binding!



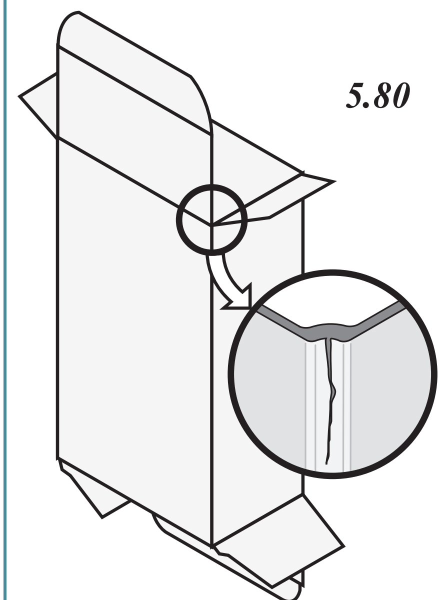
5.78

The second problem is caused by the bead, which is out of proportion for the caliper of the paperboard and the action of folding. As the panels are folded the improperly formed bead is unable to flex out of the way, and the outer edge of the bead, and the inside edge of the folding panel, bind together in each parallel fold intersection. ***See illustration 5.78***.



5.79

This conflict or interference suddenly increases the degree of folding force at 75 degrees of panel rotation, and with the continuation of the rotation/folding action consuming higher and higher degrees of resistance. ***See illustration 5.79***.

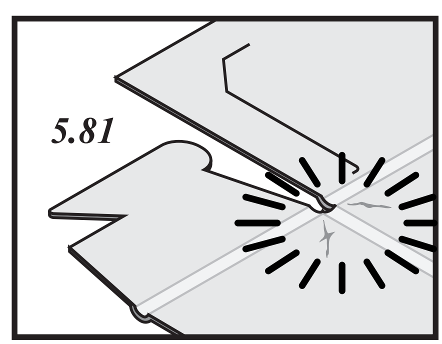


5.80

This imbalance of bead proportion, which causes ***"bead binding,"*** generates several problems, which cause spine failure, which cause gluing and cartoning problems, and which undermine the viability of an "***engineered container!***"

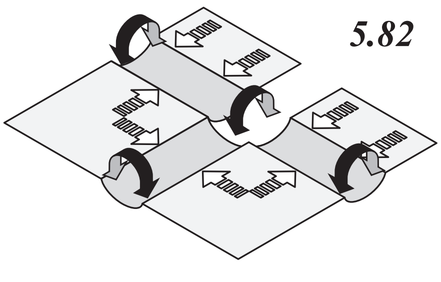
Crease End Splitting & Bursting

Crease End Splitting, ***see illustration 5.80***, and ***Bursting*** of the surface of the paperboard at crease intersections, ***see illustration 5.81***, is a clear indication of a tool imbalance.

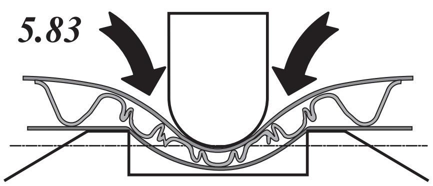


5.81

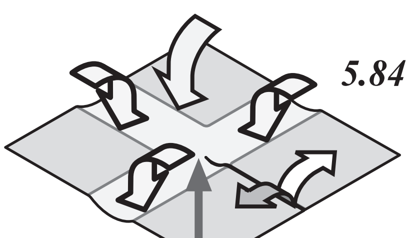
Bursting is the result of trying to force paperboard into crease channels, where the proximity


5.82

of several crease channels to one another, are all competing with each other for their share of the material. ***See illustration 5.82.*** While paperboard has a degree of elasticity, the degree of lateral stress is so high, something must give, and the surface splits apart under the excessive tensile force.

5.83


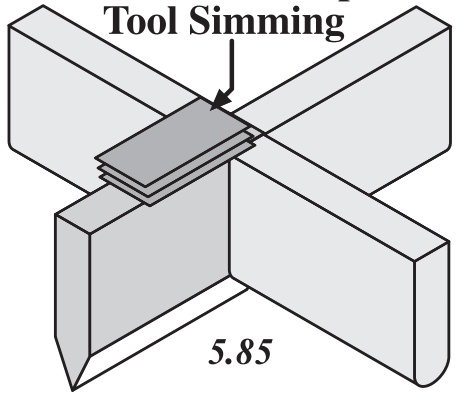
The task of forming close proximity creases requires adjusting the tooling to accept the resistance of the paperboard and this will make the traditional tool set-up, ineffective!


5.84

Area of Tensile Conflict

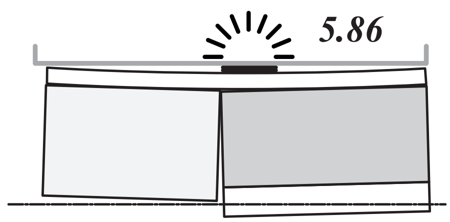
Crease End Splitting is caused by a similar problem. Because the traditional crease set-up often results in the crease being driven too deep into the crease tool channel, ***see illustration 5.83***, the surface of the material, particularly at the junction between the end of the crease rule

Knife Patch-Up Tool Simming


5.85

and the beginning of the knife, is severely stretched and stressed. ***See illustration 5.84***. (This degree of tensile spine stress at this point is often the result of the close proximity knife being patched, ***see illustration 5.85***, which further depresses the end of the crease rule. ***See illustration 5.86.***)

When the panels are folded through 90 and 180 degrees the spine stretching at the end of the crease fold is very high. As the end of the spine is intersecting with a cutting knife, which is displacing and pushing the material laterally away from the center of the cut and crease, ***see illustration 5.87***, the splitting force of the blade travels into and down the spine of the crease. ***See illustration 5.88***.

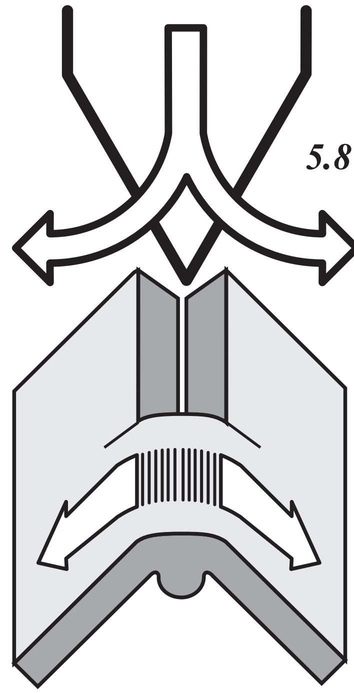

5.86

The problem of crease end splitting is generally confined to creases which fold at right angles to the paperboard grain, as the material parallel to the paperboard grain has a higher degree of elasticity, and is more resistant to splitting failure.

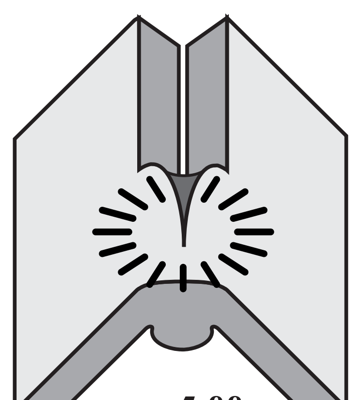
Both Bursting and Crease End Splitting require a different approach to managing crease formation stress. Unfortunately, the traditional crease set-up is poorly designed to meet these needs.

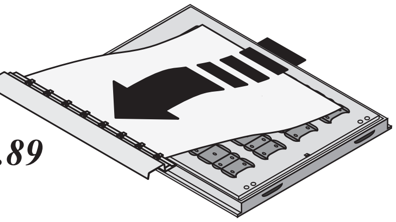
Bead & Part Snagging!

Immediately after the diecutting stroke, and as the press begins to cycle open, the gripper fingers and


5.87

gripper bar begin to pull the diecut sheet forward, as the lower platen falls away. ***See illustration 5.89***. As this happens the sheet momentarily resists forward movement, and appears to "***stick***" to the cutting plate.

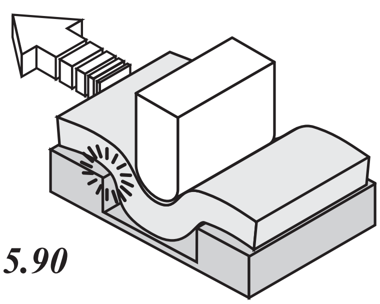

5.88



5.89

This can be the result of slight adherence to the cutting plate surface caused by a "*perfected*" tactile print film, a varnish or coating layer on the underside of the paperboard sheet, by static attraction, by a domed cutting plate, and by side to off lay or operator to gear side snagging, of the crease bead.

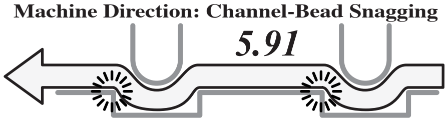
This slight contact between the leading edge of the bead and the trailing edge of the crease channel, ***see illustration 5.90***, provides a snagging action as the bead is accelerated forward in the machine



5.90

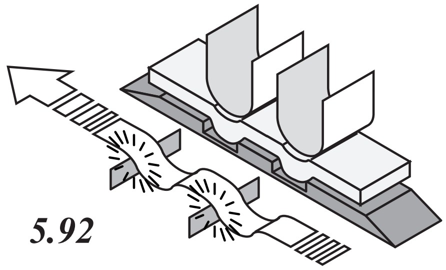
direction. ***See illustration 5.91***. Although the resistance is slight and temporary, the accumulation of all of the beads and all of the crease channels at right angles to the movement of the diecut sheet, ***see illustration 5.92,*** generates sufficient force to fracture and sever nick/tags, causing premature sheet break-up.

Machine Direction: Channel-Bead Snagging



5.91

This problem is obviously more critical on a Web Fed Platen Diecutting Press, where the diecut part of the web is "*pushed*" forward, ***see illustration 5.93***, and gravity and friction add to the degree of snagging.

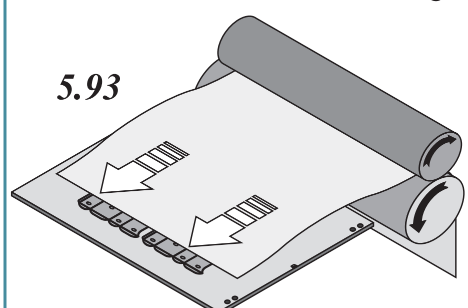


5.92

The problems of bead snagging are exacerbated by higher caliper materials with a proportionately larger bead profile, ***see illustration 5.94***, and in situations where there is a high number of creases at right angles to the machine direction. ***See illustration 5.95***.

What are the Disadvantages of Traditional Creasing: Summary

The traditional creasing system had been in operation for more than eighty years, and during those years it was generally effective. The point of this publication is not to suggest we should eliminate traditional creasing.



5.93

However, we are recommending an aggressive review of methods and practices, to ensure creasing and converting is up-to-date with changing substrates, changing design, and a changing diecutting process.

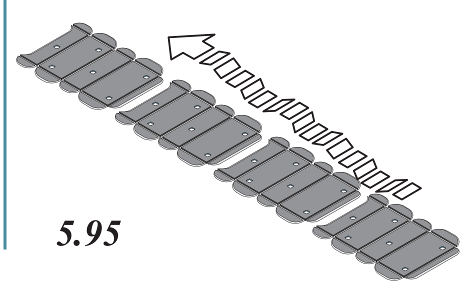
The items listed below are all key weaknesses of the current system of creasing, however, they are also a great checklist, against which

5.94

to evaluate alternative systems of creasing. The critique of traditional creasing tool set-up included the following issues.

➔ ***Single Specification Creasing***
➔ ***Spine Stress & Failure***
➔ ***Rapid Crease Tool Wear & Failure***
➔ ***Ineffective Bead Formation***
➔ ***Excess Draw: Flaking***
➔ ***Excess Draw: Nicking***
➔ ***Diecutting Pressure Resistance***
➔ ***Unstable Diecutting***
➔ ***Crease-to-Crease Competition***
➔ ***Ineffective Folding/Opening Force***
➔ ***Diecut Part Marking***
➔ ***Crease End Splitting***
➔ ***Crease Intersection Bursting***
➔ ***Bead Snagging***

If these are key potential weaknesses of the current system of tool design and parameters, what system offers an effective alternative. The answer is Reduced Bead Creasing, and the next chapter examines what it is and how it works?



5.95

Chapter 5: What are the Disadvantages of Traditional Creasing: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ In assessing the disadvantage of traditional creasing, in terms of the limitation of integrating the conflicting requirements of closing and opening force in a single crease/fold, using a single set of parameters, was deemed as a complex balancing act, which generally failed!

- ✓ As paperboard and process have changed, and continue to change, the traditional crease setting has remained a constant, which results in increasing incidents of crease spine failure exposing the limitation of the standard approach to crease set-up.

- ✓ As the stiffness, the density, and the toughness of paperboard materials has increased, the rapid wear of the female crease tool, exposes a serious imbalance in the set-up of standard crease tools.

- ✓ The use of predominantly tensile lateral draw in standard crease formation, rather than compression, leads to an incorrectly proportioned bead, which is poorly delaminated, for flexible folding control.

- ✓ The excess lateral draw of the standard crease translates to excess tensile stress on close proximity knives, which leads to flaking and to premature nick/tag fracture and failure.

- ✓ Using the standard tool set, over penetration of the crease rule into the female tool, creates temporary pressure points, and generates an unstable cutting make-ready, and rapid crease tool wear.

- ✓ The use of a protruding traditional crease tool set-up, cause product marking, and accelerated crease tool wear, which undermines folding force and/or opening force.

- ✓ The generation of excess pressure using the traditional tool specification causes excess spine stress, and particularly, crease end splitting, and bursting of the paperboard surface at crease intersections.

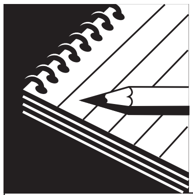
- ✓ The oversized proportion of the bead in relation to the caliper of the material, will often generate "***bead snagging***" or the temporary catching of the bead on the cross machine direction trailing channel walls.

- ✓ Although this chapter was entitled, what are the disadvantages of traditional creasing, and the chapter has hopefully shone more light on the source and the cause of the problems, it is important to remember this method of creasing has been and continues to be used successfully in many folding carton and container applications.

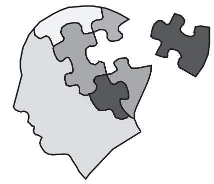
Chapter 5:
What are the Disadvantages of Traditional Creasing: Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. There is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ What is the relationship in crease tool set-up, between the caliper of the paperboard, and the thickness of the crease tool?
- ✓ How is the width of the crease channel calculated?
- ✓ Which is the narrower channel, the crease at right angles to the paperboard grain or the crease parallel to the paperboard grain?
- ✓ How can the integration of different heights of crease rule in a single fold eliminate folding bowing in a long, narrow panel?
- ✓ What important feature of the female tool is subject to rapid wear under the impact of crease formation?
- ✓ How does lateral tensile stress, generated by the knife and adjacent crease rules, impact crease formation and cutting?
- ✓ What is the force, which causes the paperboard to internally delaminate and to separate into individual layers?
- ✓ How does crease formation impact flaking and diecut edge chipping in parallel knives?
- ✓ What is the primary source of fracturing stress on the nick/tag in platen diecutting, and how does the crease formation impact the integrity of the nick/tag?
- ✓ In crease formation, what is the proportion of lateral stress and compressive force?
- ✓ How can a single specification fold be modified to integrate separate control over folding force and opening force?
- ✓ What is a key weakness the Vulcanized Fiber, Matrix and Fiberglass Counter tools share, which the steel counterplate does not?
- ✓ How will bead binding impact folding force and spine integrity, and at what point in folding is there a difference in the force required to fold?
- ✓ What is Bead Snagging in plate diecutting, and in what orientation of the creases to the machine direction of the press, would it cause sheet break-up?
- ✓ What causes diecut indentation marking and shadowing?



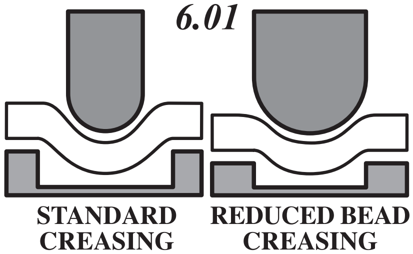
Brainstorming, Notes & Ideas



"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

Chapter 6: The Principles & Practices of Reduced Bead Creasing

As the name Reduced Bead Creasing suggests, this method of creasing uses a smaller, more precisely defined bead than a traditional crease. ***See 6.01***.



6.01

Of course there is more to it than simply making the bead narrower, and over the next two chapters we will discuss the key features of reduced bead creasing, and the practical advantages of this approach to creasing. In making the transition to Reduced Bead Creasing, there are ***Seven*** key toolmaking and tool parameter changes from the traditional approach to tool design. These require a:

1: Proportionate-Smaller Bead

2: Higher Pointage Crease Rule

3: Wider Surface Delamination

4: Balanced Bead Delamination

5: Thinner Counter

6: Compression Gap

7: Compressive Formation

In this chapter we will define the principles of the change and the practical impact on crease formation.

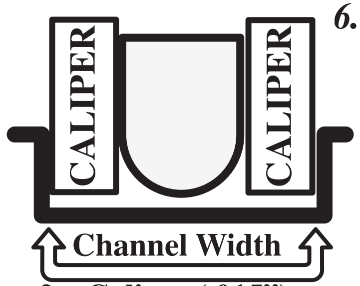
1: Proportionate-Smaller Bead

It is useful to begin by defining the word "***proportion.***" The dictionary defines the word proportion in a number of related ways...

1 *- A part considered in relation to the whole.*
2 *- A relationship between things or parts of things with respect to comparative magnitude, quantity, or degree.*
3 *- A relationship between quantities such that if one varies then another varies in a manner dependent on the first:* ***"We do not always find visible happiness in proportion to visible virtue"*** *(Samuel Johnson).*
4 *- Agreeable or harmonious relation of parts within a whole; balance or symmetry..."*

In reduced bead creasing the size of the bead is directly proportionate to the caliper of the paperboard being creased, and by comparison, in traditional creasing the caliper is only a part of the formula. We will illustrate the difference using a simple example.

6.02



2 x Caliper (.015") +
1 Thickness of Crease Rule
0.030" + 0.028" = 0.058"

In standard creasing, to calculate the channel width for a paperboard of 0.015" thickness, would require doubling the caliper and adding one thickness of the crease rule in use to the total. In this case the crease rule would almost certainly be 2 Point or 0.028" thick. ***See illustration 6.02***. Generally 0.004" would be added to the total to adjust crease formation to reflect this as a cross grain crease.

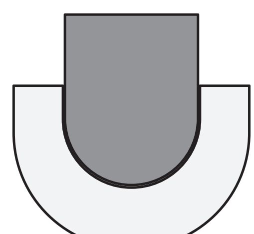
6.03

Channel Width
=
3 x Caliper = 0.045"

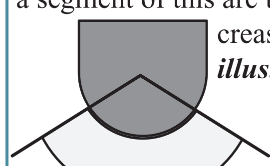
As the example shows, this would result in an initial bead width of 2 x .015, plus 0.028", to give a channel/ bead width of 0.058".

In reduced bead creasing the calculation requires simply multiplying the caliper by 3, to give a channel width or crease bead width of 0.045". ***See illustration 6.03***. In the reduced bead calculation the thickness or the pointage of the crease is not included.

In creasing we are actually using the segment of an Arc to form the crease bead. If the paperboard were wrapped around the crease rule, the curvature of the material would form a smaller inner radius and a larger outer radius, ***see illustration 6.04***, and we use a segment of this arc to form the crease bead. ***See illustration 6.05***.



6.04

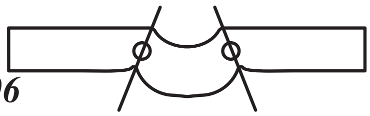


6.05

Why is this important in standard creasing and in reduced bead creasing?

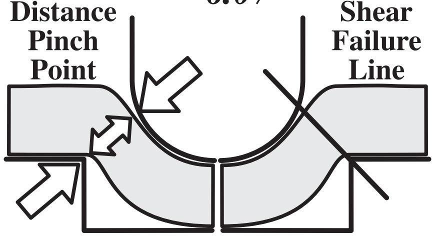
  Contact Kevin - kevin@dieinfo.com

In earlier chapters we learnt that a crease is not a single fold but it is a double fold. ***See illustration 6.06***.



6.06

We also defined the Critical Distance as the most important measurement in creasing. The critical distance defines the ***Pinch Point*** between the crease rule and the upper corners of the female channel, and a line drawn between these two points, defines the ***Crease Shear Failure Line***, induced by the shearing force of creasing formation. ***See illustration 6.07***.

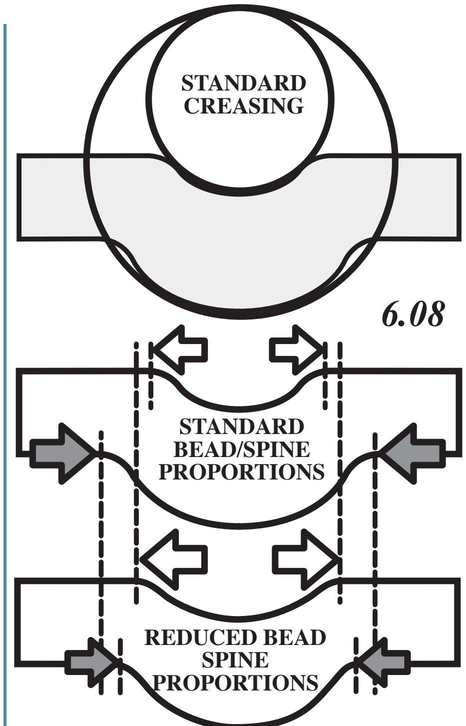


6.07

This pinch point or shear failure line is the focus of the twin folding action on both sides of the bead of the crease. ***Why is this so important in creasing?*** To answer that question we need to return to the discussion of the proportions of the standard crease and the reduced bead crease.

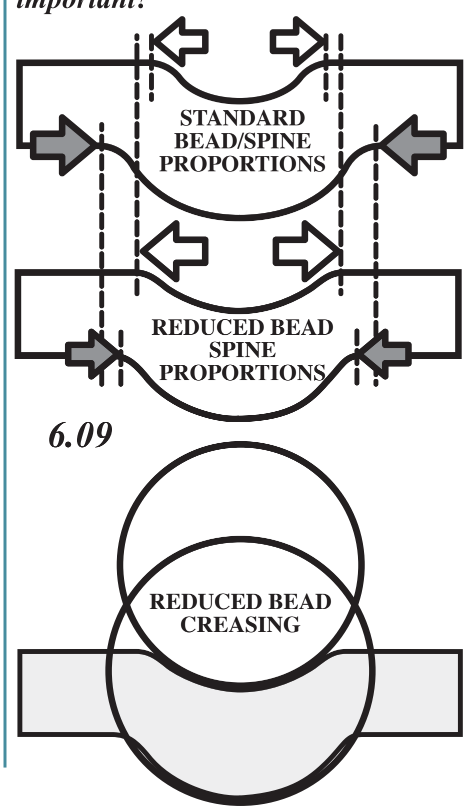
The relationship between the inner and outer profile formed between the crease rule and the caliper of the material in standard creasing are shown in ***illustration 6.08***. In the standard crease formulation the diameter of the inner segment of the Crease Arc is much smaller than the diameter of the outer segment of the Crease Arc.

By comparison the proportions of the reduced bead creasing formulation are shown in ***illustration 6.09***.



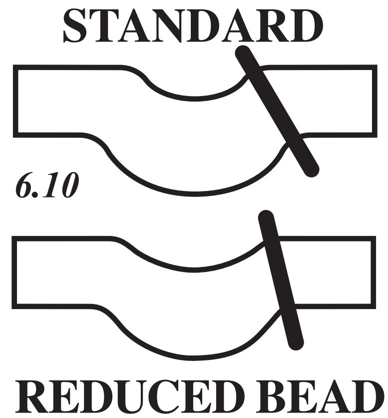
6.08

In the reduced bead crease formulation the diameter of the inner segment of the Crease Arc is almost identical to the diameter of the outer segment of the Crease Arc. ***Why are these features of both methods so important?***



6.09

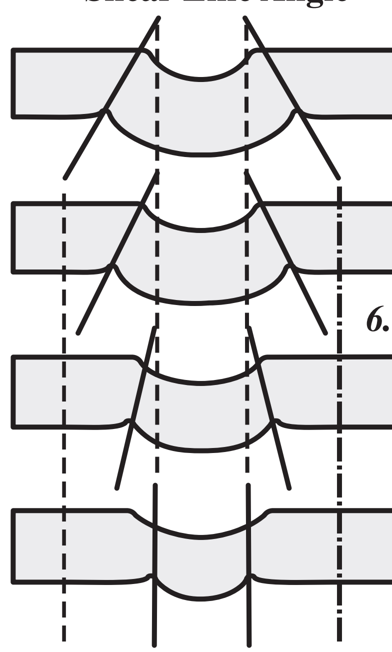
If you compare the Shear Line Failure angle in a standard crease, to the Shear Line Failure angle in the reduced bead crease, you can see the reduced bead crease angle is more vertical, while the standard crease angle is more horizontal. ***See illustration 6.10***.



6.10

In practice, as we move from the proportion of the standard crease to the proportion of the reduced bead crease, the Shear Line Failure angle gradually changes. ***See illustration 6.11. Why is this important?***

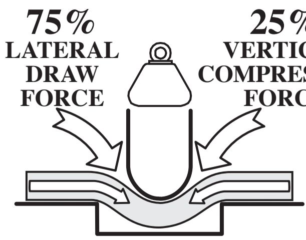
Standard Crease Formula Shear Line Angle



6.11

Reduced Bead Formula Shear Line Angle

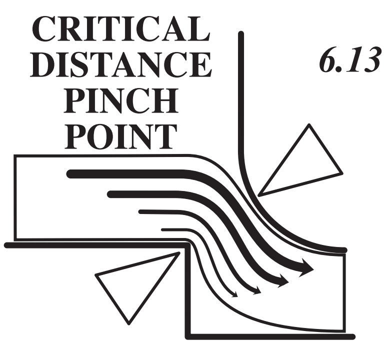
A traditional crease is formed through a combination of initial compressive force and lateral shearing draw. In the standard crease set-up this force is approximately 75% lateral draw, and 25% compressive force. ***See illustration 6.12***.



6.12

STANDARD CREASE SET-UP

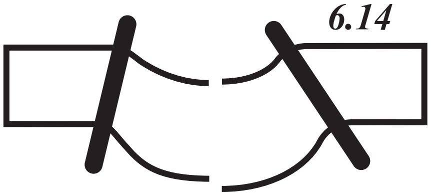
To generate the shear line failure point and sufficient internal delamination of the bead, it is necessary to pinch the paperboard between the face of the crease rule and the upper corner of the crease female channel. ***See illustration 6.13***.



6.13

However, if the Shear Line Angle is too shallow, as it is in a traditional crease set-up, ***see illustration 6.14***, the degree of lateral draw force is excessive. The disadvantages of excessive tensile draw forces in

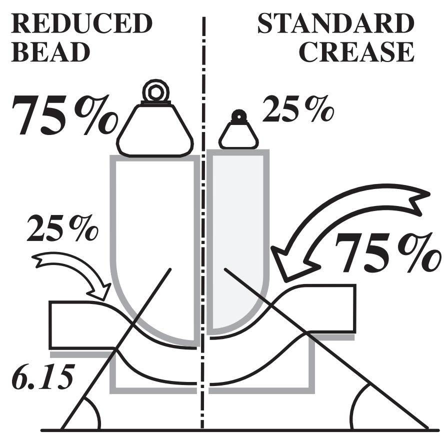
6.14



Reduced Bead Shear Line Angle **Traditional Shear Line Angle**

diecutting, in cutting, in crease to crease competition, in generating flaking, in fracturing nick/tags, and in accelerated tool wear, are well documented.

In creating the shear line fold point in this manner the resulting bead is inconsistently internally delaminated, and the degree of variation in performance is excessive. Finally, using a shallow Shear Line Angle, the definition of the bead or the crispness of bead formation is poor, and as a result, folding is inconsistent and it will generate excess spine stress.



6.15

Shear Line Angle

By adopting a Reduced Bead approach to crease set-up the roles of Tensile Draw and Compressive force are virtually reversed. ***See illustration 6.15***. In addition, the more acute Shear Line Angle in reduced bead creasing generates a more precise delamination of the bead, for essential bead folding flexibility, and it creates a more well defined, and consistent crease folding failure point.

It is also obvious that as we recommend a smaller bead, the accomplishment of the more effective shear line angle is made easier using a proportionately thicker or higher pointage male creasing tool.

2: Higher Pointage Crease Rule

What is the role of the male crease rule? The male creasing rule mounted in the steel rule die performs four key functions in the formation of the crease. These are:

1: To punch/shear the paperboard into the crease channel.
2: To form twin pinching surfaces to match the twin upper corners, of the female crease channel.
3: To define an effective shear line angle, to generate internal stress in the bead of the crease.
4: To apply even pressure to the surface of the crease, to ensure balanced internal bead delamination, and an effective, elastic crease spine.

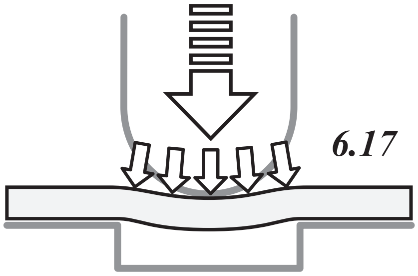
To accomplish this the thickness/pointage of the creasing rule is higher than standard crease parameters in every range. In practice ***2-Point*** creasing rule is almost entirely eliminated, other than for the thinnest material, and even then it is only used for parallel grain crease rules. ***See illustration 6.16.***

6.16

Material Caliper	Cross-Grain Pointage	With-Grain Pointage
0.011	3 - Point	2 - Point
0.012	3 - Point	2 - Point
0.013	3 - Point	2 - Point
0.014	3 - Point	2 - Point
0.015	3 - Point	2 - Point
0.016	3 - Point	3 - Point
0.017	3 - Point	3 - Point
0.018	3 - Point	3 - Point
0.019	3 - Point	3 - Point
0.020	3 - Point	3 - Point
0.021	4 - Point	3 - Point
0.022	4 - Point	3 - Point
0.023	4 - Point	3 - Point
0.024	4 - Point	3 - Point
0.025	4 - Point	3 - Point
0.026	4 - Point	4 - Point
0.027	4 - Point	4 - Point
0.028	4 - Point	4 - Point
0.029	4 - Point	4 - Point
0.030	4 - Point	4 - Point
0.031	6 - Point	4 - Point
0.032	6 - Point	4 - Point
0.033	6 - Point	4 - Point
0.034	6 - Point	4 - Point
0.035	6 - Point	4 - Point

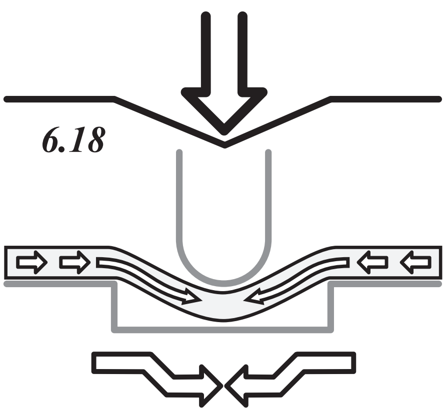
However, as we will learn in the specification section of the manual, it is dangerous to eliminate any pointage in the search for effective creasing. But in principle and in practice, the thicker the creasing rule the more effectively the bead and the crease are formed. ***Why is a higher pointage than standard more effective?***

To a greater extent than the standard set-up the higher pointage crease



6.17

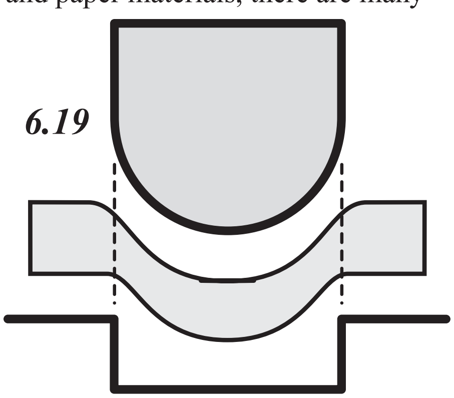
applies a more even pressure to the surface. ***See illustration 6.17***. And while the act of shearing is on either side of the crease rule, it is important not to concentrate high tensile stress to a narrow section of what will become the spine of the crease, in a traditional crease set-up. ***See illustration 6.18***.



6.18

The most difficult practice to eliminate when moving to reduced bead creasing, is to overcome the habit of assuming the width of the channel and the pointage of the crease have a linked relationship, or that the channel has to be wider than the crease rule.

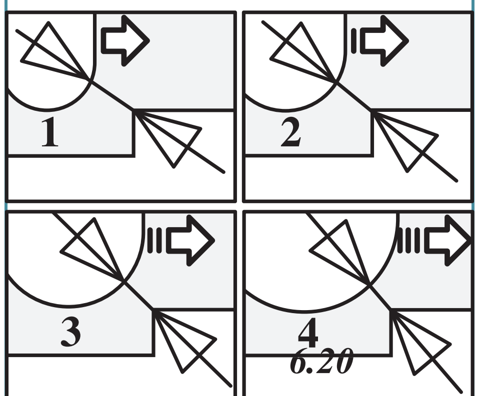
Particularly in thinner paperboard and paper materials, there are many



6.19

situations where the pointage of the crease is the same or larger than the crease channel. ***See illustration 6.19***. This is an important technique designed to solve specific creasing and folding problems, however, people are generally only convinced when they see this working for the first time!

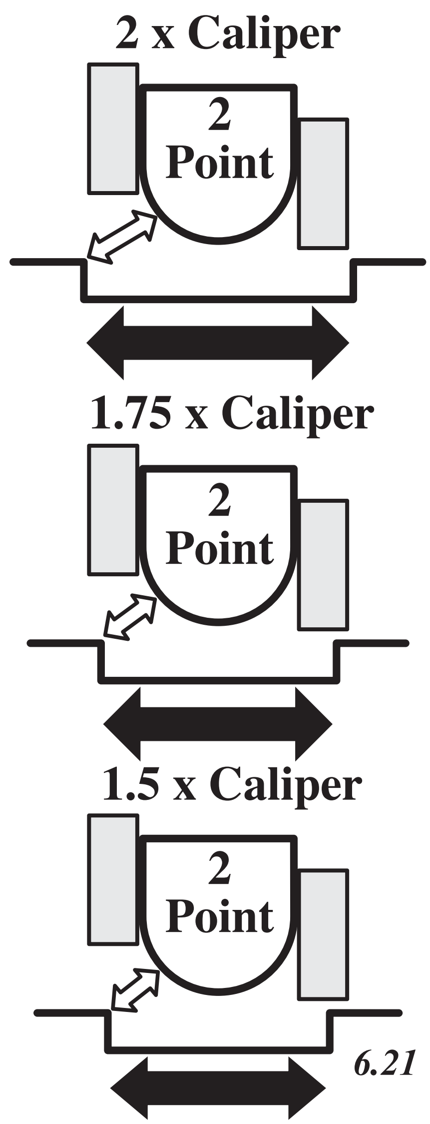
The combination of making the channel narrower both increases the punching force, between the face of the crease and the upper corner of the crease channel, and it gradually increases the angle of the Shear Failure Line. ***See illustration 6.20***.



6.20

As ***illustration 6.20*** clearly shows as the pointage increase/ and or the channel width is narrowed, the pinching distance between the face of the crease and the upper corner of each channel is gradually reduced, and the Shear Failure Angle moves from approximately 45 degrees, to an angle of approximately 60 degrees.

This could be achieved by keeping the original 2-Point Crease and simply narrowing the channel. In other parts of the world industry, the standard formula for calculating the crease channel is to multiply the caliper by 1.75, or 1.5, and add the thickness of the 2-Point Crease. ***See illustration 6.21***. These options will be discussed in the chapter on crease specification, however, the reduction in the channel width has the same effect as reducing the Critical Distance, the pinching distance, and to change the Shear Failure Angle.



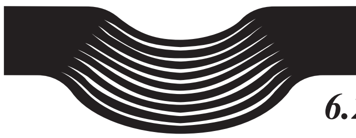
6.21

However, one of the important benefits of using a higher pointage crease than standard, is the impact on the area of surface or spine delamination.

3: Wider Surface Delamination

One of the key roles of the crease rule mounted in the steel rule die, is to generate internal delamination of the paperboard, by compressing the material against the upper corners of each channel, to form partially separated layers of material in the resulting crease bead. ***See illustration 6.22***.

PARTIAL INTERNAL



6.22

DELAMINATION

However, the proportion of the degree of delamination at the surface of the material, where the crease punched into the material, and the width of the delaminated lower layers of the bead, formed by the shearing action of the pinch points, are significantly different.

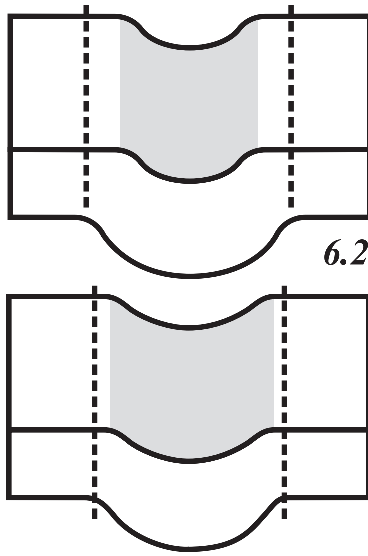
This is critical to crease performance, because as the crease folds, the surface indented by the crease rule, becomes the spine of the crease, and it is essential it is as flexible, and as elastic as possible, to absorb and to compensate for the tensile stress the spine is subjected to. ***See illustration 6.23***.

6.23

The advantage of the Reduced Bead crease over a Standard crease is first, the width of the surface delaminated area is larger, and secondly the area of surface/spine delamination is more in proportion to the delamination area of the crease bead. ***See illustration 6.24***.

In addition, because of the larger crease rule in proportion to the width of the crease channel, the shearing is more vertical than horizontal, ***see illustration 6.25***, with the result the delamination, is even and consistent

STANDARD



6.24

REDUCED BEAD

from the surface of the bead, to the surface of the crease spine. ***See illustration 6.26***. (It should also be noted that the difference in the shearing action between the standard and the reduced bead crease is a

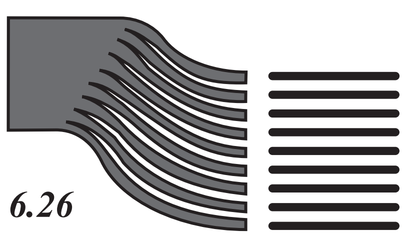
STANDARD REDUCED

6.25

SHEARING ACTION

key reason the reduced bead crease female upper channel corners are far less susceptible to abrasive wear!)

These factors translate to greater folding flexibility and the elimination of excess spine stress and spine fracturing and splitting.



6.26

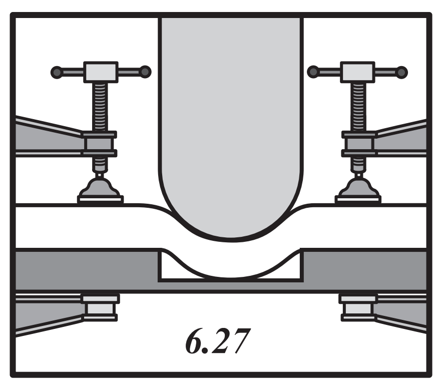
Finally, because with Reduced Bead Creasing there is far less tensile draw generated by this and other surrounding creases, and because the counter/matrix tool is much thinner, the formation of the crease bead, and particularly the spine is somewhat isolated from competitive tensile forces, further reducing the stress on the surface of the paperboard, which will become the spine of the crease.

4: Balanced Bead Delamination

It is important to remember the goal is to create an effective paperboard hinge, and the engine room of the hinge is the crease bead. It is not just that the size of the bead has been reduced in this approach to creasing, but in how that reduction in size has impacted the structure and the performance attributes of the bead.

Some of the advantages of the smaller bead include:

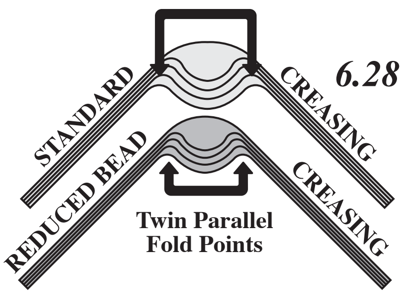
The concentrated application of compressive force in a narrower band, more efficiently uses the pressure in diecutting, and it generates more even layering and flexibility in the bead.



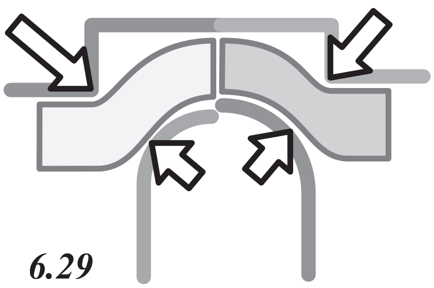
6.27

Because this crease method employs a higher proportion of compressive force rather than lateral draw to form the crease, the action of each individual crease formation is isolated. This means the formation of the bead is not influenced by the action of other crease formation and diecutting, and in turn it is not interfering with other converting activities across the steel rule die. ***See illustration 6.27***.

The relationship between the pinching faces of the crease and the pinching upper corners of each crease channel is critical to effective bead formation. Both Standard creasing and Reduced Bead creasing are double folds, and rely upon twin, parallel shear failure line/points to fold. ***See illustration 6.28***.



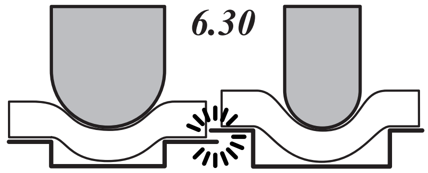
In reduced bead creasing, the shorter and more compressive action of shearing separation is more effective than the longer more lateral shearing action of the standard crease. ***See illustration 6.29***.



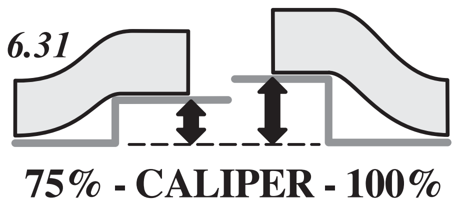
In summation, the reduced crease bead is smaller, it is more evenly delaminated, it requires less overall force to form than a standard crease, and the flexibility of the bead in folding is a significant advantage.

5: Thinner Counter

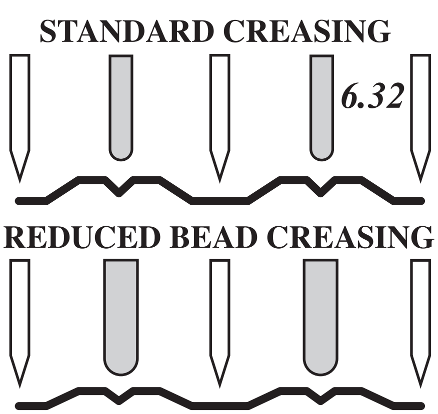
A key feature, and a significant benefit of reduced bead creasing, is this approach to male and female tool design uses a much thinner female counter/matrix than the standard crease. ***See illustration 6.30***.



In reduced bead creasing the thickness of the female tool, or the depth of the crease channel is only 75% of the caliper of the material being creased, rather than 100% of the caliper used in standard creasing. ***See illustration 6.31***.



This modification to the standard creasing profile, also means the difference in height between the knife and the crease is reduced, which reduces the distortion and wrap effect of traditional creasing. ***See illustration 6.32***.

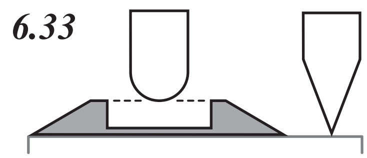


The thinner counter/matrix tool obviously limits competitive tensile draw forces to help to isolate the unencumbered formation of individual creases, and to prevent crease formation effecting surrounding creases and cutting knives.

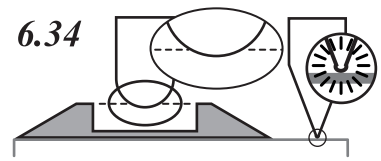
Because limiting the wrap effect of paperboard being stretched and deformed around a thinner counter, the stiffness of the material is reduced and each crease and each cut can convert more efficiently.

6: Compression Gap

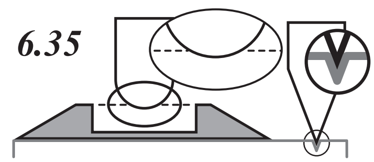
One of the more complex challenges of platen diecutting is to achieve a perfect kiss-cut impression, across the entire steel rule die layout. In standard creasing tool set up, if the knife is making perfect kiss cut contact with the surface of the cutting plate, the tip of crease rule in the die, would be level with the surface of the counter or matrix tool. ***See illustration 6.33***.



Unfortunately, variation causes some knives to strike the surface of the cutting plate with excessive force, and they suffer compressive failure of the tip of the blade. This also means the tip of the crease rule is protruding below the surface of the counter or matrix channel. ***See illustration 6.34***.

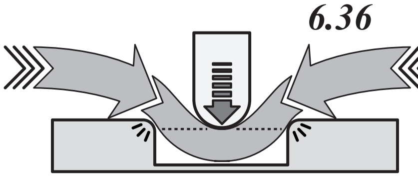


In a similar fashion the selection of Thin or Soft Cutting Plates anticipates the degree of diecutting variation, to allow the tip of the knife to penetrate the surface of the cutting plate, to eliminate damage to the sharpness of the edge. However, the tip of the crease rule is now pushing down into the counter/matrix channel, and it is below the plane formed by the surface of the tool. ***See illustration 6.35***.

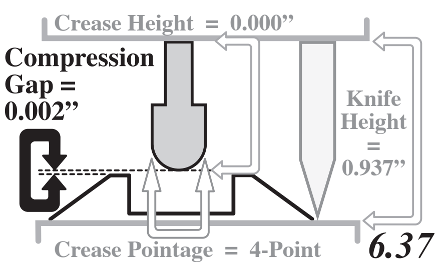


Any degree of over penetration of the tip of the crease into the counter channel and below the surface of the female tool, accelerates upper channel corner wear, and it increases the level of damaging tensile stress or lateral draw across the entire layout. ***See illustration 6.36***.

6.36



In addition, over penetration of the tip of the crease, particularly at the beginning of the press make-ready, creates a temporary high resistance point in the layout. This resistance is gradually eliminated as the upper corners of the counter channel wear down, however, during this period, the resistance prevents adjoining knives from cleanly cutting through the material. The operator responds by patching the knives, however, as the wear of the counter eliminates the crease resistance point, the knives suffer further compressive damage, and the cycle of patching continues.



6.37

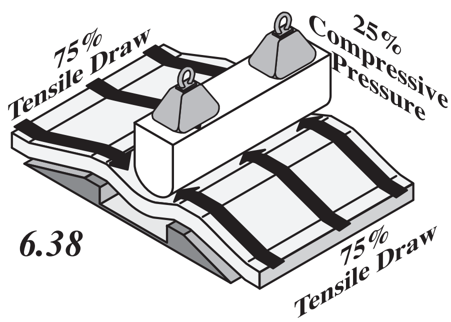
The integration of a Compression Gap in the Reduced Bead crease tool formula is an important setting adjustment, which is simply there to recognize the normal dynamic of press make-ready. ***See illustration 6.37***.

The advantage of the Compression Gap, is it enables the cutting make-ready to proceed without false pressure/resistance readings from over penetration of the crease rule into and below the surface of the counter/matrix channel.

However, the primary reason for the compression gap is this allowance for almost inevitable variation, will mean that the majority of crease rules and the counter channel, will be set-to zero penetration after press make-ready, and the cutting will be more stable and crease performance will start at optimal levels, and will change and degrade at a consistent rate.

7: Compressive Formation

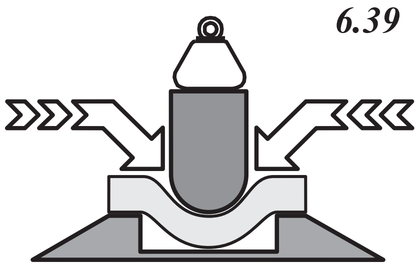
Using a thin narrow crease rule, a thicker counter, and a wider female tool channel, crease formation and shearing rely primarily upon, and generate excessive levels of tensile draw and stress. ***See illustration 6.38***.



6.38

Therefore, one of the primary differences between the Standard Crease Tool Set-Up and Reduced Bead Crease Tool Set-Up, is the standard crease uses more than 75% lateral draw as the crease formation force. ***See illustration 6.39***.

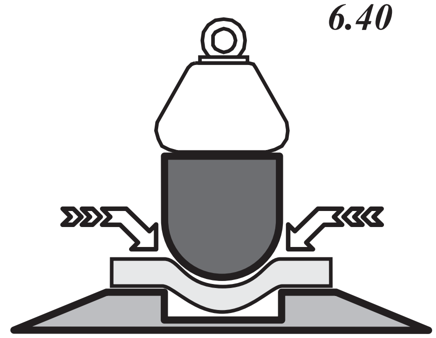
6.39



STANDARD CREASE
75% LATERAL DRAW
25% COMPRSSIVE FORCE

By comparison the Reduced Bead Crease Set-Up is approximately 75% Compression Pressure, and less than 25% Lateral Draw. ***See illustration 6.40***.

6.40



REDUCED BEAD CREASE
25% LATERAL DRAW
75% COMPRSSIVE FORCE

The importance of this difference in tool set-up and crease formation forces cannot be underestimated. By using a majority of compressive force, reduced bead set-up minimizes damaging lateral tensile draw, it minimizes rapid and uneven tool wear, and the more vertical shearing action generates better delamination and folding flexibility.

To summarize the seven distinct tool set-up features, which make Reduced Bead Creasing so unique are:

1: Proportionate-Smaller Bead

2: Higher Pointage Crease Rule

3: Wider Surface Delamination

4: Balanced Bead Delamination

5: Thinner Counter

6: Compression Gap

7: Compressive Formation

Chapter 6:
The Principles & Practices of Reduced Bead Creasing: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

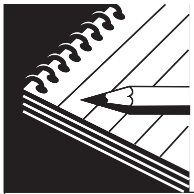
- ✓ In Reduced Bead Creasing the width of the female crease tool channel is directly related to the caliper of the paperboard being converted.
- ✓ The calculation used to determine the width of the female channel in Reduced Bead Creasing simply requires multiplying the caliper of the material by three.
- ✓ The Critical Distance defines the two pinch points of the face of the crease rule and the upper corner of the crease channel, and a line drawn between these points, defines the Shear Failure Line in creasing.
- ✓ The proportion of the inner part of the crease arc, formed by the indentation of the crease rule mounted in the steel rule die, is very different to the arc formed by the profile of the crease bead in standard creasing, but almost identical in Reduced Bead Creasing.
- ✓ One of the primary differences between standard creasing and reduced bead creasing is the Crease Shear Failure Line angle.
- ✓ In standard creasing the angle of the crease shear failure line reflects the lateral shearing action of this method of creasing.
- ✓ In reduced bead creasing the angle of the crease shear failure line reflects the vertical shearing action of this method of creasing
- ✓ The disadvantage of the shallow shear failure line angle in standard creasing, is it requires excess lateral draw to generate effective bead delamination.
- ✓ It is not necessary for the female crease channel to be wider than the pointage of the crease rule when using the reduced bead creasing formula!
- ✓ In reduced bead creasing the use of 2-Point Crease rule is almost entirely eliminated.
- ✓ As an alternative to the reduced bead formula, some simply retain the 2-Point crease rule and multiply the caliper of the paperboard by 1.75 or by 1.5.
- ✓ One of the key advantages of the reduced bead creasing technique is the use of minimal lateral tensile draw enabling the crease to be formed in virtual isolation from other creases and knives.
- ✓ A key difference between reduced bead creasing and standard creasing is the thickness of the female tool is only 75% of the caliper of the paperboard.

Chapter 6:
The Principles & Practices of Reduced Bead Creasing: Questions?

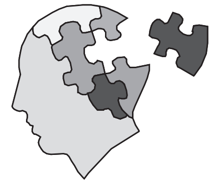
The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ How is the width of the female crease tool channel calculated in the standard crease formula?
- ✓ How is the width of the female crease tool channel calculated in the Reduced Bead creasing formula?
- ✓ How is the Crease Shear Failure Line defined in both standard and in reduced bead creasing?
- ✓ What is the difference in the angle of the crease shear failure line in standard creasing as compared to reduced bead creasing?
- ✓ How does the angle of the Crease Shear failure line in standard creasing and in reduced bead creasing reflect the differences in the approach to shearing?
- ✓ What happens to the angle of the Crease Shear Failure line as we move from standard creasing to a reduced bead crease formulation?
- ✓ What is the break down in percentages between the compressive pressure and the lateral draw forces used in standard creasing?
- ✓ What are some of the key disadvantages of using excessive lateral draw in generating effective bead delamination in standard creasing?
- ✓ What would be the pointage of the crease rule when using an 0.022” paperboard when using the reduced bead crease formula?
- ✓ How does the difference in width of the surface delamination in reduced bead creasing compared to the width of the delaminated area in standard creasing, impact the performance of the reduced bead crease?
- ✓ Why is the thinner counter used in reduced bead creasing such an advantage over standard creasing?
- ✓ How does over penetration of the crease rule in standard creasing impact setting and sustaining a kiss cut diecutting make-ready?

  Contact Kevin - kevin@dieinfo.com



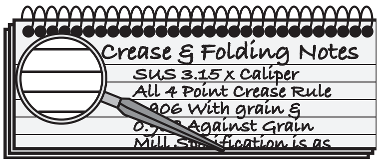
Brainstorming, Notes & Ideas



"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

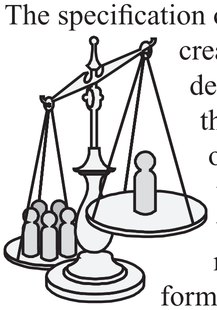
Chapter 7:
What are the Benefits of Reduced Bead Creasing?

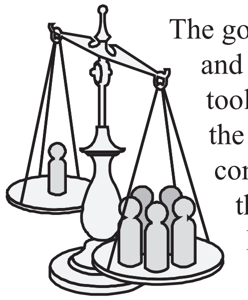
Reduced Bead creasing is an innovative and an effective approach to creasing and folding paperboard. However, it should be initially used to solve difficult problems traditional creasing seems unable to cope with. In this way, the user gains experience with new methods and practices, while overcoming a challenging



issue. By testing and evaluating, by recording and noting results, and by keeping a "***Creasing Journal,***" this technique can be fully integrated into crease tool specification and design. It is obviously essential to upgrade tool parameters, setting charts and specifications, to determine what worked well, what worked poorly, and how we can improve future performance.

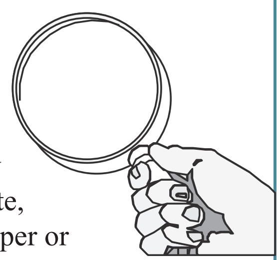
In the evaluation discipline it is important to look for improvement beyond simply creasing and folding performance, as it is impossible to avoid the impact crease formation has on diecutting, nor the impact diecutting has on crease formation. The specification of reduced bead creasing tools are designed to isolate the formation of each crease, while minimizing the potentially negative impact the formation of the crease bead has on surrounding cutting, scoring, perforating, and other creasing activity.





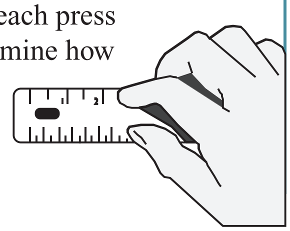
The goal in specifying and designing tools is to avoid the theoretical and concentrate on the pragmatic. It is important to be realistic and to anticipate the difficulty of precise control of diecutting/converting, and to choose a tool set-up, which recognizes the unpredictability of press make-ready.

It should also be obvious that the entire focus of the crease specification, toolmaking, and on-press set-up procedure is to convert and manipulate paperboard material, to achieve a specific outcome.



Therefore, paperboard should never be classified by a single attribute, such as the caliper or the thickness of the material. By testing and evaluating creasing and folding performance, against each individual paperboard, we can determine the most effective approach for each paperboard, and learn a great deal more about the material we are supposed to be an expert in using.

The Reduced Bead technique is not the only approach to creasing, and it is important to test and to evaluate each tool and each press set-up to determine how and why one set-up is more effective than the next.

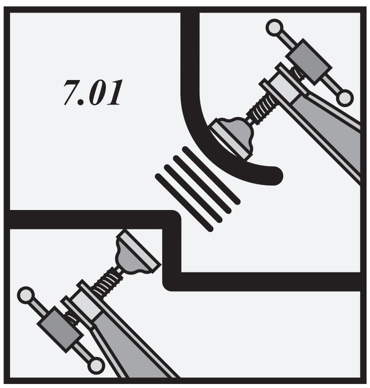


The ultimate goal is to create a systematic approach to creasing and folding, which integrates all of the knowledge and all of the experience you can collect from every source. As part of this evaluation process it is useful to consider the proven advantages of reduced bead creasing. These advantages and benefits would include the following:

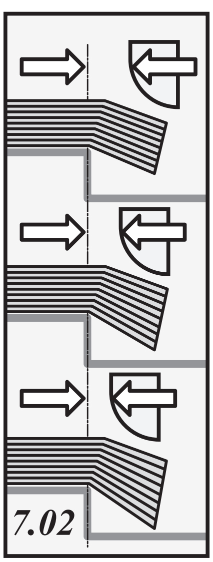
➔ ***Critical Distance Stability***
➔ ***Fold & Opening Force Control***
➔ ***Improve Bead Flexibility***
➔ ***Improve Cartoning Performance***
➔ ***The Elimination of Bead Binding***
➔ ***Crease Spine Stress & Failure***
➔ ***Crease End Splitting***
➔ ***Crease to Crease Competition***
➔ ***Minimize Draw Induced Flaking***
➔ ***Minimize Nicking-Draw Stress***
➔ ***A Stable Cutting Make-Ready***
➔ ***Improved Overall Quality***
➔ ***Eliminate Bead Snagging***
➔ ***Faster Press Speed***
➔ ***Lower Material/Machining Cost***

Critical Distance Stability

Throughout this manual we have described the Critical Distance as the most important dimension in creasing. In practice the entire focus of creasing is to find and then sustain the optimal pinching distance between the upper corner of the female channel and the face of the crease rule. ***See illustration 7.01***.

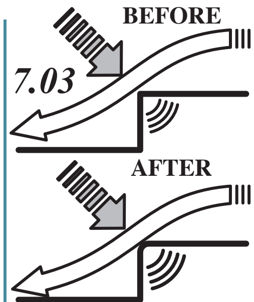


By regulating this pinching gap between the male crease rule and the female channel, the degree of internal bead delamination is controlled. ***See illustration 7.02***.



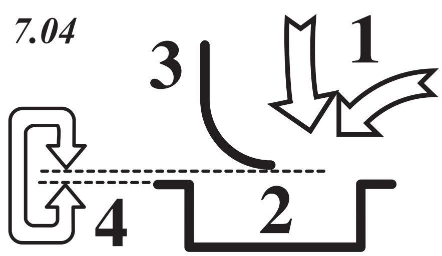
The majority of traditional crease/ tool specification result in rapid and variable initial damage to the upper corners of the female counter channel. In addition, this approach often results in progressive abrasive wear to this key tool surface, throughout the production cycle. ***See illustration 7.03***.

The combination of compressive rather than lateral force, a narrower female channel, a more balanced



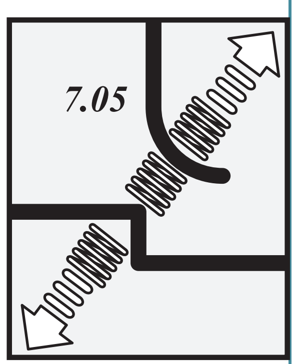
application of force using a wider crease, and the compression gap in Reduced Bead Creasing, ***see illustration 7.04***, eliminate many of these problems.

Therefore, using Reduced Bead Creasing ensures the end user receives the consistency, the repeatability, and the uniformity of folding performance they were promised!

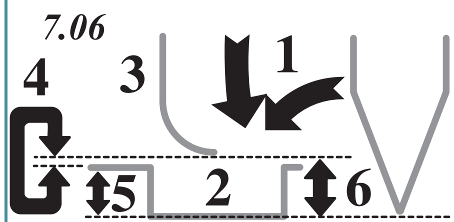


1: Compression rather than Lateral Force
2: A Narrower Crease Channel
3: A Wider Crease Rule
4: A Tool-to-Tool Compression Gap

However, the stability of the critical distance in reduced creasing provides another, almost equally important benefit in diecutting converting performance. Obviously, if the Critical Distance is a ***Pinch Point*** it is also a ***Resistance Point*** in diecutting. ***See illustration 7.05.*** If the balance between knife pressure and critical distance resistance is not balanced, the cutting make-ready will be unstable in preparation and in production performance.



As this pressure imbalance is integrated into the standard male and female tool crease specification, both cutting and creasing performance are compromised, and neither will work effectively or consistently. It is vital in tool specification and design, to achieve a balance of pressure distribution to enable the knives to work effectively and for the creases to work effectively.



1: Compression rather than Lateral Force
2: A Narrower Crease Channel
3: A Wider Crease Rule
4: A Tool-to-Tool Compression Gap
5: A Thinner Counter/Matrix Tool
6: Shearing Distance Knife to Crease

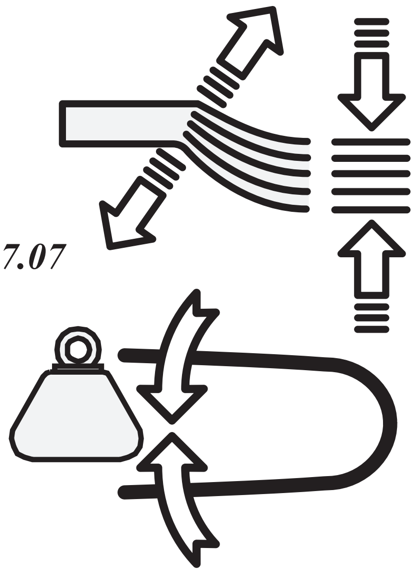
The goal is to select crease tool parameters to optimize creasing and folding performance, but also to protect the stability of a kiss cut make-ready.

In reduced bead creasing the use of compressive rather than lateral force; the use of a narrow channel combined with a wider crease; the integration of a thinner counter/matrix tool; the use of the compression gap; and the reduced shearing distance between the height of the crease rule and the height of the cutting knife, ***see illustration 7.06***; ensure a simpler, faster kiss-cut make-ready, with greater consistency and stability in the complete diecutting converting process.

Therefore, using Reduced Bead Creasing ensures more consistent and reliable creasing and this approach improves the precision of setting and sustaining a kiss-cut press make-ready.

Fold & Opening Force Control

The Critical Distance is important because it controls folding and opening force in creasing. If the critical distance is increased, the



7.07

degree of compressive pinching and internal delamination is reduced, the degree of separation between the internal layers is reduced, and the force required to fold the material is increased. ***See illustration 7.07***.

Obviously in contrast, if the critical distance is reduced, the degree of compressive pinching and internal delamination is increased, the degree of separation between the internal layers is increased, and the force required to fold the material is decreased. ***See illustration 7.08***.

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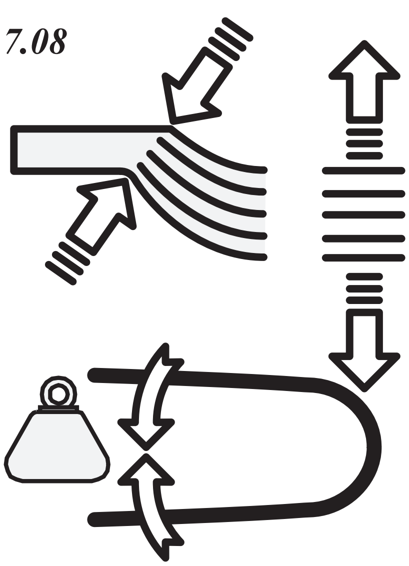
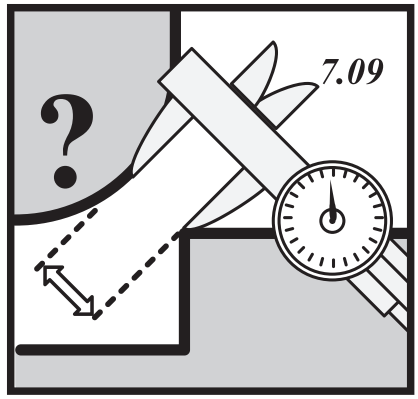
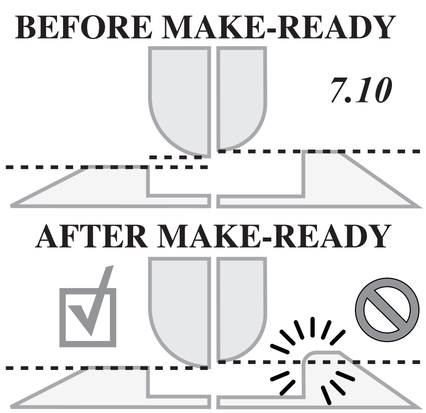




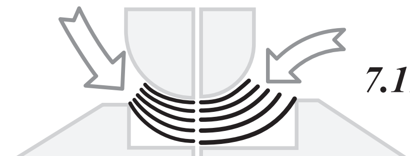
Because reduced bead creasing is designed to stabilize this key setting, the feedback to the diecutter and the toolmaker, as to what crease tool setting works best for each material, is far more reliable.



Control of folding force and opening force in creasing requires control of the critical distance or the pinching distance in crease tool set-up. ***See illustration 7.09***. What is vital in creasing is how much the critical distance changes from the start to the end of the press make-ready, and from the start to the end of the production run.

Using the compression gap to absorb make-ready variation and an inevitable gradual reduction in the platen gap, the abrasive wear on the upper channel corner is significantly reduced, ***see illustration 7.10***, and the stability and consistency of diecutting and product quality is improved.

Vertical compressive shearing provides a more effective method of generating internal delamination than lateral tensile shearing, ***see illustration 7.11***, which means even under identical conditions the reduced bead setting will give greater



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control of folding and opening force. When a comparison between the wear of the traditional crease set-up and the reduced bead setting is charted, ***see illustration 7.12***, it is obvious that in precisely adjusting and controlling crease folding and opening force, the reduced bead method is far more effective.

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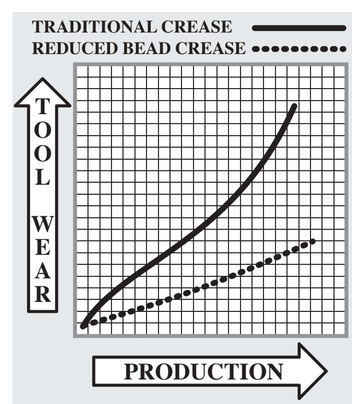

Improve Bead Flexibility

We have previously identified a paperboard crease as a double fold, ***see illustration 7.13***, with the pinch

7.13

A Crease is a "Double Fold."

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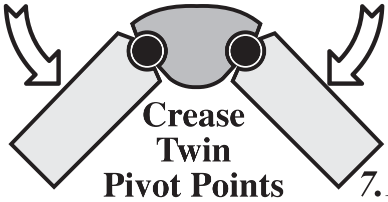

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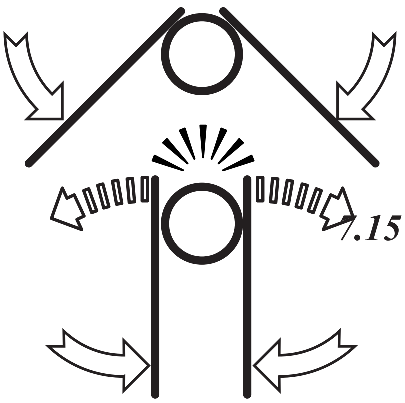
point or shear line between the face of the crease and the upper corner of each channel providing the pivot point or the fulcrum of the folding action of each panel, on each side of the central bead. ***See illustration 7.14***. However, this should not be seen to undermine the dynamic and important role of the crease bead.



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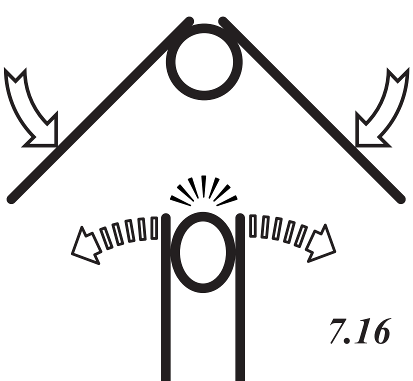
If the bead were simply a solid welt of paperboard as it initially appears, the action of folding the connected panels would force the panels to ***pivot around*** this central inflexible core, and the outer spine or surface of the crease spine would be subjected to high levels of lateral pull and tensile stress. ***See illustration 7.15***.



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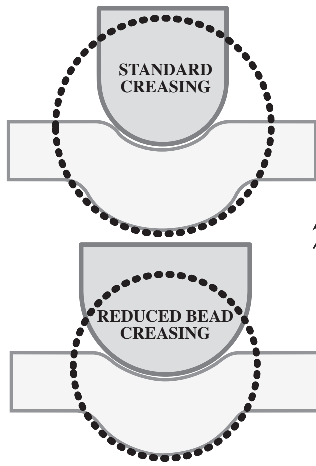
However, when the bead is properly internally delaminated, and therefore flexible, the folding action causes the bead to collapse and expand into the space between the folding panels. ***See illustration 7.16***. As a result, the degree of lateral pull and tensile stress on the outside of the fold, or the spine of the crease, is significantly reduced.



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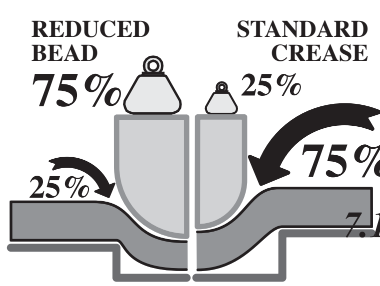
Why is Reduced Bead Creasing more effective than the Traditional Crease setting option?

The immediate and obvious advantage is the bead is smaller than the traditional bead, ***see illustration 7.17***, and therefore presents less of an obstacle to folding, and has to do minimal work to accommodate the stress generated by folding.



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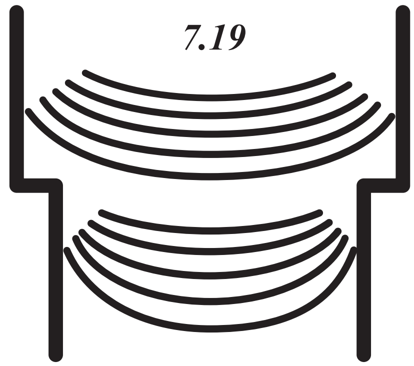
Furthermore, even though the reduced bead approach uses a more compressive shearing action rather than the traditional lateral or draw action, ***see illustration 7.18***, the reduced size of the strip of paperboard, which must be delaminated, means less overall force is required for reduced bead creasing. In addition, by concentrating the force in a narrower area, shearing is more precise and more consistent, and internal delamination is more even and more uniform. ***See illustration 7.19***.



7.19

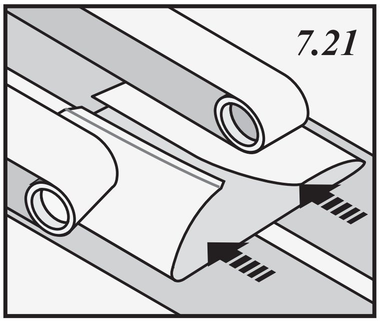
The great benefit in bead formation using the reduce bead approach to creasing, is the bead is smaller, which requires less effort, there is less potential for variation, and the concentrated shearing force produces a flexible and more effective central crease bead.

Improved Cartoning Performance

7.20

Although the focus of diecutting is converting performance, the ultimate focus of the process should always be on the end use application of the diecut product. ***See illustration 7.20***.

For example, the first customer is the gluing and the finishing department, ***see illustration 7.21***; the second is the customer cartoning and packaging line, ***see illustration 7.22***; and finally, the primary customer is the end user of the carton or the container. ***See illustration 7.23***.



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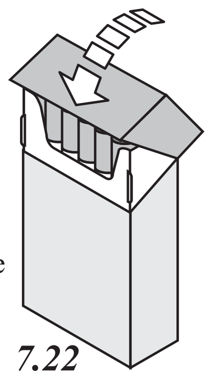
The diecutter should always spend time with his initial customer, the gluing machine operator, because gluing speed and yield is the first test of the folding abilities and the consistency of the folding product. This is important because it is a pragmatic demonstration of the erection capabilities of the container, the potential for trouble free product insertion, and the potential for trouble free sealing before product shipment.



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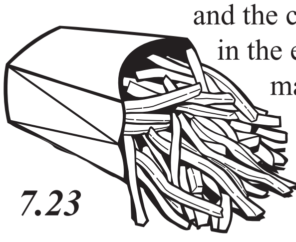
Why is Reduced Bead Creasing more effective in each of these closely related applications? The advantages are simple but critically important to the role of the carton and the container in the efficient management and distribution of consumer products. Reduced bead creasing provides:



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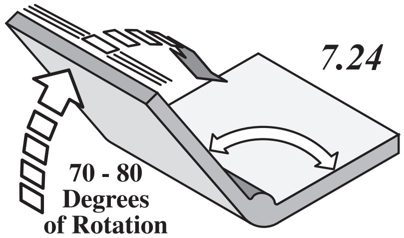
- ☑ *Greater bead flexibility and consistency through 90 and 180 degrees of folding and unfolding.*
- ☑ *Greater folding uniformity and repeatability from the first impression to the last diecut part.*
- ☑ *Greater control of key folding and opening force attributes.*
- ☑ *The elimination of common folding failures, which disrupt cartoning speed and yield.*
- ☑ *A longer more effective shelf life.*

Clearly, in terms of folding control and precise adjustment, reduced bead creasing provides the customer and the end user of the diecut product, with a more effective carton or container.



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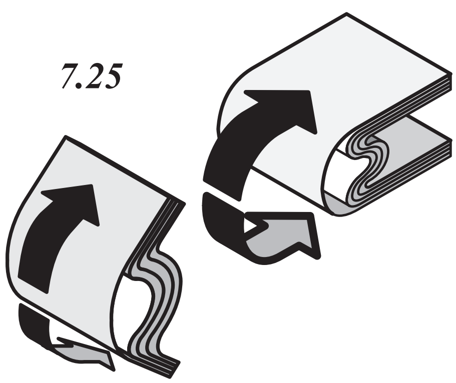
The Elimination of Bead Binding

When the two panels intersected by a crease are folded, there is minimal resistance until about 70 to 80 degrees of rotation. ***See illustration 7.24***. At this point there should be a slight increase in folding resistance, as the stress of folding is completing the delamination of the layers within the crease bead, and as the partial internal delamination of crease formation, is converted into full delamination under the stress of folding. ***See illustration 7.25***. The resistance will increase again as the panels are folded through a full 180 degrees of rotation.



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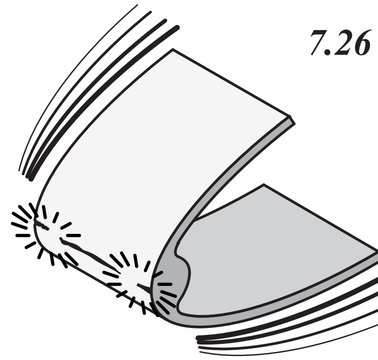

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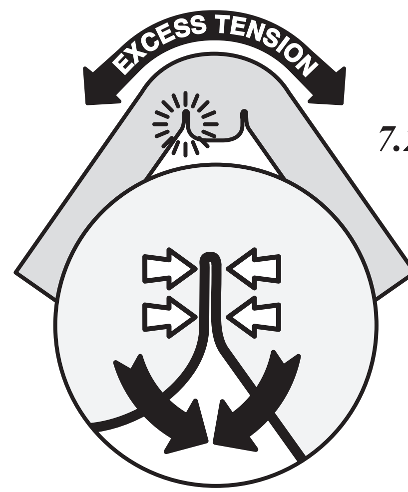
However, the increase in resistance should not be so high as to cause panel bowing and or tensile failure of the crease spine. ***See illustration 7.26***. Unfortunately, the degree of resistance at the transition point, between 70 and 90 degrees, often climbs to unacceptable levels in traditional creasing because of bead binding. ***See illustration 7.27***.



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This type of problem/failure sharply illustrates a key difference between traditional and reduced bead creasing. As we have identified a number of times, an important difference between the two approaches to creasing is the size of the bead. ***See***

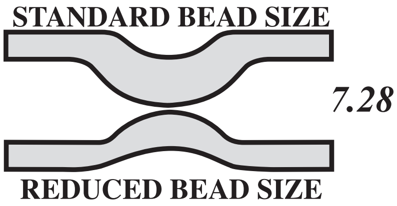
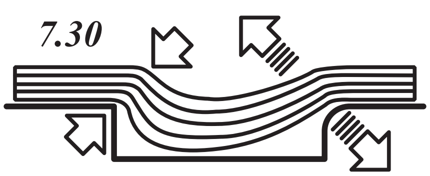


Illustration 7.28.

The disadvantage of the traditional crease bead it is too large and poorly proportioned, particularly for materials thicker than 0.025." A bead which is too large for the paperboard hinge, causes bead binding, which most commonly results in spine failure.

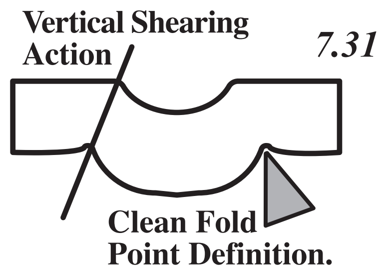
The problem is more pronounced with traditional creasing because of the rapid wear of the counter/matrix channel corners, ***see illustration 7.29***, which leads to lower shearing force at the critical distance, which results in poor definition of a critical fold point at the intersection of the bead and the attached panel. ***See illustration 7.30***.



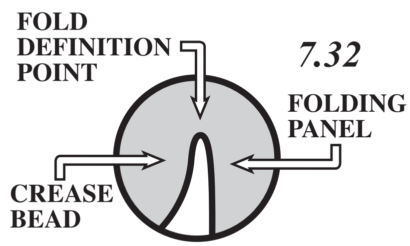
As ***illustration 7.30*** shows, as the channel corners wear the degree of internal delamination in the bead is reduced, which results in a bead which is not flexible, which is difficult to compress, and a bead which becomes part of the problem rather than the solution it is designed to be.

The combination of poor fold point definition and the reduced internal bead delamination, results in a crease which is more difficult to fold, and one which generates high levels of tensile stress in the crease spine.

Fortunately, reduced bead creasing eliminates this potential problem, by utilizing vertical pinching which improves shear point definition. ***See illustration 7.31***. In addition,



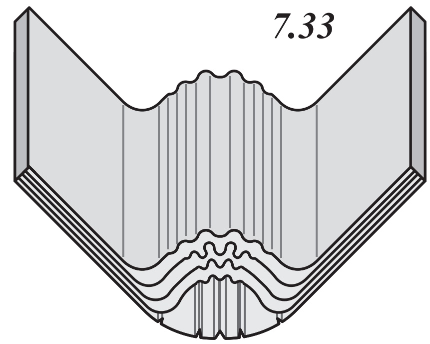
because the reduced bead is proportionately correct for the caliper of the paperboard or fluted material, a gap is created between the side of the bead and the inner wall of the folding panel. ***See illustration 7.32***.



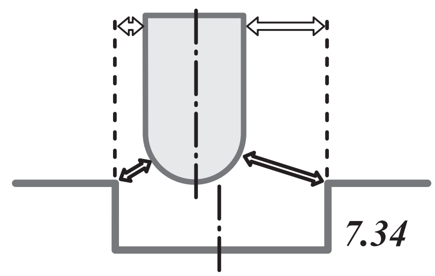
Bead binding is a common source of folding failure, which is often missed in the analysis of the source of a folding problem. Reduced bead creasing avoids this potential problem by using a formula, which produces a smaller more flexible bead than the traditional method of creasing.

Crease Spine Stress & Failure

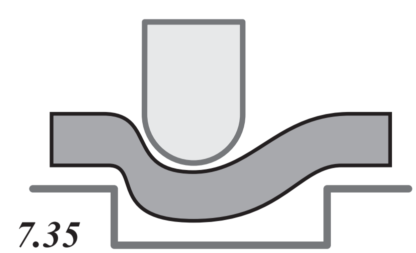
Crease spine fracturing and failure is generally mistaken for a problem of excess pressure in crease formation, in fact the reverse is true. An increase in excess tensile stress in the crease spine as a result of folding, is caused by a bead with incomplete internal delamination, which results in a bead, which is neither flexible nor compressive, and which is unable to act as a shock and a stress absorber. In fact, the reverse of this happens. ***See illustration 7.33***.



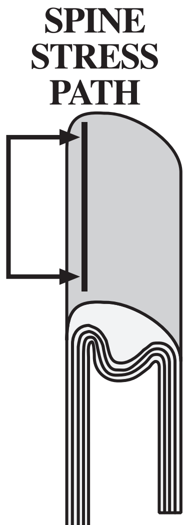
Spine splitting and fracturing is the result of a bead which is proportionately too large for the hinge application it is being used in. This naturally leads to bead binding, and subsequently to excess spine stress.



The spine fracture can also be the result of tool-to-tool misalignment, ***see illustration 7.34***, which leads to a one sided crease. ***See illustration***



7.35. The clue to this source of a spine splitting problem, is the spine fracture or split will be on one side of the crease spine, ***see illustration 7.36***, rather than in the center of the spine. Naturally, the primary source of this spine fracture will be on the side of the crease with the greatest stress, where the asymmetrical bead causes bead binding.



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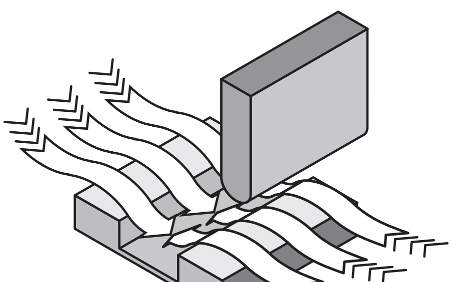
It is critical to note, that in comparison, Reduced Bead Creasing is far less susceptible to the impact of tool-to-tool misalignment, than a traditional crease.



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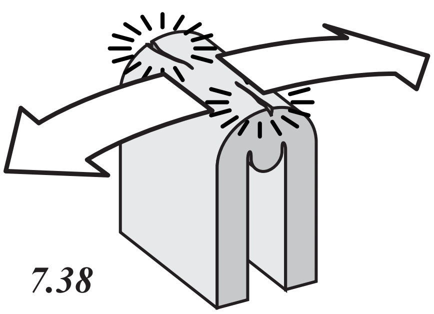
Because the traditional crease relies upon tensile draw in crease formation, ***see illustration 7.37***,



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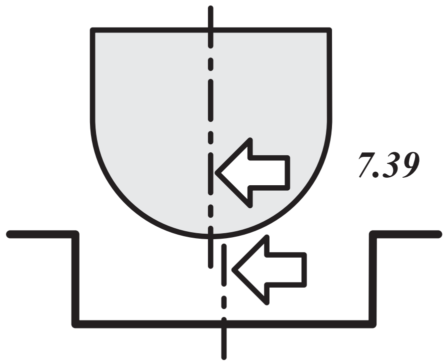
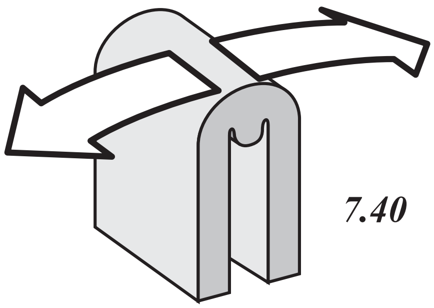
any tool-to-tool misalignment has disastrous results. ***See illustration 7.38***. Even a slight misalignment in traditional creasing will result in high spine stress, spine crazing and fracturing, and ultimately spine fracturing.

By comparison, the reduced bead crease uses primarily vertical shearing force to form the bead, ***see illustration 7.39***, and because the



7.39

crease rule is much wider than in the traditional crease, the effect of a slight tool-to-tool misalignment is minimal. ***See illustration 7.40***.

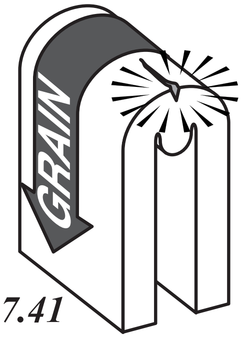


7.40

Reduced Bead Creasing eliminates many of these potential problems, because it incorporates a more efficient vertical shearing action, in a concentrated area, which results in a more consistently and a more evenly delaminated bead. As a result the smaller bead is more flexible, it eliminates bead binding, and it absorbs the stress of folding to avoid crease spine fracturing and failure.

Crease End Splitting

Partial fracturing or full spine splitting at the ends of a crease folded through 180 degrees, generally occurs at right angles to the paperboard grain, and usually at the junction between the cross grain crease and a knife. ***See illustration 7.41***. This type of failure is exacerbated by the lateral draw competition between the three creases at a standard crease intersection. ***See illustration 7.42***.



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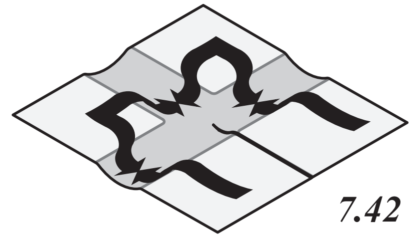

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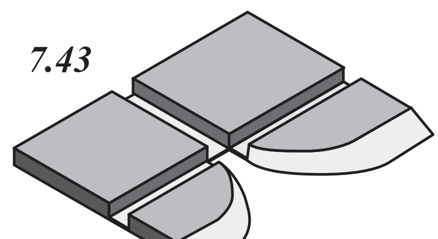
This area of tensile stress concentration is further complicated by the excessive thickness of the traditional creasing counter, ***see illustration 7.43*** (including the



7.43

thickness of the membrane, usually 0.004” to 0.006”) which when combined with over penetration of the tip of the crease rule below the surface of the counter/matrix

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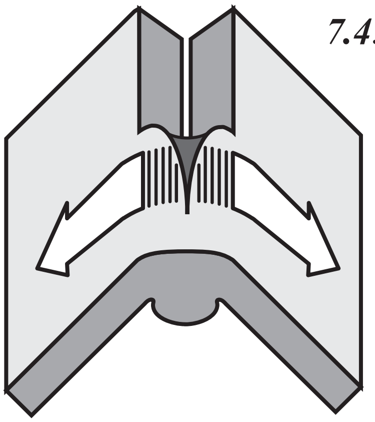
channel, ***see illustration 7.44***; creates excess spine stress, particularly toward and at the highest at the end of the crease spine. ***See illustration 7.45***.



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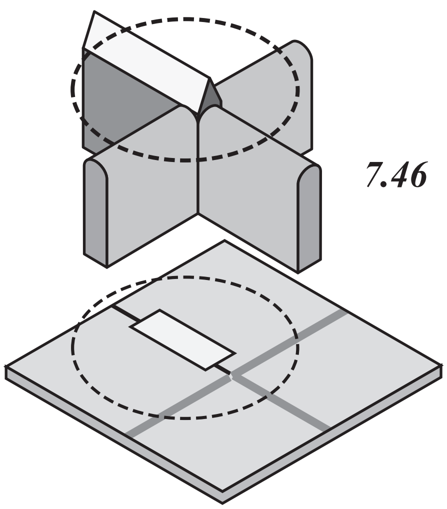
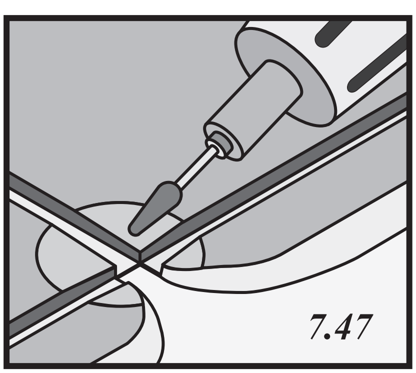
This is further compounded by patching the surrounding knives, because the pressure zone generated by the shimming material, also adds



7.46

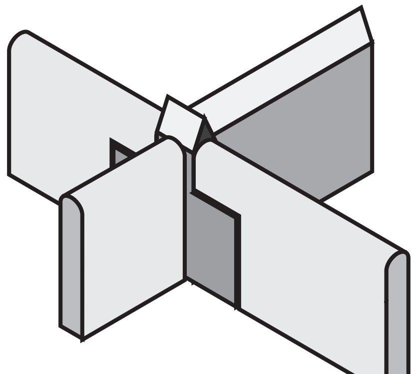
unnecessary pressure to the ends of the crease and the crease intersection. ***See illustration 7.46***. It is interesting to note that the most common on-press solution to this problem is to sand the intersection of the counter,



7.47

see illustration 7.47, to reduce the thickness of the counter and thereby reducing the punching stress on the paperboard.

The most dangerous issue with crease end splitting, is while the ends of the spine may not split during gluing, they are often found to have failed as the cartons sit in boxes on the customer floor!



7.48

A very pragmatic solution is to integrate T-Knives at any intersection between knives and crease at right angles to the paperboard grain. ***See illustration 7.48***. However, the most effective solution is Reduced Bead Creasing. Crease end splitting is eliminated because of the combination of a thinner counter, the significant reduction in lateral draw force in crease formation, the use of a smaller more flexible bead, and the increased width of surface delamination from a higher pointage crease rule.

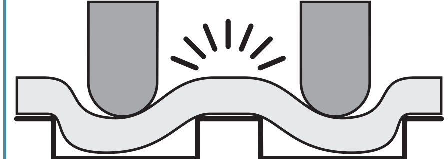
In eliminating crease end splitting the adoption of reduced bead creasing provides the most comprehensive and effective solution to this common problem.

7.49

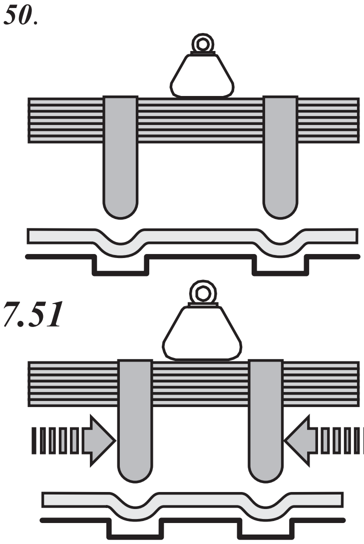
Crease to Crease Competition

One of the significant problems with traditional creasing methods is their reliance on excessive amounts of lateral draw to generate internal delamination of a crease bead. ***See 7.49***. This negatively impacts diecutting and the quality of the converted product in a number of ways.

7.50

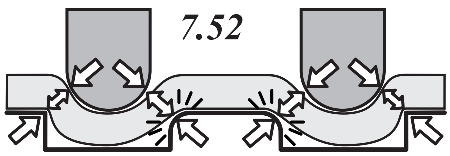


As creases are moved closer together two damaging effects undermine performance. The first is the competition between each crease grows to a level, that the material is unable to stretch and to accommodate the strain, and both of the subsequent crease beads are poorly formed and are not symmetrical. ***See illustration 7.50***.



7.51

The other damaging effect, is as creases get closer together the pressure or the resistance in the area of the creases becomes disproportionately higher. ***See illustration 7.51***. This is only temporary, because the stress on the inner channel walls of the two creases will cause them to abrade more rapidly, ***see illustration 7.52***, and thereby reducing the temporary resistance spike. However, the resistance generated by the crease is sufficient to require excess patching of the surrounding knives, which will lead to knife damage as the counter wears and lowers the resistance.

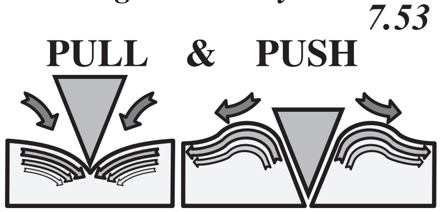


7.52

Other problems generated by this phenomena are crease end splitting; surface bursting at intersections; increased product marking; over patching of the knives; increased flaking; a need for more and larger nicks to counter the pull from these creases; and a severe impact on the folding quality and consistency of folding carton or container.

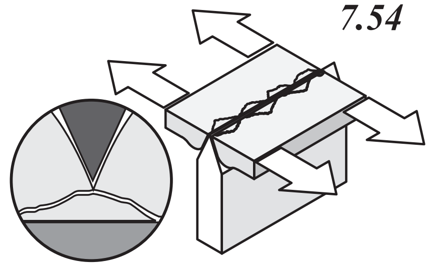
The use of more compressive rather than lateral force in reduced bead creasing, eliminates the draw and pressure problems, and the compression gap and the use of a smaller bead, eliminates the problems of temporary resistance or pressure spikes in diecutting make-ready.

7.53



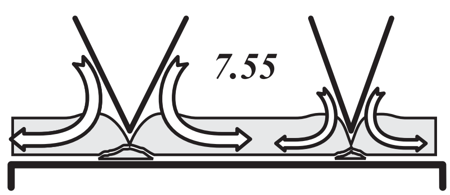
Minimize Draw Induced Flaking

One of the dangers of displacement platen diecutting, is the use of the wedge/knife results in greater displacement or pushing pressure at the top of the material, by comparison with the base of the material. ***See illustration 7.53***. This variation of the degree of lateral shearing force in platen diecutting can generate premature splitting and tearing, which will result in flaking and edge chipping. ***See illustration 7.54***.



7.54

To eliminate this effect, it is a common practice to lower the displacement force by using a lower angle cutting blade. ***See illustration 7.55***. This not only reduced the lateral push from the bevel faces of the knife, it also lowers the overall pressure required to cut. ***See illustration 7.56***. In addition,



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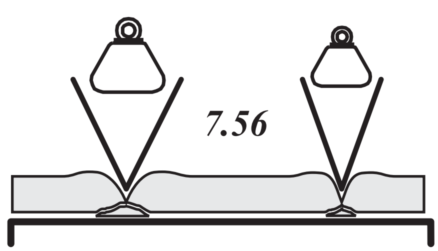
as a further precaution we use high density, specialized ejection material on both sides of the knife, to isolate the cutting action from external influences. ***See illustration 7.57***.



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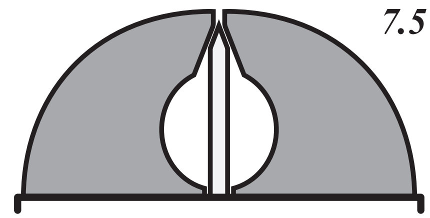
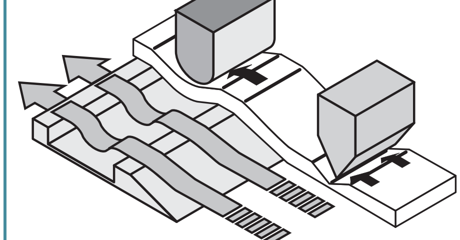
Unfortunately, all of these precautions are undermined if creases using the traditional tool formula are placed parallel to the knife where flaking is occurring. ***See illustration 7.58***. The combination of lateral

7.57

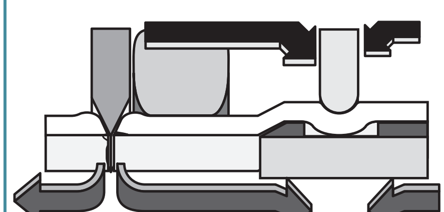


draw and tensile stretching of the paperboard, and particularly the upper surface of the material, by the formation of the crease, overcomes the advantage of using a specialized knife and a more effective ejection material. ***See illustration 7.59***.

7.58



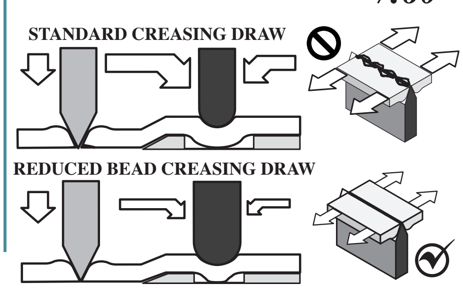
Why is reduced bead so much more effective? First it utilizes a thinner counter, which significantly reduced the degree of wrap around stretching. ***See illustration 7.60***. Second the



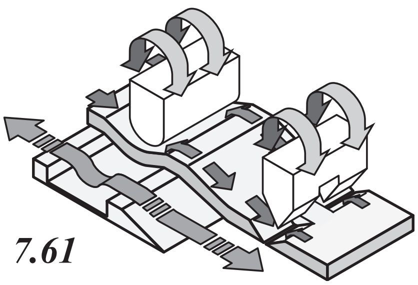
7.59

combination of a vertical shearing action rather than the lateral draw of the traditional crease, when combined with the compression gap setting of reduce bead, further reduces the degree of lateral tension in the material.

7.60



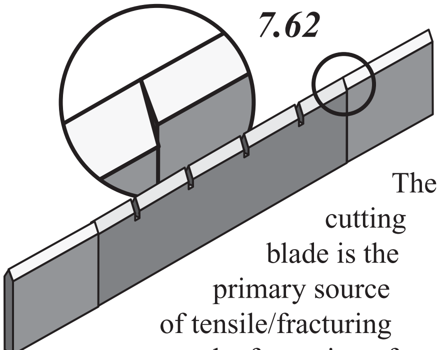
To reduce the incidence and the degree of flaking in platen diecutting, it is a significant advantage to adopt the use of a reduced bead creasing tool formulation.



7.61

Minimize Nicking-Draw Stress

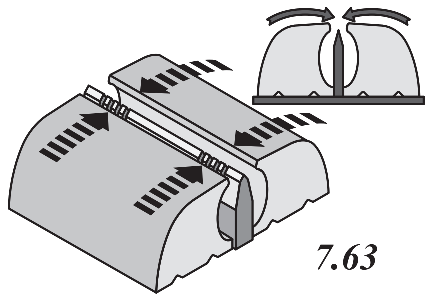
In a similar fashion to the previous example, the excess lateral draw of traditional crease set-up has an equally damaging impact on nicks in adjacent knives. ***See illustration 7.61***.



7.62

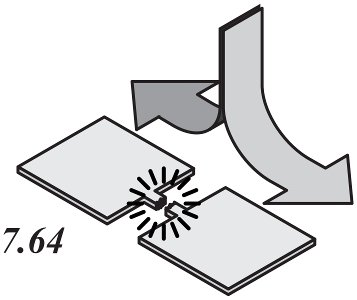
The cutting blade is the primary source of tensile/fracturing stress on the formation of an effective tag in paperboard. As a result, it is an effective strategy to reduce the lateral displacement push from a high bevel angle blade, by replacing the knife, where nicks are to be machined, with a lower bevel angle profile. ***See illustration 7.62***.

In the same way as in the flaking failure, higher durometer, specialized profile rubber is used on either side of the blade to isolate the cutting action and the formation of the nick/tag from both internal push and lateral pull from external sources. ***See illustration 7.63***.



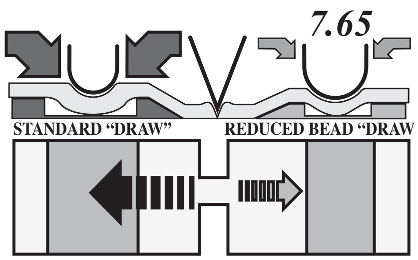
7.63

Unfortunately, as with the flaking example, parallel creases, and particularly close proximity parallel creases, will generate such a high level of lateral stress the formation of an undamaged nick/tag is compromised. ***See illustration 7.64***.



7.64

Reduced Bead Creasing solves this problem by employing a thinner counter, to minimize stretch deformation of the material, ***see illustration 7.65***; and vertical shearing rather than lateral shearing, to isolate the action of crease formation, ***see illustration 7.66***; and finally the use of a compression gap, ***see illustration 7.67***, eliminates over penetration of the crease, which would normally further increase the degree of lateral draw.



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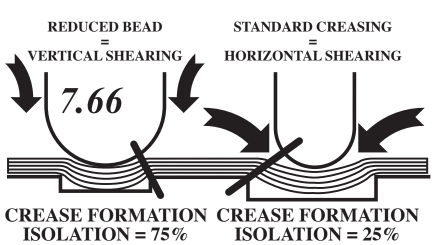

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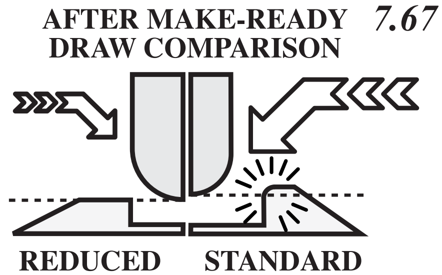
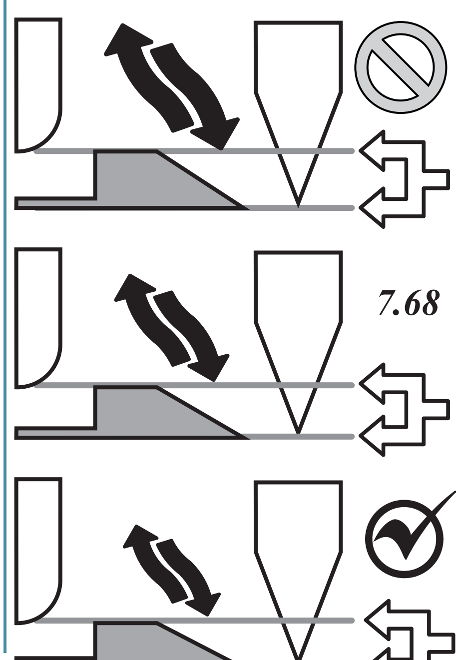


7.67

To reduce the incidence of premature nick/tag failure, and to enable the use of less nicks of a smaller size, reduced bead creasing aids the unencumbered formation of each nick/tag.

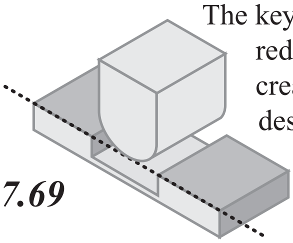
A Stable Cutting Make-Ready

A stable, kiss cut press make-ready is the foundation of an effective diecutting operation, and essential for converting quality and uniformity. Therefore, it is important to specify and to design tools, which isolate cutting, to prevent cutting set-up undermining crease set-up, and to



7.68

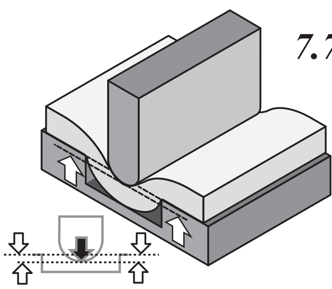
prevent crease set-up undermining cutting set-up.



7.69

The key issues in reduced bead creasing tool design are the thinner counter, the compression gap, and the use of vertical, rather than lateral shearing in crease formation. In diecutting, the greater the difference between the height of the knife and the height of the crease rule, the greater the tensile stress on the material, ***see illustration 7.68***, and the greater the negative impact cutting has on creasing and vice versa.

In terms of the importance of the compression gap, is if the tip of the crease begins the press make-ready level with the plane formed by the surface of the counter or matrix strip,



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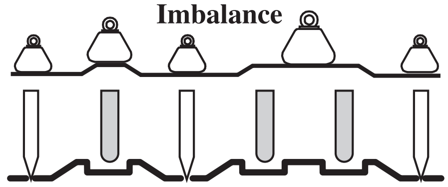
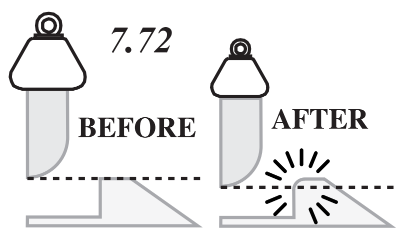
see illustration 7.69, any subsequent patch-up and pressure adjustment, will drive the tip of the crease into the crease channel and below the surface of the female tool. ***See illustration 7.670***. As this puts excessive pinching pressure on the material and the upper corners of each channel, this will become a high resistance point or pressure spike in the press make ready. ***See illustration 7.71***. Although the progressive and even accelerated wear of the upper corners of each channel will abrade the counter to gradually reduce the high pressure point, ***see illustration 7.72***, the damage to the cutting make ready has been done. The over penetration of each crease adds resistance to the platen stroke, which appears as though there is insufficient pressure

7.71 **Standard Crease “Pressure Resistance” Imbalance**

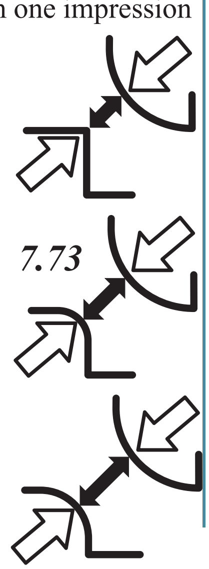


on the cutting knives. The knives are patched to compensate, the crease is driven further into each channel, the channels wear, press resistance is eliminated and the knives now strike the plate with excessive force. More pressure is added, the creases are driven further into the channel, a pressure spike is generated, and the destructive cycle continues.

7.72



Obviously, this continuous adjustment is changing the crease Critical Distance, ***see illustration 7.73***, and generating significant folding variation from one impression to the next. However, it is the important relationship between crease tool design and cutting pressure control, which is consistently overlooked.



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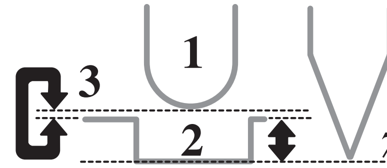
The combination of the thinner counter, the higher pointage crease, and the compression gap, built into



7.74

1: Higher Pointage Crease Rule
2: Thinner Counter/Matrix
3: Compression Gap

the reduced bead formula, ***see illustration 7.74***, is an important feature, designed to minimize excess shearing force, and to prevent a pressure imbalance.

Reduced Bead Creasing is designed to improve creasing and folding performance, however, this method of creasing also has an important and a positive impact on generating a stable, kiss-cut press make-ready

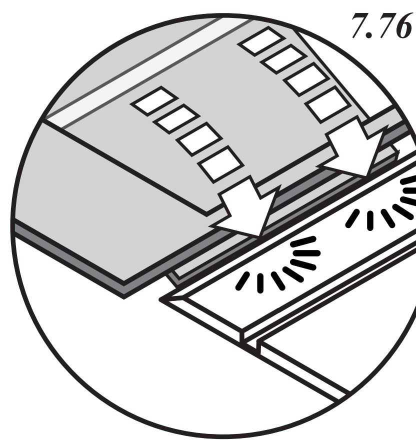
Eliminate Bead Snagging

One of the hidden disadvantages of traditional creasing is the thickness

7.75

of the counter and the proportion of the bead lead to bead snagging, see ***illustration 7.75***, and part snagging on the protruding counter. ***See illustration 7.76***. These effects are made much worse because of the severe stretching of the material. This is caused by the combination of the

7.76



lateral pull of crease formation and the punching force the crease rule,

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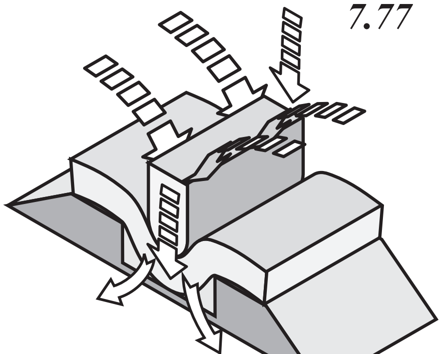
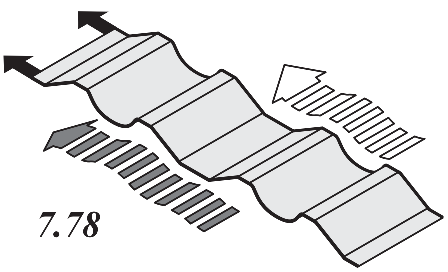
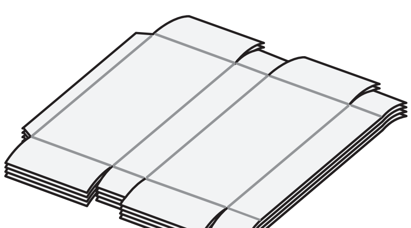


see illustration 7.77, and the wrap around effect of the thicker counter. ***See illustration 7.78***. This generates



7.78

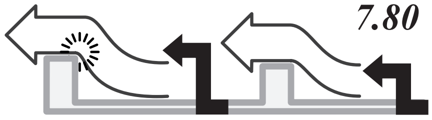
such high levels of tensile stress in the material, the resulting tension causes the material to bow and to deform, ***see illustration 7.79***, further complicating an already complex problem.

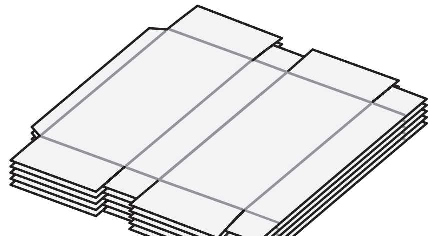


7.79

Reduced bead creasing minimizes these problems by using a thinner counter and a smaller bead, to minimize bead snagging and part catching, ***see illustration 7.80***, and the resulting diecut parts and the

7.80





7.81

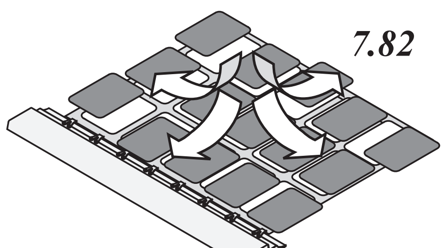
entire layout are flatter and more aligned. ***See illustration 7.81***.

Reduced Bead Creasing is effective not just as a method of improving crease formation and folding performance, but it has a positive impact on press productivity and output.

Faster Press Speed

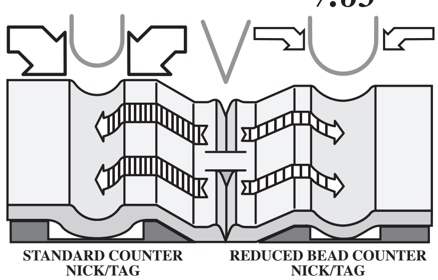
Press speed in diecutting is a function of lowering the lateral stress on the diecut sheet to prevent

7.82

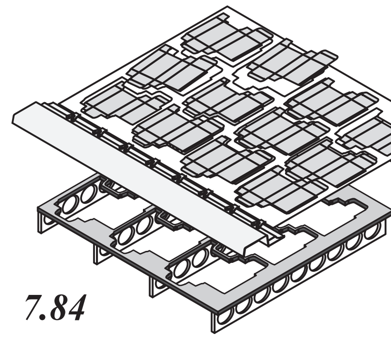


it breaking apart. ***See illustration 7.82***. By minimizing stretching and deformation stress of the paperboard around the thicker traditional counter, the nick/tags holding the diecut parts together are subjected to significantly less stress and can perform more effectively. ***See illustration 7.83***.

7.83



The elimination of bead snagging is obviously an advantage, however, the ability to keep the diecut sheet and parts level, flat, and aligned,



7.84

minimize snagging and sheet break-up in stripping and in blanking. ***See illustration 7.84***.

In addition, the reduction in the pressure conflict between creasing and cutting, which prevents the crease and the knife/wedge generating excess lateral draw and displacement push, is a productive advantage in maintaining continual production.

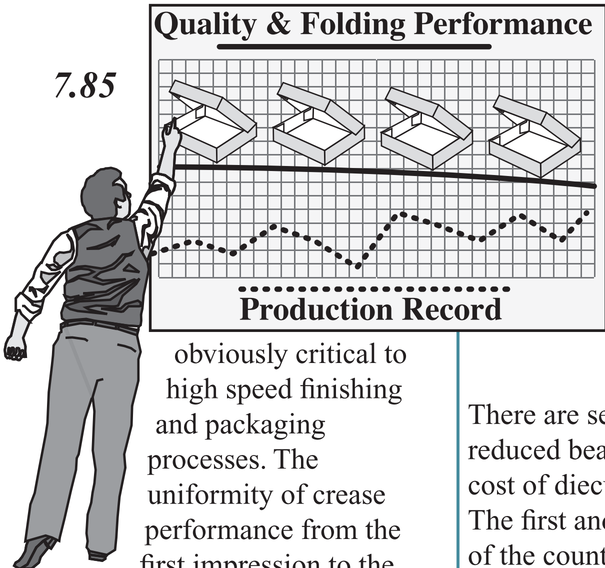
A key benefit of reduced bead creasing is the positive impact it has on achieving maximum press speed and yield in diecutting.

Improved Overall Quality

Reduced bead creasing was originally designed to solve key problems in crease formation and in the folding and the erection of folding cartons and fluted containers. We have seen in this chapter some of the remarkable benefits of adopting this method of tool specification and design. However, it is how reduced bead impacts quality and consistency of the carton and container product, which is the real story.

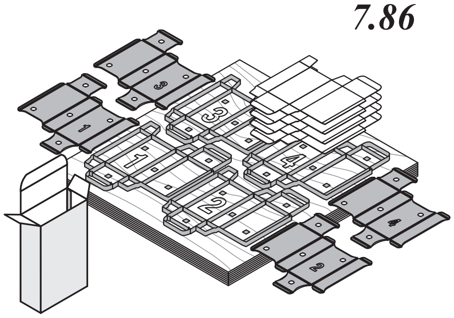
Crease formation and folding consistency and repeatability are

7.85



obviously critical to high speed finishing and packaging processes. The uniformity of crease performance from the first impression to the last is a key benefit. ***See illustration 7.85***. The uniformity of folding and opening force from die-station to die station is another valuable attribute of the reduced bead method. ***See illustration 7.86***.

7.86



The elimination of product marking by utilizing a thinner counter and reduced lateral paperboard stress is an aesthetic advantage. ***See illustration 7.87***.

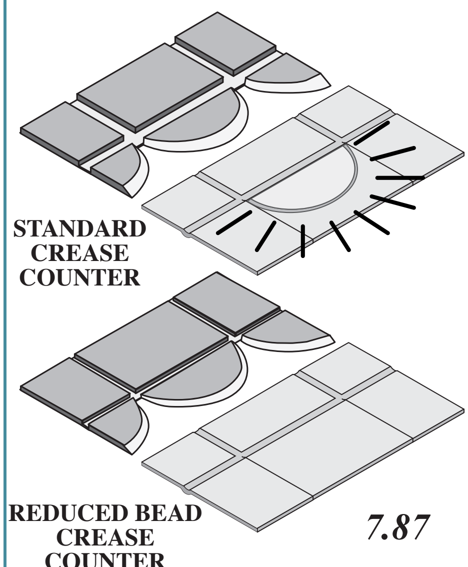
Finally, simpler press set-up, lower incidents of spine fracturing and crease end splitting, all contribute to a method of creasing which generates an outstanding folding carton and container.

Reduced Bead Creasing has proven to be a method of creasing, which improves folding quality, consistency, and productivity.

Lower Material & Machining Cost

The final word in assessing the benefits of reduced bead creasing, like everything else in the process, has to be about the benefit of lower material costs.

There are several areas in which reduced bead creasing can lower the cost of diecutting manufacturing. The first and most obvious is the life of the counter is more than double that of the traditional method of tool design and of crease formation.



7.87

Matrix, Fiberglass Counters, Vulcanized Fiber, and even Steel Counter Plates simply last longer, and perform more consistently, through their extended operational life.

The stability of reduced bead creasing contributes to higher press speeds, to greater yield, and to lower material and resource waste, by minimizing sheet break-up.

The performance of reduced bead tooling and crease formation methods ensure greater consistency, uniformity, and repeatability in folding carton and container manufacturing. However, it is the customer which receives the greatest benefit of this method of converting manufacturing.

The benefits are as they should be, invisible. The diecut product the customer invested in meets or surpasses their expectations.

Summary

As you see from this impressive list of benefits, the Reduced Bead Creasing tool design method, provides the diecutter with a simpler and more bullet proof method of crease formation, and it provides the end user of the carton or container, with the folding consistency and repeatability they demand.

However, it should be noted that cellulose based materials are inherently variable, and their range of properties and converting attributes will vary from batch-to-batch, and from Mill run to Mill run. It is vital to be constantly vigilant and to avoid complacency as the materials, the structural designs, and the process are constantly changing.

Fortunately, Reduced Bead Creasing is a highly effective solution. It provides a more reliable and a more predictable method of crease formation, and it generates a paperboard hinge, which will fold and unfold with remarkable consistency.

Chapter 7:
What are the Benefits of Reduced Bead Creasing: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ One of the most important settings in creasing is the Critical Distance, or the gap between the face of the crease rule and the upper corner of each channel. This chapter described how using the Reduced Bead formula and settings, stabilized this key crease formation gap.

- ✓ Controlling folding and opening force is critical to high speed, automatic packaging systems, and Reduced Bead Creasing provides more precise, more consistent, and more stable management of key folding variables.

- ✓ The crease bead is the engine room of an effective paperboard hinge, and reduced bead settings ensure a smaller, more evenly delaminated, and a more flexible crease bead.

- ✓ One of the hidden problems in creasing is bead binding, where the side of the crease bead and the inner wall of the folding panel are crushed together, increasing folding force and spine stress.

- ✓ Crease spine stress and failure is often mistakenly attributed to excess pressure and the channels are widened to reduce the pinching force. However, spine failure is a sign of insufficient crease formation pressure, and the channels should be narrower and/or the crease rule thicker.

- ✓ One of the invisible conflicts in converting is the destructive draw competition from one crease to the next and to adjoining knives. Reduced Bead minimizes tensile stress and isolates the formation of each crease and the performance of each cutting rule.

- ✓ The draw generated using standard creasing parameters increases diecut edge flaking and nick/tag failure, however, Reduced Bead creasing parameters, minimize edge chipping and premature nick/tag failure.

- ✓ One of the key benefits of the reduced bead approach to creasing, is it eliminates pressure spikes during make-ready, which destabilize the cutting impression.

- ✓ An important attribute of reduced bead creasing, is the combination of a smaller bead and a thinner counter minimize bead and part snagging, to prevent sheet break-up, and to enable faster press speed and yield.

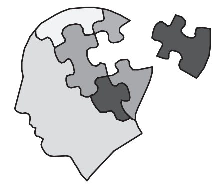
- ✓ The primary goal of reduced bead creasing is it solves critical creasing problems and it improves folding performance and consistency, from die station to die station, and from the first impression to the last.

Chapter 7:
What are the Benefits of Reduced Bead Creasing: Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ Why is the stability of the Critical Distance setting in creasing so important to folding performance?
- ✓ What are the two forces, which cause the Critical Distance to change?
- ✓ How does the Critical Distance setting impact the overall pressure to diecut?
- ✓ Why does the Compression Gap provide an advantage in reduced bead creasing?
- ✓ Why is the penetration of the tip of the crease rule mounted in the steel rule die, below the surface of the female crease tool channel surface, such a disadvantage in folding performance and in folding stability?
- ✓ There are two forms of stress used to create the delaminated bead in creasing, vertical and lateral. Which is used for Reduced Bead creasing?
- ✓ What is the difference in female crease tool wear characteristics in reduced bead and traditional creasing, and how does this impact folding performance and consistency.
- ✓ How can you tell a crease is a double fold?
- ✓ What should happen to the crease bead as the panels are folded through 90 and 180 degrees?
- ✓ How does bead binding impact folding performance?
- ✓ What causes crease spine tensile stress and failure?
- ✓ Why is tool-to-tool misalignment more of a problem in traditional crease tool set-up than it is in Reduced Bead crease set-up?
- ✓ What happens to bead formation as parallel crease are brought closer together?

Brainstorming, Notes & Ideas



"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

Chapter 8:
The Specification & Design of Reduced Bead Creasing?

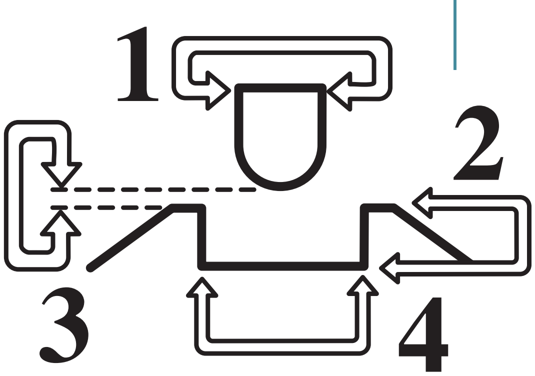
In practice the specification and design of Reduced Bead Creasing is simple to understand and easy to execute. It is also important to recognize, that while some of the differences between traditional creasing and reduced bead creasing are small, they are all significant in terms of improving the performance of crease formation and effective folding.

There are four key elements of Reduced Bead Creasing tool specification and design. These elements area:

- ✓ ***The Pointage of the Crease Rule***
- ✓ ***The Thickness of the Counter/ Matrix***
- ✓ ***The Compression Gap***
- ✓ ***The Channel Width***

See illustration 8.01.

8.01



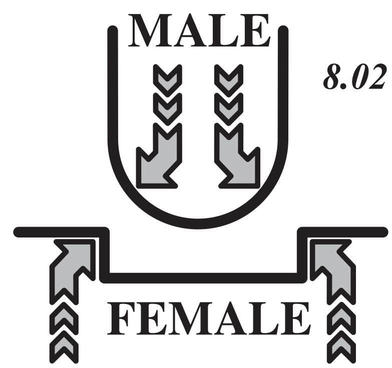
1: Crease Rule Pointage
2: Counter/Matrix Thickness
3: Compression Gap
4: Channel Width

Each change to the standard procedure provide measurable improvement in crease formation and in folding performance, in process productivity, and in the quality and the consistency of the carton and the container. It is important to remember that the design process should be a open minded discipline, in which personal knowledge and experience, should play a key part.

Designing an effective paperboard hinge requires understanding the structural design, the material, the folding and gluing process, and the cartoning and packaging process. Therefore, every set-up should be adjusted to reflect specialized knowledge and experience, and the unique folding application the tools are being designed for.

This publication will ultimately present several alternative crease set-up methods. However, each new design and specification challenge, may need to include and integrate several design options, for what may appear to be competing options. Clearly we are recommending Reduced Bead Creasing as the default method of choice, however, you should always consider and never preclude the partial or complete adoption of another method of tool calculation.

Whatever the tool design decision you ultimately make, it is important to use feedback from the press team and from the gluing and finishing team to learn and to adjust future specification decisions. Naturally, a high priority should be placed on feedback from the customer, and of course your personal assessment of what worked well, what was less effective, and how you will adjust specification methods in the future.



8.02

Crease Tool System

The bottom line?

Reduced Bead Creasing is the most effective method for creasing in both paperboard and fluted materials. However, every production cycle is a learning curve and an opportunity to gain invaluable experience.

8.03

The Pointage of the Crease Rule

The steel rule mounted in the dieboard forms the male part of a male/female trapping, pinching, and shearing tool. ***See illustration 8.02***. Traditionally the profile of the working end of the crease rule has always been rounded, ***see illustration 8.03***, as the original intention in

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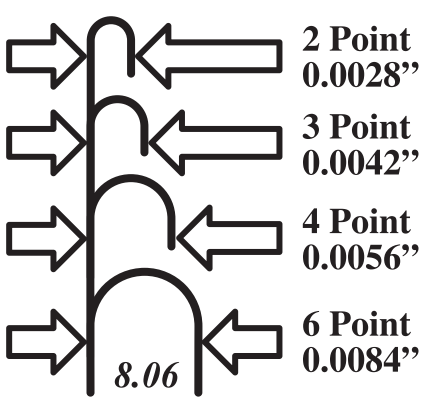
the 19th century, was to create an indentation in the material to form a accurate fold point. As the gradual development of an increasingly

8.04

sophisticated paperboard hinge progressed, the shape of the crease has remained unchanged, even though a tapered shape would be more effective, ***see illustration 8.04***, particularly when coupled with a tapered wall female channel. ***See illustration 8.05***.

8.05

One of the obvious questions to ask is why 2-point or 0.028" thick creasing is used? ***See illustration 8.06***. Obviously, the thickness of



8.06

the material is related to existing materials and thicknesses driven by the Printing Process, and the ***"Point-System"*** of measurement used in this industry. As diecutting evolved from the printing process, and originally adopted many of the standards and parameters of printing, it is illogical to continue to use outdated materials and measurement criteria, established in the early days of the diecutting industry.

So what are the benefits of increasing the pointage of the crease rule from the thinnest to the thickest paperboards and fluted materials?

There are 7 reasons to increase the pointage of the crease in proportion to the thickness of the paperboard and the width of the channel. These are as follows:

1: To change the Angle of Attack.
2: To evenly distribute Compressive Force.
3: To reduce dependence on Lateral Draw.
4: To delaminate a wider area of the Material Surface.
5: To use vertical force to minimize Female Tool Wear.
6: To minimize the impact of tool-to-tool Misalignment.
7: To provide a stiffer and a Stronger Tool.

So how do we accomplish this?

In Reduced Bead Creasing we eliminate 2-point creasing from the process, except for the thinnest material, between 0.001" and 0.010", and even then a 2-point wide male former has limited usefulness.

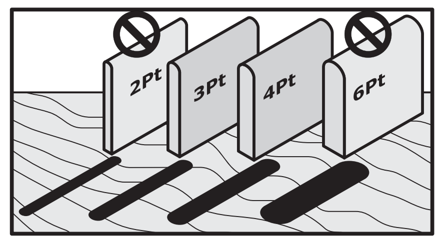
The charts provided cover the standard range of paperboard between 0.011" and 0.035." Starting at the lowest caliper, 0.011", we use 3-point creasing rule, however,

CALIPER	Against Grain	With Grain
0.011 - 0.014	3-Point	3-Point
0.015 - 0.019	3-Point	3-Point
0.020 - 0.024	4-Point	3-Point
0.025 - 0.029	4-Point	4-Point
0.030 - 0.035	6-Point	4-Point

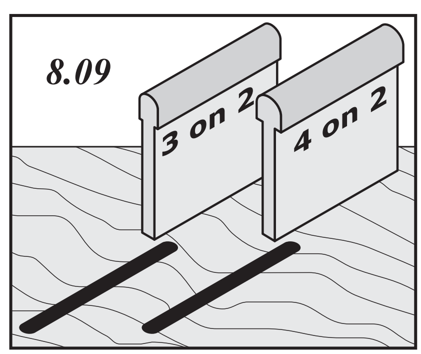
8.07

as it is important in this approach to delaminate as large an area of the channel/bead as possible, it is necessary to increase the pointage of the crease rule, at selected points as the caliper of the material being converted gets thicker. ***See illustration 8.07***.

8.08



When evaluating the information and recommendations in this manual, it is important to remember that they are simply that, recommendations. For example, many choose to use 3-point creasing rule for the entire range of caliper. This is because of the cost, complexity, and time involved in



8.09

lasercutting a 3, 4 & 6-point kerf, ***See illustration 8.08***. And as a result they often choose to use 3-on-2-point, or even 4-on-2-point creasing rule, inserted into a 2-Point lasercut slot. ***See illustration 8.09***.

It is obviously important for you and the team to experiment and find what pointage is most effective, for each caliper of paperboard.

The Crease Specification Charts at the end of this chapter will specify our recommendations for creasing, based on the caliper or the thickness of the paperboard material. ***However, this is only one specification set!*** It is not our recommendation to treat a Clay Coated Newsback, or a Solid-Unbleached-Sulphate, or a lamination of two materials, the same even though they may have identical calipers!

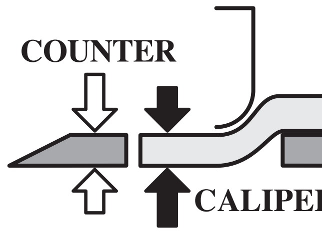
The specification chart is a set of recommendations, however, they must be adjusted based upon the type of material, the folding application, and the end use purpose of the container. It is also important to reiterate the reasons why we are using a higher pointage creasing rule than the standard formula. They are:

1: To change the Angle of Attack.
2: To evenly distribute Compressive Force.
3: To reduce dependence on Draw.
4: To delaminate a wider area of the Material Surface.
5: To use vertical force to minimize Female Tool Wear.
6: To minimize the impact of tool-to-tool Misalignment.
7: To provide a Stronger Tool.

The bottom line? The higher the pointage of crease rule you can successfully use, the better the formation of the bead, and folding performance will be more reliable, and more consistent.

The Thickness of the Counter/Matrix

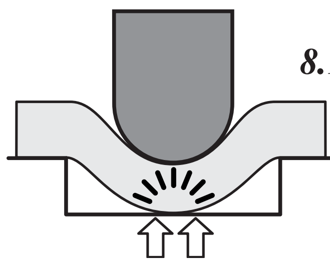
As the entire focus of Reduced Bead Creasing is on a proportionately smaller bead than the standard formula, there is no need for the thickness of the counter or matrix tool, to match the thickness of the caliper. ***See illustration 8.10***.



8.10

In practice the thickness of the female tool, and/or the depth of the female channel can be reduced as a percentage of the caliper of the paperboard.

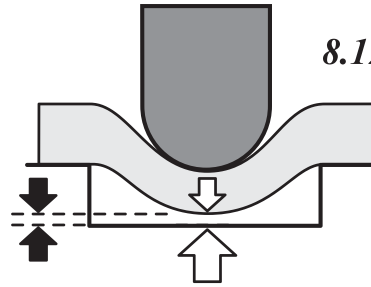
The original concept of the caliper and the female tool thickness matching, was based upon the misconception that the paperboard would make contact with the base of the female tool channel. ***See illustration 8.11***. However, in reality the paperboard trapped between the upper corners of the channel is stretched as it is sheared, so the total thickness of the material at the centerpoint of crease formation, is less than the caliper of the material. ***See illustration 8.12***.



8.11

This provides a number of important advantages in crease formation.

So what are the benefits of reducing the thickness of the Counter tool or Matrix strip?



8.12

There are 6 reasons to reduce the thickness of the female crease tool. These are as follows:

1: The Knife-to-Crease Vertical Shearing Distance.
2: The Reduced Competitive Draw and Lateral Tension.
3: The ability to keep the diecut sheet Flatter and Aligned.
4: The positive impact on Nicking & Flaking.
5: The reduction in Product Marking.
6: The reduction in Material & Processing Cost.

So how do we accomplish this?

The list of benefits of making this change are too important to ignore, however, as with any tool design issues we have to be realistic. Let us start with the recommendations. ***See illustration 8.13***.

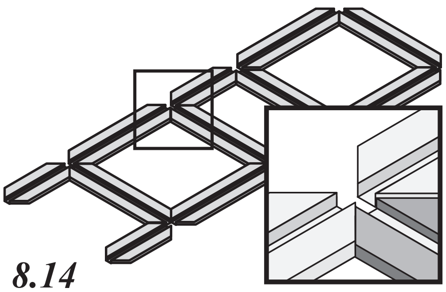
The recommendations specify the

8.13

Female Crease Tool Thickness
0.010” - 0.014” = 90% - Caliper
0.015” - 0.020” = 85% - Caliper
0.021” - 0.025” = 80% - Caliper
0.026” - 0.030” = 75% - Caliper
0.031” - 0.035” = 70% - Caliper
0.036” - 0.040” = 65% - Caliper

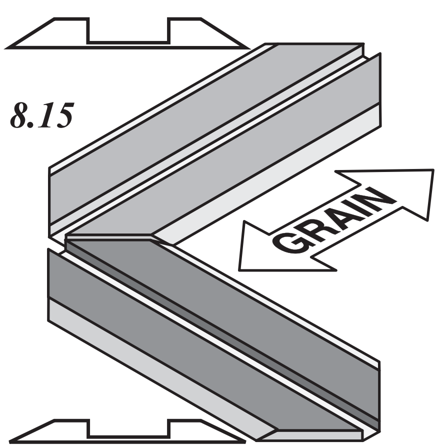
thickness of the counter or matrix strip should be a percentage of the caliper. However, this has to be mitigated by what crease tool materials are available. The recommendation is to use the closest material available, and round up to the next size.

The closer to the recommended thicknesses the better, however, plus or minus 0.001” is fine, and frankly by using the ***“wrong”*** thickness of counter material, you may discover an even more effective crease formulation!



8.14

A good example of this flexibility is the option to use different heights and of course types of ***Matrix Strips*** at right angles to the paperboard grain, and parallel to the paperboard grain. ***See illustration 8.14***. This means you can use a lower thickness parallel to the paperboard grain, or a higher thickness. ***See illustration 8.15***. In addition, one of the great benefits of using Matrix is the flexibility to ***“mix & match”*** thicknesses to emphasize

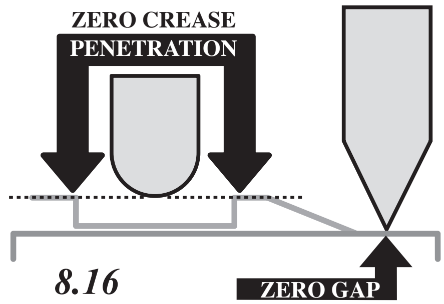


8.15

a specific fold, or to increase or decrease the folding force, of a specific carton feature.

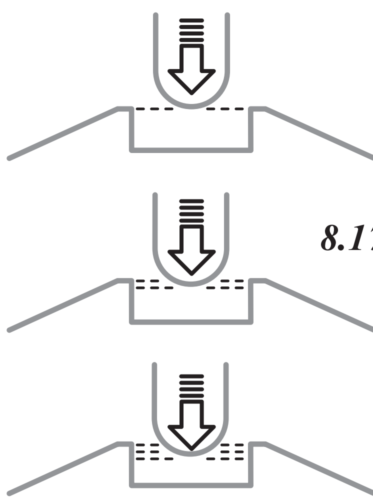
The Compression Gap

Setting the tip of the crease rule level with the surface of the female tool, ***see illustration 8.16***, in designing creasing tools, is a recipe for quality



8.16

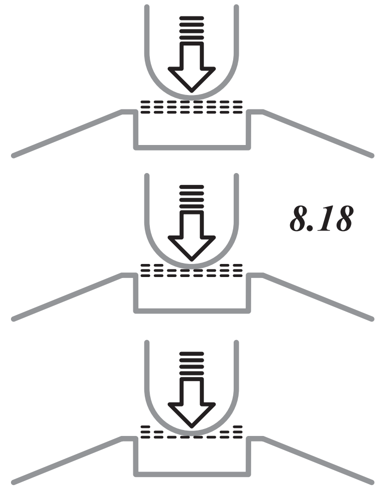
and productive disaster. The practical reality of platen diecutting press make-ready, is that after the cutting impression has been set, the male crease rule is now protruding below the surface of the female channel. ***See illustration 8.17***. This leads to a multitude of obvious and some



8.17

hidden problems. These include uneven crease formation, progressive product variation, and an unstable diecutting press cutting make-ready, to name only a few?

The Reduced Bead Creasing method integrates a gap between the tip of the crease rule and the surface of the counter or matrix strip, as a buffer to compensate for inevitable compression of the steel rule die. ***See illustration 8.18***.



8.18

The Compression Gap is a key element of Reduced Bead Creasing as it is a buffer, designed to compensate for over-pressurization and the progressive deterioration of the standard press make-ready.

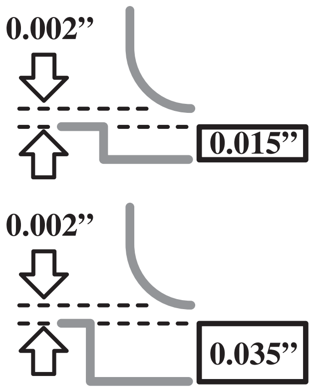
So what are the benefits of setting the male and female tools so that when the press is at the optimal Shut Height, there is a gap between the tip of the crease and the surface of the counter/matrix?

There are 6 reasons to set the male and female tool to include a gap between the tools. These are as follows:

1: Eliminate over-penetration of the crease rule.
2: Minimize the Press Make-Ready “Resistance” Point.
3: Reduce rapid wear of key female tool features.
4: Design for the “After” press make-ready process.
5: Improve Press Speed & Yield.
6: Improve Folding Performance & Consistency.

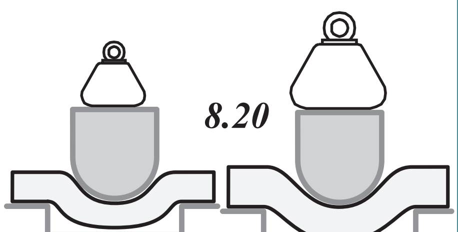
So how do we accomplish this?

There are a number of equally valid ways to accomplish this, however, the bottom line is all methods integrate a Compression Gap into the crease calculation. The questions is how should the gap be calculated?



8.19

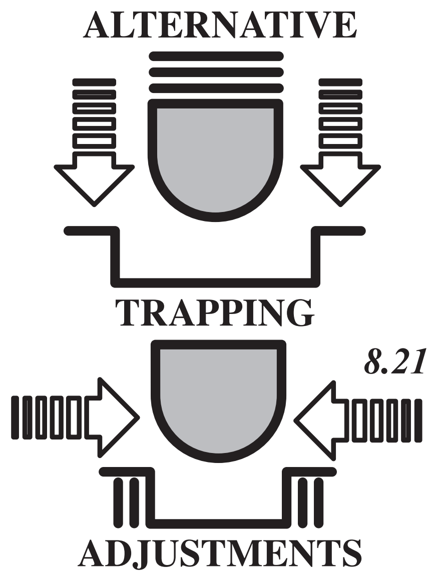
For many, even though the caliper changes, the steel rule knife is a constant height. Therefore the argument is, the compression of the knife will be identical whether the material is 0.010” or 0.030.”



8.20

As a result this approach recommends a fixed compression gap of 0.002” or 0.003” through the entire range of crease calculation. So the compression gap on a material of 0.015” would be the same as the compression gap on a material of 0.035.” ***See illustration 8.19***.

The other side of the argument is the increasing pressure required to punch a thicker material into a channel, would meet with such a high level of resistance, it is setting the diecutter up for failure. ***See illustration 8.20***. Further, the argument on this side of the ledger notes the formation of the crease is accomplished by trapping and by the distance between the trapping points. ***See illustration 8.21***. Therefore, they would argue it is more effective and more efficient to reduce the distance between the trapping points, than to attempt to muscle the paperboard into the channel.



8.21

This argument, based upon the increasing thickness and therefore stiffness of a paperboard, reasons the Compression Gap should increase as the caliper increases. ***See illustration 8.22***. As you can see in ***illustration 8.22***, there is a different calculation for Virgin Fiber, than Recycled Fiber. This is based on experience, which demonstrates recycled material is more malleable and less stiff, than the equivalent caliper of virgin fiber paperboard.

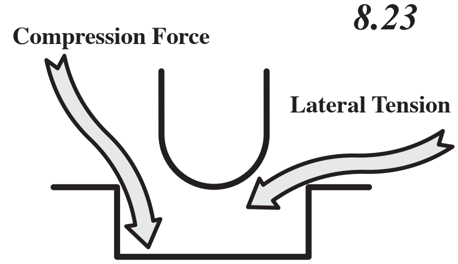
8.22

Compression Gap Calculation		
Caliper	**Virgin**	**Recycle**
0.010” - 0.014”	**0.001”**	**0.000”**
0.015” - 0.020”	**0.002”**	**0.001”**
0.021” - 0.025”	**0.003”**	**0.002”**
0.026” - 0.030”	**0.004”**	**0.003”**
0.031” - 0.035”	**0.005”**	**0.004”**
0.036” - 0.040”	**0.006”**	**0.005”**

The bottom line? The consensus is a Compression Gap in creasing provides multiple benefits, and is essential. However, whether you integrate a fixed gap into your crease tool calculation or you adjust the gap based upon the caliper of the material, it is a matter of personal experience.

It is not unusual to see both methods employed based upon the characteristics of the paperboard being converted.

8.23



The Channel Width

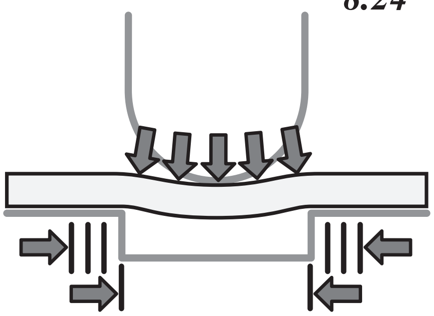
The goal of Reduced Bead Creasing is to produce a smaller, more evenly delaminated bead, which is flexible and elastic as the panels are folded. This requires concentrating the delamination force in a narrower band, and utilizing a Vertical Compressive Force for shearing, rather than the standard Lateral Draw Stress method of shearing. ***See illustration 8.23***.

This requires a narrower channel, proportionate to the caliper of the paperboard, and it requires a thicker male tool to more evenly distribute the delamination force. ***See***

  Contact Kevin - kevin@dieinfo.com

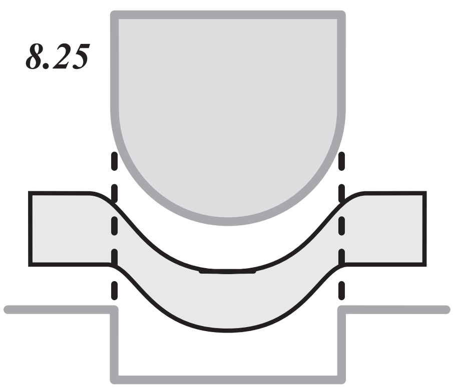
illustration 8.24.

8.24



What is different from the standard approach, is the relationship between the width of the female tool channel and the thickness of the male tool. There are many instances in Reduced Bead Creasing methods where the pointage of the crease is the same or is larger than the width of the female channel. ***See illustration 8.25***.

8.25



This is very different from standard creasing and the advantages of this approach are well proven.

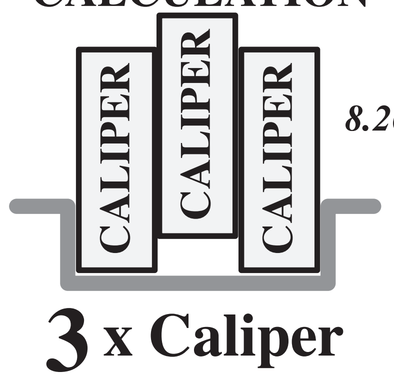
So what are the benefits of setting the male and female tools so that it is proportionate to the caliper of the paperboard, and narrower than the traditional calculation?

There are 6 reasons to reduce the width of the female crease tool channel. These are as follows:

1: Generate a smaller, more evenly delaminated crease bead.
2: Base the bead parameters on the caliper of the paperboard.
3: Change from predominantly Lateral Draw to Compressive Force for crease formation.
4: Increase crease formation consistency by reducing tool wear.
5: Generate a more effective folding bead.
6: Improve control and consistency of folding performance.

So how do we accomplish this?

REDUCED BEAD CHANNEL WIDTH CALCULATION



8.26

In principle the basis for Reduced Bead Creasing tool design is to calculate the width of the channel soley on the caliper of the paperboard. This calculation multiplies the caliper of the paperboard times three, to define the width of the female tool crease channel. ***See illustration 8.26***. The words in principle are selected carefully because as individuals and organizations gain experience in designing reduced bead creasing tools they develop alternative, and equally valid variations on the basic approach to multiplying the caliper by three.

However, some will choose to multiply by 2.9 times the caliper through the entire paperboard range; others may choose to multiply by 3.0 through every range of caliper: and others will choose a sliding scale with a different multiplier, for each caliper range. See illustration 8.27.

All of these methods are valid if they achieve the quality of crease/ bead formation and the folding performance, which meets or exceeds customer expectation. The formulation DieInfo recommends starting with, is based upon multiplying the paperboard caliper by 3 for the entire range of calipers from 0.010” to 0.035.” This is the basis for the charts at the end of this chapter.

Remember, folding performance is the key to what is right and/or what is wrong!

The selection of crease tool parameters is solely judged on folding performance, and in spite of every argument to the contrary, making an assessment of folding performance is always subjective.

Use the specified recommendations as a start point and not an end point!

Having discussed the basis for calculating the width of the channel, it is necessary to consider a key characteristic of paperboard. ***Grain Direction***.

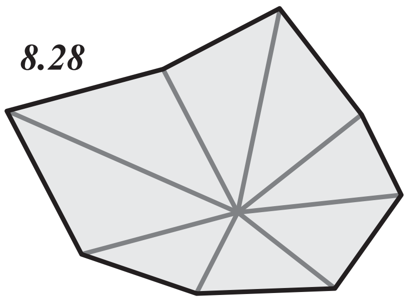
8.27

POTENTIAL Channel Width Calculation

Caliper	DieInfo	Option 1	Option 2
0.010” - 0.014”	3 times	2.9 times	3.1 times
0.015” - 0.020”	3 times	2.9 times	3.0 times
0.021” - 0.025”	3 times	2.9 times	2.9 times
0.026” - 0.030”	3 times	2.9 times	2.8 times
0.031” - 0.035”	3 times	2.9 times	2.7 times
0.036” - 0.040”	3 times	2.9 times	2.6 times

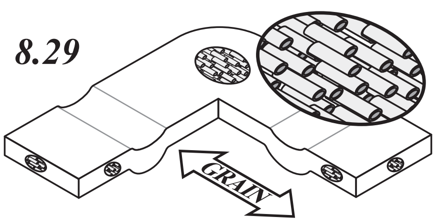
The goal of the papermaker is to create a material which has ***Bidirectional Folding Properties***. This simply means forming a crease in any direction would require identical parameters and the subsequent folding force of every crease would be the same! ***See illustration 8.28***.

8.28



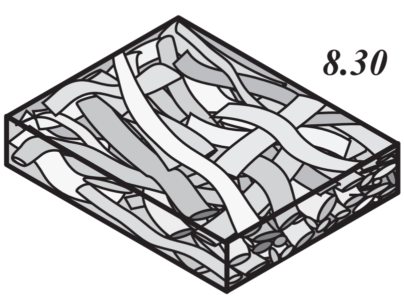
You may have noticed in this manual, those illustrations, which depict grain direction, do so with representation of perfectly formed fibers orientated at right angles or parallel to one another. ***See illustration 8.29***.

8.29

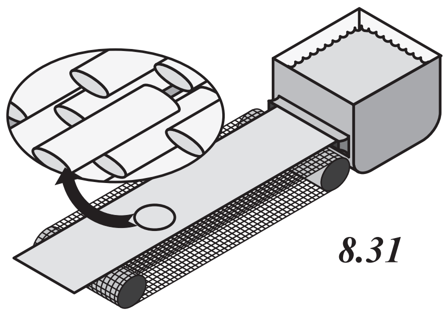


As we have seen earlier, the reality of grain direction is a great deal more dynamic and unpredictable. ***See illustration 8.30.***

8.30



The goal of the papermaker is to manipulate the pulp in the slurry as it is extruded onto the moving wire, and to shake and vibrate the wire to induce the fiber to settle and bond in a more random pattern and less oriented in the papermaking machine direction. ***See illustration 8.31***.

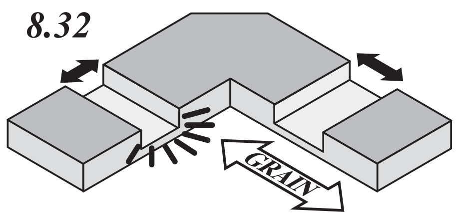


8.31

However, the practical reality is all paperboard has a detectable grain direction, and the differences between cross grain folding stiffness and parallel grain folding stiffness can be relatively small or they can be significant.

Adding to this issue is the function of cross web shrinkage as the pulp stream is drained, pressed, and heated, in the papermaking process. In practice paperboard becomes more elastic as it is shrunk, and the increased elasticity is parallel to the grain.

8.32



As elasticity is the enemy of delamination, it is necessary to make the parallel grain channels narrower than the cross grain channels. ***See illustration 8.32***.

It is also important to factor in the differences between Virgin Fiber Paperboard parallel grain creases and Recycled Fiber Paperboard parallel grain creases. The differences in cross grain and parallel grain folding stiffness between a Virgin Fiber paperboard and a Recycled paperboard can be quite different, therefore it is necessary to treat the two materials differently, with regard to the channel grain adjustment. ***See illustration 8.33***. As you can see we are recommending a graduated adjustment cased upon a caliper range.

However, as with all of the recommendations we make,

8.33

Grain Allowance Calculation

Caliper	Virgin	Recycle
0.010” - 0.014”	0.000”	0.002”
0.015” - 0.020”	0.002”	0.004”
0.021” - 0.025”	0.004”	0.006”
0.026” - 0.030”	0.006”	0.008”
0.031” - 0.035”	0.008”	0.010”
0.036” - 0.040”	0.010”	0.012”

this chart is a suggested starting point. For example, if you are diecutting on sheet fed platen press with a separate printing function, as opposed to a Web Fed Platen Press with In-line Printing, the grain allowance adjustment could be quite different.

Because of residual drying heat on the Web Fed Press and the speed of processing, it may be necessary to make the parallel grain channels significantly narrower than if the job were running on a platen diecutter.

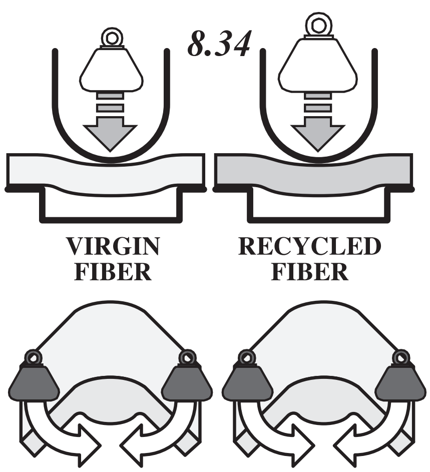
In other words, the adjustment between cross grain and parallel grain channel width is an important factor in tool design, but the difference between the cross grain channel width and the parallel grain channel width must be predicated on the specific characteristics of the paperboard being converted!

So what other factors must be included in the channel width calculation?

The final issue requires categorizing the material to be converted/creased as Virgin Fiber or Reduced Fiber.

To reiterate an obvious warning, it is dangerous to categorize any material by a single attribute, however, for the basis of calculating channel widths, there are key characteristics, which can be assumed to be typical of each category of paperboard. In terms of creasing, Virgin Fiber Paperboard is generally a lower density, stiffer material, compared to Recycled Fiber, which is generally a higher density, more malleable material.

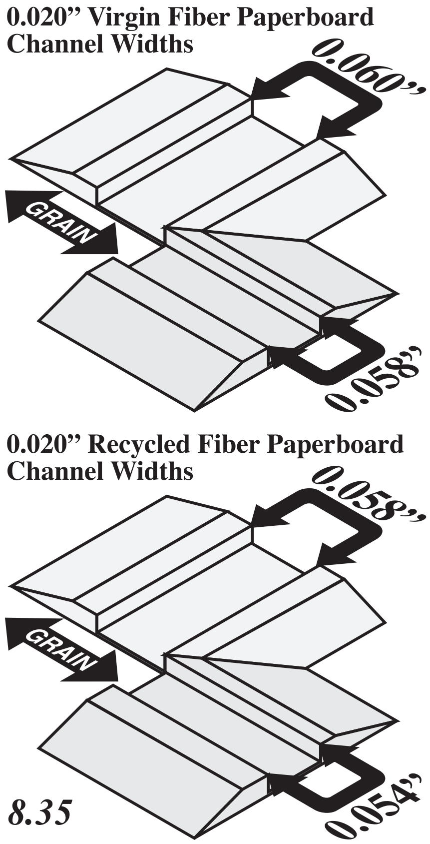
In terms of creasing this means it is necessary to apply greater shearing force/pressure to an identical crease in Recycled Paperboard, than an identical crease in Virgin Paperboard. ***See illustration 8.34***.



8.34

How do we handle this variable in the Reduced Bead Creasing tool calculation?

The most common approach to this problem is to make an often inconsistently applied decision to reduce the width of the Recycled Paperboard channels in comparison to the channels used for Virgin Fiber of the same caliper. In practice if this works then that is fine. However, in Reduced Bead Creasing we use a simple and consistently applied formula.



8.35

For example, if we were calculating the channel width for a Virgin Fiber paperboard of 0.020” in thickness, the calculation of three times the caliper, would give a cross grain channel width of 0.060”. And using the grain allowance chart the parallel grain channel width would be 0.058”.

However, if we were using Recycled Paperboard we would use the parallel grain channel width from the Virgin Fiber calculation, which is 0.058,” for the cross grain Recycled Fiber Channels. And using the grain allowance chart we would note that in the range of caliper of 0.015” to 0.020” the grain allowance for Recycled Paperboard is 0.004.” Therefore, we would subtract this from 0.058” to give a parallel channel width of 0.054”. ***See illustration 8.35***.

This recommendation as with all others is a guideline for developing your own approach. However, this recommendation is based upon practical experience, successful problem solving projects, and from feedback from users.

In the first part of this chapter based upon specification of Reduced Bead Creasing we have focussed upon the four primary ingredients of tool design. These were:

- ✓ ***The Pointage of the Crease Rule***
- ✓ ***The Thickness of the Counter/ Matrix***
- ✓ ***The Compression Gap***
- ✓ ***The Channel Width***

Next we need to explain the different formulas and provide the Crease Specification Charts we use.

Then it will be a benefit to work through some practical examples.

Finally, we will provide a method of a simple on-press testing system, which can be integrated into the production cycle, with minimal disruption. So the next four sections are:

- ▶ ***Specification Assumptions***
- ▶ ***Crease Specification Charts***
- ▶ ***Calculation Examples***
- ▶ ***Crease & Folding Research & Development***

Specification Assumptions

The quote I often hear about myself is that he has 40 plus years of experience in the converting process. The great problem with this, is it is one year, repeated 40 times!

Every specification of creasing or the design of any diecutting tooling may be based upon years of experience and accumulated knowledge, but it is still a subjective process.

I thought it would be helpful to collect some of the key charts I use to determine Reduced Bead settings on a single page, so that you can more easily develop your own alternatives.

For example, it is necessary to determine at which caliper, the change is made from one pointage to the next highest. ***Illustration 8.36*** shows a traditional breakdown for changing the pointage for one type of paperboard. If you compare this to ***illustration 8.37***, which is the pointage I have used in the Reduced Bead Specification, you can see the significant differences in this approach.

PAPERBOARD CLASSIFICATION : Solid Unbleached Sulphate (SUS)			
Caliper Range			Pointage
0.010	- 0.012	=	1+1/2 Pt
0.013	- 0.020	=	2 Pt
0.021	- 0.027	=	3 Pt
0.028	- 0.035	=	4 Pt
0.036	- 0.045	=	6 Pt
0.046	- 0.065	=	8 Pt

Example Only

8.36

8.37

CALIPER	Against Grain	With Grain
0.011 - 0.014	3-Point	3-Point
0.015 - 0.019	3-Point	3-Point
0.020 - 0.024	4-Point	3-Point
0.025 - 0.029	4-Point	4-Point
0.030 - 0.035	6-Point	4-Point

Female Crease Tool Thickness
0.010" - 0.014" = 90% - Caliper
0.015" - 0.020" = 85% - Caliper
0.021" - 0.025" = 80% - Caliper
0.026" - 0.030" = 75% - Caliper
0.031" - 0.035" = 70% - Caliper
0.036" - 0.040" = 65% - Caliper

8.38

What thickness of counter or matrix would be most effective? ***Illustration 8.38*** shows the basic guidelines you could follow in setting up your own specification or in modifying the specification in the charts to follow.

8.39

POTENTIAL Channel Width Calculation			
Caliper	DieInfo	Option 1	Option 2
0.010" - 0.014"	3 times	2.9 times	3.1 times
0.015" - 0.020"	3 times	2.9 times	3.0 times
0.021" - 0.025"	3 times	2.9 times	2.9 times
0.026" - 0.030"	3 times	2.9 times	2.8 times
0.031" - 0.035"	3 times	2.9 times	2.7 times
0.036" - 0.040"	3 times	2.9 times	2.6 times

Illustration 8.39 shows three of the many alternative methods calculating channel width used throughout the industry, and it includes the method used in the charts in the following pages.

One of the disciplines in crease specification is in determining the degree to which the cross grain crease channel is reduced to accommodate parallel grain folding. ***Illustration 8.40*** shows the method used in the Reduced Bead specification charts, however, as with every other element of these recommendations it should be subject to your own knowledge and experience, and changed as the result of pragmatic experience.

The final chart, ***see illustration 8.41***, specifies the Compression Gap in creasing. This may be a new setting, however, as with the others, this is a important design decision, which will have an impact on crease formation and on folding performance.

The goal of this page is to show how the settings for each key attribute were organized and cross referenced. In addition, by collecting some of the key parameters together it will be easier to evaluate these settings as you review the charts.

These recommendations are effective and practical, but you must be willing and open to experimentation. It is vital to keep an open mind and to make changes and upgrades, based upon your own and your colleagues experience.

8.40

Compression Gap Calculation		
Caliper	Virgin	Recycle
0.010" - 0.014"	0.001"	0.000"
0.015" - 0.020"	0.002"	0.001"
0.021" - 0.025"	0.003"	0.002"
0.026" - 0.030"	0.004"	0.003"
0.031" - 0.035"	0.005"	0.004"
0.036" - 0.040"	0.006"	0.005"

8.41

Grain Allowance Calculation		
Caliper	Virgin	Recycle
0.010" - 0.014"	0.000"	0.002"
0.015" - 0.020"	0.002"	0.004"
0.021" - 0.025"	0.004"	0.006"
0.026" - 0.030"	0.006"	0.008"
0.031" - 0.035"	0.008"	0.010"
0.036" - 0.040"	0.010"	0.012"

Caliper Range 0.011" - 0.015" 0.279 mm - 0.00 mm	Channel Width AG	Channel Width WG	Crease Point AG	Crease Point WG	Crease Height AG	Crease Height WG	Counter Thickness	Compress Gap AG	Compress Gap WG
0.011" - 0.279 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.033	0.033	3-Point	3-Point	0.926	0.926	0.010	0.001	0.001
	0.838	0.838	3-Point	3-Point	23.520	23.520	0.254	0.025	0.025
Reduced Bead Recycled Fiber	0.033	0.031	3-Point	3-Point	0.927	0.927	0.010		
	0.838	0.787	3-Point	3-Point	23.545	23.545	0.254		
Standard US Calculation	0.050	0.050	2-Point	2-Point	0.926	0.926	0.011		
	1.270	1.270	2-Point	2-Point	23.520	23.520	0.279		
Calculation 1.25 Multiple	0.042	0.042	2-Point	2-Point	0.926	0.926	0.011		
	1.060	1.060	2-Point	2-Point	23.520	23.520	0.279		
Calculation 1.50 Multiple	0.045	0.045	2-Point	2-Point	0.926	0.926	0.011		
	1.143	1.143	2-Point	2-Point	23.520	23.520	0.279		
Calculation 1.75 Multiple	0.047	0.047	2-Point	2-Point	0.926	0.926	0.011		
	1.200	1.200	2-Point	2-Point	23.520	23.520	0.279		
0.012" - 0.304 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.036	0.036	3-Point	3-Point	0.926	0.926	0.010	0.001	0.001
	0.914	0.914	3-Point	3-Point	23.520	23.520	0.254	0.025	0.025
Reduced Bead Recycled Fiber	0.036	0.034	3-Point	3-Point	0.927	0.927	0.010		
	0.914	0.864	3-Point	3-Point	23.545	23.545	0.254		
Standard US Calculation	0.052	0.052	2-Point	2-Point	0.926	0.926	0.010		
	1.321	1.321	2-Point	2-Point	23.520	23.520	0.254		
Calculation 1.25 Multiple	0.043	0.043	2-Point	2-Point	0.927	0.927	0.010		
	1.092	1.092	2-Point	2-Point	23.545	23.545	0.254		
Calculation 1.50 Multiple	0.046	0.046	2-Point	2-Point	0.927	0.927	0.010		
	1.168	1.168	2-Point	2-Point	23.545	23.545	0.254		
Calculation 1.75 Multiple	0.049	0.049	2-Point	2-Point	0.927	0.927	0.010		
	1.245	1.245	2-Point	2-Point	23.545	23.545	0.254		
0.013" - 0.330 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.039	0.039	3-Point	3-Point	0.924	0.924	0.012	0.001	0.001
	0.991	0.991	3-Point	3-Point	23.724	23.724	0.305	0.025	0.025
Reduced Bead Recycled Fiber	0.039	0.037	3-Point	3-Point	0.925	0.925	0.012		
	0.991	0.940	3-Point	3-Point	23.749	23.749	0.305		
Standard US Calculation	0.054	0.054	2-Point	2-Point	0.924	0.924	0.013		
	1.372	1.372	2-Point	2-Point	0.000	0.000	0.330		
Calculation 1.25 Multiple	0.044	0.044	2-Point	2-Point	0.924	0.924	0.013		
	1.124	1.124	2-Point	2-Point	23.724	23.724	0.330		
Calculation 1.50 Multiple	0.048	0.048	2-Point	2-Point	0.924	0.924	0.013		
	1.207	1.207	2-Point	2-Point	23.724	23.724	0.330		
Calculation 1.75 Multiple	0.051	0.051	2-Point	2-Point	0.924	0.924	0.013		
	1.289	1.289	2-Point	2-Point	23.724	23.724	0.330		
0.014" - 0.355 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.042	0.042	3-Point	3-Point	0.924	0.924	0.012	0.001	0.001
	1.067	1.067	3-Point	3-Point	23.724	23.724	0.305	0.025	0.025
Reduced Bead Recycled Fiber	0.042	0.040	3-Point	3-Point	0.925	0.925	0.012		
	1.067	1.016	3-Point	3-Point	23.749	23.749	0.305		
Standard US Calculation	0.056	0.056	2-Point	2-Point	0.923	0.923	0.014		
	1.422	1.422	2-Point	2-Point	23.444	23.444	0.356		
Calculation 1.25 Multiple	0.046	0.046	2-Point	2-Point	0.923	0.923	0.014		
	1.156	1.156	2-Point	2-Point	23.444	23.444	0.356		
Calculation 1.50 Multiple	0.049	0.049	2-Point	2-Point	0.923	0.923	0.014		
	1.245	1.245	2-Point	2-Point	23.444	23.444	0.356		
Calculation 1.75 Multiple	0.053	0.053	2-Point	2-Point	0.923	0.923	0.014		
	1.334	1.334	2-Point	2-Point	23.444	23.444	0.356		
0.015" - 0.381 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.045	0.043	3-Point	3-Point	0.923	0.923	0.012	0.002	0.002
	1.143	1.143	3-Point	3-Point	23.444	23.444	0.305	0.051	0.051
Reduced Bead Recycled Fiber	0.043	0.039	3-Point	3-Point	0.924	0.924	0.012	0.001	0.001
	1.143	0.991	3-Point	3-Point	23.724	23.724	0.305	0.025	0.025
Standard US Calculation	0.058	0.054	2-Point	2-Point	0.922	0.922	0.015		
	1.473	1.372	2-Point	2-Point	23.419	23.419	0.381		
Calculation 1.25 Multiple	0.047	0.047	2-Point	2-Point	0.922	0.922	0.015		
	1.187	1.187	2-Point	2-Point	23.419	23.419	0.381		
Calculation 1.50 Multiple	0.051	0.051	2-Point	2-Point	0.922	0.922	0.015		
	1.283	1.283	2-Point	2-Point	23.419	23.419	0.381		
Calculation 1.75 Multiple	0.054	0.054	2-Point	2-Point	0.922	0.922	0.015		
	1.372	1.372	2-Point	2-Point	23.419	23.419	0.381		

Caliper Range 0.016" - 0.020" 0.406 mm - 0.508 mm	Channel Width AG	Channel Width WG	Crease Point AG	Crease Point WG	Crease Height AG	Crease Height WG	Counter Thickness	Compress Gap AG	Compress Gap WG
0.016" - 0.406 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.048	0.046	3-Point	3-Point	0.921	0.921	0.014	0.002	0.002
	1.219	1.168	3-Point	3-Point	23.393	23.393	0.356	0.051	0.051
Reduced Bead Recycled Fiber	0.046	0.042	3-Point	3-Point	0.922	0.922	0.014	0.001	0.001
	1.168	1.067	3-Point	3-Point	23.419	23.419	0.356	0.025	0.025
Standard US Calculation	0.060	0.058	2-Point	2-Point	0.921	0.921	0.016		
	1.524	1.473	2-Point	2-Point	23.393	23.393	0.406		
Calculation 1.25 Multiple	0.048	0.044	2-Point	2-Point	0.921	0.921	0.016		
	1.219	1.118	2-Point	2-Point	23.393	23.393	0.406		
Calculation 1.50 Multiple	0.052	0.048	2-Point	2-Point	0.921	0.921	0.016		
	1.321	1.219	2-Point	2-Point	23.393	23.393	0.406		
Calculation 1.75 Multiple	0.056	0.052	2-Point	2-Point	0.921	0.921	0.016		
	1.422	1.321	2-Point	2-Point	23.393	23.393	0.406		
0.017" - 0.432 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.051	0.049	3-Point	2-Point	0.921	0.921	0.014	0.002	0.002
	1.295	1.245	3-Point	3-Point	23.393	23.393	0.356	0.051	0.051
Reduced Bead Recycled Fiber	0.049	0.045	3-Point	3-Point	0.922	0.922	0.014	0.001	0.001
	1.245	1.143	3-Point	3-Point	23.419	23.419	0.356	0.025	0.025
Standard US Calculation	0.062	0.058	2-Point	2-Point	0.920	0.920	0.017		
	1.575	1.473	2-Point	2-Point	23.368	23.368	0.432		
Calculation 1.25 Multiple	0.049	0.045	2-Point	2-Point	0.920	0.920	0.017		
	1.245	1.143	2-Point	2-Point	23.368	23.368	0.432		
Calculation 1.50 Multiple	0.054	0.050	2-Point	2-Point	0.920	0.920	0.017		
	1.359	1.270	2-Point	2-Point	23.368	23.368	0.432		
Calculation 1.75 Multiple	0.058	0.054	2-Point	2-Point	0.920	0.920	0.017		
	1.473	1.359	2-Point	2-Point	23.368	23.368	0.432		
0.018" - 0.457 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.054	0.052	3-Point	3-Point	0.920	0.920	0.015	0.002	0.002
	1.359	1.321	3-Point	3-Point	23.368	23.368	0.381	0.051	0.051
Reduced Bead Recycled Fiber	0.052	0.048	3-Point	3-Point	0.921	0.921	0.015	0.001	0.001
	1.321	1.219	3-Point	3-Point	23.393	23.393	0.381	0.025	0.025
Standard US Calculation	0.078	0.074	3-Point	3-Point	0.919	0.919	0.018		
	1.981	1.880	3-Point	3-Point	23.343	23.343	0.457		
Calculation 1.25 Multiple	0.065	0.061	3-Point	3-Point	0.919	0.919	0.018		
	1.638	1.549	3-Point	3-Point	23.343	23.343	0.457		
Calculation 1.50 Multiple	0.069	0.065	3-Point	3-Point	0.919	0.919	0.018		
	1.753	1.638	3-Point	3-Point	23.343	23.343	0.457		
Calculation 1.75 Multiple	0.074	0.070	3-Point	3-Point	0.919	0.919	0.018		
	1.880	1.778	3-Point	3-Point	23.343	23.343	0.457		
0.019" - 0.483 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.057	0.055	3-Point	3-Point	0.920	0.920	0.015	0.002	0.002
	1.448	1.397	3-Point	3-Point	23.368	23.368	0.381	0.051	0.051
Reduced Bead Recycled Fiber	0.055	0.051	3-Point	3-Point	0.921	0.921	0.015	0.001	0.001
	1.397	1.295	3-Point	3-Point	23.393	23.393	0.381	0.025	0.025
Standard US Calculation	0.080	0.076	3-Point	3-Point	0.918	0.918	0.019		
	2.032	1.930	3-Point	3-Point	23.317	23.317	0.483		
Calculation 1.25 Multiple	0.066	0.062	3-Point	3-Point	0.918	0.918	0.019		
	1.670	1.575	3-Point	3-Point	23.317	23.317	0.483		
Calculation 1.50 Multiple	0.071	0.067	3-Point	3-Point	0.918	0.918	0.019		
	1.791	1.702	3-Point	3-Point	23.317	23.317	0.483		
Calculation 1.75 Multiple	0.075	0.071	3-Point	3-Point	0.918	0.918	0.019		
	1.905	1.791	3-Point	3-Point	23.317	23.317	0.483		
0.020" - 0.508 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.060	0.058	4-Point	3-Point	0.919	0.919	0.016	0.002	0.002
	1.524	1.473	4-Point	3-Point	23.343	23.343	0.406	0.051	0.051
Reduced Bead Recycled Fiber	0.058	0.054	4-Point	3-Point	0.920	0.920	0.016	0.001	0.001
	1.473	1.372	4-Point	3-Point	23.368	23.368	0.406	0.025	0.025
Standard US Calculation	0.068	0.064	3-Point	3-Point	0.917	0.917	0.020		
	1.727	1.626	3-Point	3-Point	23.292	23.292	0.508		
Calculation 1.25 Multiple	0.067	0.063	3-Point	3-Point	0.917	0.917	0.020		
	1.702	1.600	3-Point	3-Point	23.292	23.292	0.508		
Calculation 1.50 Multiple	0.072	0.068	3-Point	3-Point	0.917	0.917	0.020		
	1.829	1.727	3-Point	3-Point	23.292	23.292	0.508		
Calculation 1.75 Multiple	0.077	0.073	3-Point	3-Point	0.917	0.917	0.020		
	1.956	1.854	3-Point	3-Point	23.292	23.292	0.508		

Caliper Range 0.021" - 0.025" 0.533 mm - 0.635 mm	Channel Width AG	Channel Width WG	Crease Point AG	Crease Point WG	Crease Height AG	Crease Height WG	Counter Thickness	Compress Gap AG	Compress Gap WG
0.021" - 0.533 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.063	0.059	4-Point	3-Point	0.916	0.916	0.018	0.003	0.003
	1.600	1.499	4-Point	3-Point	23.266	23.266	0.457	0.076	0.076
Reduced Bead Recycled Fiber	0.059	0.053	4-Point	3-Point	0.917	0.917	0.018	0.002	0.002
	1.499	1.346	4-Point	3-Point	23.292	23.292	0.457	0.051	0.051
Standard US Calculation	0.084	0.082	3-Point	3-Point	0.916	0.916	0.021		
	2.134	2.083	3-Point	3-Point	23.266	23.266	0.533		
Calculation 1.25 Multiple	0.068	0.064	3-Point	3-Point	0.916	0.916	0.021		
	1.727	1.626	3-Point	3-Point	23.266	23.266	0.533		
Calculation 1.50 Multiple	0.074	0.070	3-Point	3-Point	0.916	0.916	0.021		
	1.880	1.778	3-Point	3-Point	23.266	23.266	0.533		
Calculation 1.75 Multiple	0.079	0.075	3-Point	3-Point	0.916	0.916	0.021		
	2.007	1.905	3-Point	3-Point	23.266	23.266	0.533		
0.022" - 0.559 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.066	0.062	4-Point	3-Point	0.916	0.916	0.018	0.003	0.003
	1.616	1.575	4-Point	3-Point	23.266	23.266	0.457	0.076	0.076
Reduced Bead Recycled Fiber	0.062	0.056	4-Point	3-Point	0.917	0.917	0.018	0.002	0.002
	1.575	1.422	4-Point	3-Point	23.292	23.292	0.457	0.051	0.051
Standard US Calculation	0.086	0.082	3-Point	3-Point	0.915	0.915	0.022		
	2.184	2.083	3-Point	3-Point	23.241	23.241	0.559		
Calculation 1.25 Multiple	0.070	0.066	3-Point	3-Point	0.915	0.915	0.022		
	1.766	1.676	3-Point	3-Point	23.241	23.241	0.559		
Calculation 1.50 Multiple	0.075	0.071	3-Point	3-Point	0.915	0.915	0.022		
	1.905	1.803	3-Point	3-Point	23.241	23.241	0.559		
Calculation 1.75 Multiple	0.081	0.077	3-Point	3-Point	0.915	0.915	0.022		
	2.045	1.956	3-Point	3-Point	23.241	23.241	0.559		
0.023" - 0.584 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.069	0.065	4-Point	3-Point	0.914	0.914	0.020	0.003	0.003
	1.753	1.651	4-Point	3-Point	23.216	23.216	0.508	0.076	0.076
Reduced Bead Recycled Fiber	0.065	0.059	4-Point	3-Point	0.915	0.915	0.020	0.002	0.002
	1.651	1.499	4-Point	3-Point	23.241	23.241	0.508	0.051	0.051
Standard US Calculation	0.088	0.084	3-Point	3-Point	0.914	0.914	0.023		
	2.235	2.134	3-Point	3-Point	23.216	23.216	0.584		
Calculation 1.25 Multiple	0.071	0.067	3-Point	3-Point	0.914	0.914	0.023		
	1,797	1.702	3-Point	3-Point	23.216	23.216	0.584		
Calculation 1.50 Multiple	0.077	0.073	3-Point	3-Point	0.914	0.914	0.023		
	1.956	1.854	3-Point	3-Point	23.216	23.216	0.584		
Calculation 1.75 Multiple	0.082	0.078	3-Point	3-Point	0.914	0.914	0.023		
	2.083	1.981	3-Point	3-Point	23.216	23.216	0.584		
0.024" - 0.610 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.072	0.068	4-Point	3-Point	0.914	0.914	0.020	0.003	0.003
	1.829	1.727	4-Point	3-Point	23.216	23.216	0.508	0.076	0.076
Reduced Bead Recycled Fiber	0.068	0.062	4-Point	3-Point	0.915	0.915	0.020	0.002	0.002
	1.727	1.575	4-Point	3-Point	23.241	23.241	0.508	0.051	0.051
Standard US Calculation	0.090	0.086	3-Point	3-Point	0.913	0.913	0.024		
	2.286	2.184	3-Point	3-Point	23.190	23.190	0.610		
Calculation 1.25 Multiple	0.072	0.068	3-Point	3-Point	0.913	0.913	0.024		
	1.829	1.727	3-Point	3-Point	23.190	23.190	0.610		
Calculation 1.50 Multiple	0.078	0.074	3-Point	3-Point	0.913	0.913	0.024		
	1.981	1.880	3-Point	3-Point	23.190	23.19	0.610		
Calculation 1.75 Multiple	0.084	0.080	3-Point	3-Point	0.913	0.913	0.024		
	2.134	2.032	3-Point	3-Point	23.190	23.190	0.610		
0.025" - 0.635 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.075	0.071	4-Point	4-Point	0.914	0.914	0.020	0.003	0.003
	1.905	1.803	4-Point	4-Point	23.216	23.216	0.508	0.076	0.076
Reduced Bead Recycled Fiber	0.071	0.065	4-Point	4-Point	0.915	0.915	0.020	0.002	0.002
	1.803	1.651	4-Point	4-Point	23.241	23.241	0.508	0.051	0.051
Standard US Calculation	0.092	0.088	3-Point	3-Point	0.912	0.912	0.025		
	2.337	2.235	3-Point	3-Point	23.165	23.165	0.635		
Calculation 1.25 Multiple	0.073	0.069	3-Point	3-Point	0.912	0.912	0.025		
	1.854	1.753	3-Point	3-Point	23.165	23.165	0.635		
Calculation 1.50 Multiple	0.080	0.078	3-Point	3-Point	0.912	0.912	0.025		
	2.032	1.981	3-Point	3-Point	23.165	23.165	0.635		
Calculation 1.75 Multiple	0.086	0.082	3-Point	3-Point	0.912	0.912	0.025		
	2.184	2.083	3-Point	3-Point	23.165	23.165	0.635		

Caliper Range 0.026" - 0.030" 0.660 mm - 0.762 mm	Channel Width AG	Channel Width WG	Crease Point AG	Crease Point WG	Crease Height AG	Crease Height WG	Counter Thickness	Compress Gap AG	Compress Gap WG
0.026" - 0.660 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.078	0.072	4-Point	4-Point	0.913	0.913	0.020	0.004	0.004
	1.981	1.829	4-Point	4-Point	23.190	23.190	0.508	0.102	0.102
Reduced Bead Recycled Fiber	0.072	0.066	4-Point	4-Point	0.913	0.913	0.020	0.003	0.003
	1.829	1.676	4-Point	4-Point	23.190	23.190	0.508	0.076	0.076
Standard US Calculation	0.108	0.102	4-Point	3-Point	0.911	0.911	0.026		
	2.243	2.591	4-Point	3-Point	23.139	23.139	0.660		
Calculation 1.25 Multiple	0.089	0.083	4-Point	3-Point	0.911	0.911	0.026		
	2.248	2.108	4-Point	3-Point	23.139	23.139	0.660		
Calculation 1.50 Multiple	0.095	0.089	4-Point	3-Point	0.911	0.911	0.026		
	2.413	2.248	4-Point	3-Point	23.139	23.139	0.660		
Calculation 1.75 Multiple	0.102	0.096	4-Point	3-Point	0.911	0.911	0.026		
	2.578	2.438	4-Point	3-Point	23.139	23.139	0.660		
0.027" - 0.686 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.081	0.075	4-Point	4-Point	0.913	0.913	0.020	0.004	0.004
	2.057	1.905	4-Point	4-Point	23.190	23.190	0.508	0.102	0.102
Reduced Bead Recycled Fiber	0.075	0.067	4-Point	4-Point	0.913	0.913	0.020	0.003	0.003
	1.905	1.702	4-Point	4-Point	23.190	23.190	0.508	0.076	0.076
Standard US Calculation	0.110	0.104	4-Point	3-Point	0.910	0.910	0.027		
	2.794	2.642	4-Point	3-Point	23.114	23.114	0.686		
Calculation 1.25 Multiple	0.090	0.084	4-Point	3-Point	0.910	0.910	0.027		
	2.280	2.134	4-Point	3-Point	23.114	23.114	0.686		
Calculation 1.50 Multiple	0.097	0.091	4-Point	3-Point	0.910	0.910	0.027		
	2.451	2.311	4-Point	3-Point	23.114	23.114	0.686		
Calculation 1.75 Multiple	0.103	0.097	4-Point	3-Point	0.910	0.910	0.027		
	2.616	2.451	4-Point	3-Point	23.114	23.114	0.686		
0.028" - 0.711 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.084	0.078	4-Point	4-Point	0.911	0.911	0.022	0.004	0.004
	2.134	1.981	4-Point	4-Point	23.139	23.139	0.559	0.102	0.102
Reduced Bead Recycled Fiber	0.078	0.070	4-Point	4-Point	0.911	0.911	0.022	0.003	0.003
	1.981	1.778	4-Point	4-Point	23.139	23.139	0.559	0.076	0.076
Standard US Calculation	0.112	0.106	4-Point	3-Point	0.909	0.909	0.028		
	2.845	2.692	4-Point	3-Point	23.089	23.089	0.711		
Calculation 1.25 Multiple	0.091	0.085	4-Point	3-Point	0.909	0.909	0.028		
	2.311	2.159	4-Point	3-Point	23.089	23.089	0.711		
Calculation 1.50 Multiple	0.098	0.092	4-Point	3-Point	0.909	0.909	0.028		
	2.489	2.337	4-Point	3-Point	23.089	23.089	0.711		
Calculation 1.75 Multiple	0.105	0.099	4-Point	3-Point	0.909	0.909	0.028		
	2.667	2.515	4-Point	3-Point	23.089	23.089	0.711		
0.029" - 0.737 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.087	0.081	4-Point	4-Point	0.911	0.911	0.022	0.004	0.004
	2.210	2.057	4-Point	4-Point	23.139	23.139	0.559	0.102	0.102
Reduced Bead Recycled Fiber	0.081	0.073	4-Point	4-Point	0.911	0.911	0.022	0.003	0.003
	2.057	1.854	4-Point	4-Point	23.139	23.139	0.559	0.076	0.076
Standard US Calculation	0.114	0.108	4-Point	4-Point	0.909	0.909	0.029		
	2.896	2.743	4-Point	4-Point	23.089	23.089	0.737		
Calculation 1.25 Multiple	0.092	0.086	4-Point	4-Point	0.909	0.909	0.029		
	2.343	2.184	4-Point	4-Point	23.089	23.089	0.737		
Calculation 1.50 Multiple	0.100	0.094	4-Point	4-Point	0.909	0.909	0.029		
	2.540	2.388	4-Point	4-Point	23.089	23.089	0.737		
Calculation 1.75 Multiple	0.107	0.101	4-Point	4-Point	0.909	0.909	0.029		
	2.718	2.565	4-Point	4-Point	23.089	23.089	0.737		
0.030" - 0.762 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.090	0.084	6-Point	4-Point	0.909	0.909	0.024	0.004	0.004
	2.286	2.134	6-Point	4-Point	23.089	23.089	0.610	0.102	0.102
Reduced Bead Recycled Fiber	0.084	0.076	6-Point	4-Point	0.909	0.909	0.024	0.003	0.003
	2.134	1.930	6-Point	4-Point	23.089	23.089	0.610	0.076	0.076
Standard US Calculation	0.116	0.110	4-Point	4-Point	0.907	0.907	0.030		
	2.946	2.794	4-Point	4-Point	23.038	23.038	0.762		
Calculation 1.25 Multiple	0.094	0.088	4-Point	4-Point	0.907	0.907	0.030		
	2.388	2.235	4-Point	4-Point	23.038	23.038	0.762		
Calculation 1.50 Multiple	0.101	0.095	4-Point	4-Point	0.907	0.907	0.030		
	2.565	2.413	4-Point	4-Point	23.038	23.038	0.762		
Calculation 1.75 Multiple	0.109	0.103	4-Point	4-Point	0.907	0.907	0.030		
	2.756	2.616	4-Point	4-Point	23.038	23.038	0.762		

Caliper Range 0.031” - 0.035” 0.787 mm - 0.889 mm	Channel Width AG	Channel Width WG	Crease Point AG	Crease Point WG	Crease Height AG	Crease Height WG	Counter Thickness	Compress Gap AG	Compress Gap WG
0.031” - 0.787 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.093	0.085	6-Point	4-Point	0.908	0.908	0.024	0.005	0.005
	2.362	2.159	6-Point	4-Point	23.063	23.063	0.610	0.127	0.127
Reduced Bead Recycled Fiber	0.085	0.075	6-Point	4-Point	0.909	0.909	0.024	0.004	0.004
	2.159	1.905	6-Point	4-Point	23.089	23.089	0.610	0.102	0.102
Standard US Calculation	0.118	0.114	4-Point	4-Point	0.906	0.906	0.031		
	2.997	2.896	4-Point	4-Point	23.012	23.012	0.889		
Calculation 1.25 Multiple	0.095	0.091	4-Point	4-Point	0.906	0.906	0.031		
	2.407	2.311	4-Point	4-Point	23.012	23.012	0.889		
Calculation 1.50 Multiple	0.103	0.099	4-Point	4-Point	0.906	0.906	0.031		
	2.604	2.515	4-Point	4-Point	23.012	23.012	0.889		
Calculation 1.75 Multiple	0.110	0.106	4-Point	4-Point	0.906	0.906	0.031		
	2.800	2.692	4-Point	4-Point	23.012	23.012	0.889		
0.032” - 0.813 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.096	0.088	6-Point	4-Point	0.908	0.908	0.024	0.005	0.005
	2.438	2.235	6-Point	4-Point	23.063	23.063	0.610	0.127	0.127
Reduced Bead Recycled Fiber	0.088	0.078	6-Point	4-Point	0.909	0.909	0.024	0.004	0.004
	2.235	1.981	6-Point	4-Point	23.089	23.089	0.610	0.102	0.102
Standard US Calculation	0.148	0.144	6-Point	4-Point	0.905	0.905	0.032		
	3.759	3.658	6-Point	4-Point	22.987	22.987	0.813		
Calculation 1.25 Multiple	0.124	0.120	6-Point	4-Point	0.905	0.905	0.032		
	3.150	3.048	6-Point	4-Point	22.987	22.987	0.813		
Calculation 1.50 Multiple	0.132	0.128	6-Point	4-Point	0.905	0.905	0.032		
	3.353	3.251	6-Point	4-Point	22.987	22.987	0.813		
Calculation 1.75 Multiple	0.140	0.136	6-Point	4-Point	0.905	0.905	0.032		
	3.556	3.454	6-Point	4-Point	22.987	22.987	0.813		
0.033” - 0.838 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.099	0.091	6-Point	4-Point	0.906	0.906	0.026	0.005	0.005
	2.515	2.311	6-Point	4-Point	23.012	23.012	0.660	0.127	0.127
Reduced Bead Recycled Fiber	0.091	0.081	6-Point	4-Point	0.907	0.907	0.026	0.004	0.004
	2.311	2.057	6-Point	4-Point	23.038	23.038	0.660	0.102	0.102
Standard US Calculation	0.150	0.146	6-Point	4-Point	0.904	0.904	0.033		
	3.810	3.708	6-Point	4-Point	22.962	22.962	0.838		
Calculation 1.25 Multiple	0.125	0.121	6-Point	4-Point	0.904	0.904	0.033		
	3.181	3.073	6-Point	4-Point	22.962	22.962	0.838		
Calculation 1.50 Multiple	0.134	0.130	6-Point	4-Point	0.904	0.904	0.033		
	3.391	3.302	6-Point	4-Point	22.962	22.962	0.838		
Calculation 1.75 Multiple	0.142	0.138	6-Point	4-Point	0.904	0.904	0.033		
	3.600	3.454	6-Point	4-Point	22.962	22.962	0.838		
0.034” - 0.864 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.102	0.094	6-Point	4-Point	0.906	0.906	0.026	0.005	0.005
	2.591	2.388	6-Point	4-Point	23.012	23.012	0.660	0.127	0.127
Reduced Bead Recycled Fiber	0.094	0.084	6-Point	4-Point	0.907	0.907	0.026	0.004	0.004
	2.388	2.134	6-Point	4-Point	23.038	23.038	0.660	0.102	0.102
Standard US Calculation	0.152	0.148	6-Point	4-Point	0.903	0.903	0.034		
	3.861	3.759	6-Point	4-Point	22.936	22.936	0.864		
Calculation 1.25 Multiple	0.127	0.123	6-Point	4-Point	0.903	0.903	0.034		
	3.213	3.124	6-Point	4-Point	22.936	22.936	0.864		
Calculation 1.50 Multiple	0.135	0.131	6-Point	4-Point	0.903	0.903	0.034		
	3.429	3.327	6-Point	4-Point	22.936	22.936	0.864		
Calculation 1.75 Multiple	0.144	0.140	6-Point	4-Point	0.903	0.903	0.034		
	3.645	3.556	6-Point	4-Point	22.936	22.936	0.864		
0.035” - 0.889 Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber	0.115	0.107	6-Point	4-Point	0.904	0.904	0.028	0.005	0.005
	2.921	2.718	6-Point	4-Point	22.962	22.962	0.711	0.127	0.127
Reduced Bead Recycled Fiber	0.107	0.097	6-Point	4-Point	0.905	0.905	0.028	0.004	0.004
	2.718	2.464	6-Point	4-Point	22.987	22.987	0.711	0.102	0.102
Standard US Calculation	0.154	0.150	6-Point	4-Point	0.902	0.902	0.035		
	3.912	3.810	6-Point	4-Point	22.911	22.911	0.889		
Calculation 1.25 Multiple	0.128	0.124	6-Point	4-Point	0.902	0.902	0.035		
	3.245	3.150	6-Point	4-Point	22.911	22.911	0.889		
Calculation 1.50 Multiple	0.137	0.133	6-Point	4-Point	0.902	0.902	0.035		
	3.467	3.378	6-Point	4-Point	22.911	22.911	0.889		
Calculation 1.75 Multiple	0.145	0.141	6-Point	4-Point	0.902	0.902	0.035		
	3.689	3.581	6-Point	4-Point	22.911	22.911	0.889		

Caliper Range 0.____" - 0.____" 0.____ mm - 0.____ mm	Channel Width AG	Channel Width WG	Crease Point AG	Crease Point WG	Crease Height AG	Crease Height WG	Counter Thickness	Compress Gap AG	Compress Gap WG
0.____" - 0.____ Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber									
Reduced Bead Recycled Fiber									
Standard US Calculation									
Calculation 1.25 Multiple									
Calculation 1.50 Multiple									
Calculation 1.75 Multiple									
0.____" - 0.____ Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber									
Reduced Bead Recycled Fiber									
Standard US Calculation									
Calculation 1.25 Multiple									
Calculation 1.50 Multiple									
Calculation 1.75 Multiple									
0.____" - 0.____ Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber									
Reduced Bead Recycled Fiber									
Standard US Calculation									
Calculation 1.25 Multiple									
Calculation 1.50 Multiple									
Calculation 1.75 Multiple									
0.____" - 0.____ Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber									
Reduced Bead Recycled Fiber									
Standard US Calculation									
Calculation 1.25 Multiple									
Calculation 1.50 Multiple									
Calculation 1.75 Multiple									
0.____" - 0.____ Millimeter Paperboard Thickness									
Reduced Bead Virgin Fiber									
Reduced Bead Recycled Fiber									
Standard US Calculation									
Calculation 1.25 Multiple									
Calculation 1.50 Multiple									
Calculation 1.75 Multiple									

Calculation Examples

As you can see from the charts on the previous five pages, they cover the caliper range from 0.011” to 0.035.” In addition, each individual caliper is broken down into 6 sets of crease tool parameters. These are:

1: Reduced Bead: Virgin Fiber
2: Reduced Bead: Recycled Fiber
3: The Standard US Calculation
4: The 1.25 Multiple Calculation
5: The 1.50 Multiple Calculation
6: The 1.75 Multiple Calculation

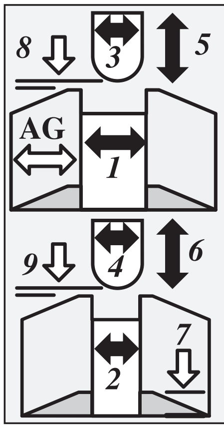
The first two are based upon the ***Reduced Bead Creasing Method*** and reflect the basic starting point of calculating the width of the channel by multiplying the caliper of the paperboard by 3. Let us calculate the setting for a recycled paperboard of 0.026” as an example of how this would work.

One, multiply the caliper by three to give a total of 0.078.”

Two, as the recycled setting is based upon the virgin fiber starting point, and the recycled cross grain creasing is set to the width of the virgin fiber parallel grain channel, this is 0.078” minus the grain allowance of 0.006” to give a recycled cross grain channel width of 0.072.”

Three, as the recycled fiber grain allowance for 0.026” is 0.008,” the parallel grain channel width for a recycled paperboard of 0.026” is 0.072” minus 0.008” to give a channel width of 0.066”

Four, the other key parameters, Crease Pointage, Crease Heights, and the Compression Gaps for both Against Grain and With Grain, and the Counter Thickness are read from the chart. ***See illustration 8.42***.



Paperboard: Caliper: 0.026 - 0.660	
***01**: Channel Width AG*	*01: = **0.072” 1.829 mm***
***02**: Channel Width WG*	*02: = **0.066” 1.676 mm***
***03**: Crease Pointage AG*	*03: = **0.084” 4-Point***
***04**: Crease Pointage WG*	*04: = **0.084” 4-Point***
***05**: Crease Height AG*	*05: = **0.913” 23.19 mm***
***06**: Crease Height WG*	*06: = **0.913” 23.19 mm***
***07**: Counter Thickness*	*07: = **0.020” 0.508 mm***
***08**: Compress Gap AG*	*08: = **0.003” 0.076 mm***
***09**: Compress Gap WG*	*09: = **0.003” 0.076 mm***

8.42

(If you are using a counter material with a specific thickness of membrane, or a Matrix Strip, with a channel base, then all of the appropriate calculations should be adjusted by the amount required.)

The third, set of parameters is for the generally practiced ***Standard US Calculation***. This is based upon doubling the caliper and adding in the pointage of the creasing rule, selected for that specific caliper of paperboard. ***See illustration 8.43***.

Using an example of 0.019” material, the calculation would be as follows:

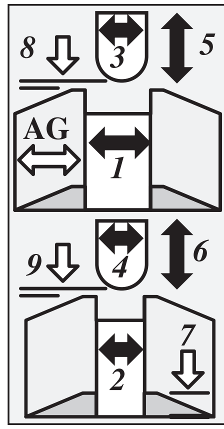
One, multiply the caliper by two to give a total of 0.038.”

Two, add the thickness of the crease rule used for this caliper, which is 3-point or 0.042,” to give an Against the Grain Channel With of 0.080.”

Three, calculate the With Grain Channel Width by reducing the Against Grain Channel width of 0.080,” by the Grain Allowance for this caliper of paperboard, which is 0.004,” to give a With Grain Channel Width of 0.076.”

Four, the other key parameters, Crease Pointage, Counter Thickness, and Crease Heights are read from the chart. ***See illustration 8.43***. *(If you are using a counter material with a specific thickness of membrane, or a Matrix Strip, with a channel base, then all of the appropriate calculations should be adjusted by the amount required.)*

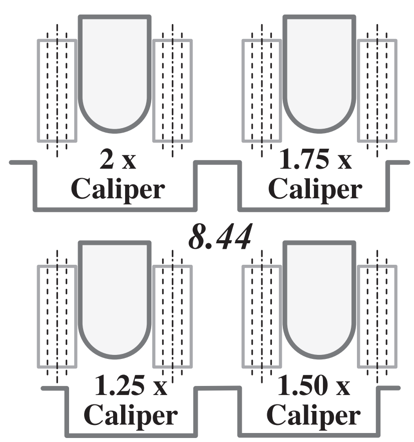
8.43



Paperboard: Caliper: 0.019” - 0.483	
***01**: Channel Width AG*	*01: = **0.080” 2.032 mm***
***02**: Channel Width WG*	*02: = **0.076” 1.930 mm***
***03**: Crease Pointage AG*	*03: = **0.042” 3-Point***
***04**: Crease Pointage WG*	*04: = **0.042” 3-Point***
***05**: Crease Height AG*	*05: = **0.918” 23.317 mm***
***06**: Crease Height WG*	*06: = **0.918” 23.317 mm***
***07**: Counter Thickness*	*07: = **0.019” 0.483 mm***
***08**: Compress Gap AG*	*08: = **0.000” 0.000 mm***
***09**: Compress Gap WG*	*09: = **0.000” 0.000 mm***

The final three calculation formulas reflect a trend in the industry to find a more effective design for tooling, by changing a single variable, the width of the channel. Whereas the Standard US Calculation is to multiply the caliper by 2 and add the thickness of the creasing rule, these alternative methods reduce the channel width by multiplying the caliper of the paperboard by ***1.75, 1.50, & 1.25*** respectively. All other factors remain the same. ***See illustration 8.44***. This approach is growing in popularity, and shows a determination to find a more effective method of crease formation.

Finally, the top line in each set of parameters is Imperial Measurement and the lower, Metric Equivalents.



8.44

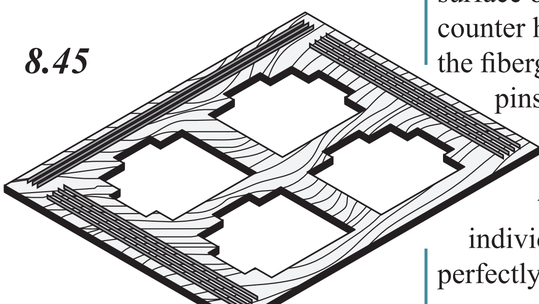
Crease Research & Testing

Given the diversity of paperboard types, new multi-layer fiber mixes, the range and the increased use of thicker calipers, the necessity of mixing Mills and batches of new and older paperboard; it is important to be able to quickly test each material, with as many crease/fold options as possible, under standard press conditions.

The Crease Test Die

The simplest approach to this challenge is to create a test die which fits into the format of a sheet fed platen diecutter. The dieboard is made with

8.45

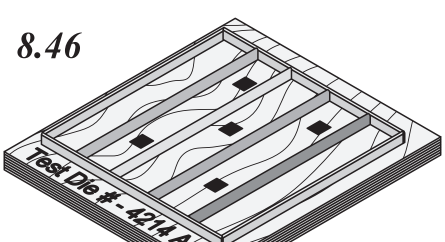


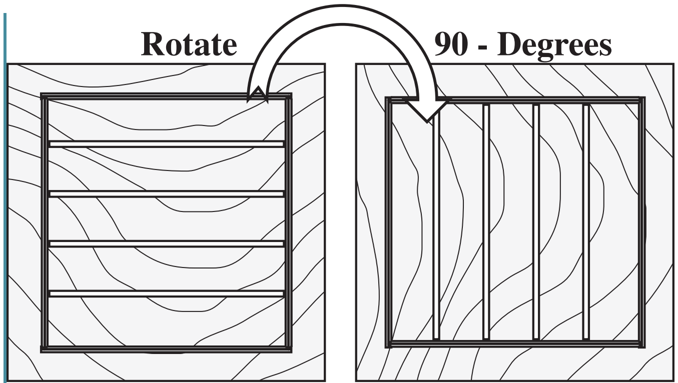
three sided bearers to ensure optimal pressure balance and leveling. ***See illustration 8.45***.

It is important this tool is either made using a stable dieboard material such as Rayform or Permaplex. This tool represents a long term investment and it is also important that the test results generated in the use of this tool are not compromised by a warped or a distorted dieboard.

Illustration 8.45 shows 4 cavities in

8.46

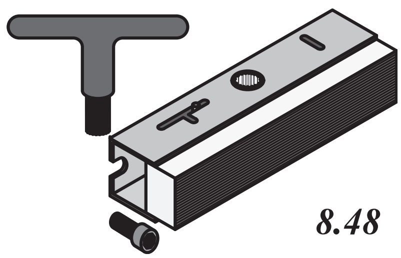




8.47

the dieboard. These are designed to hold the 4 individual test dies, ***see illustration 8.46***, which will enable a complete range of crease tests to be performed on each material. Note the test die has an Identification Number, laser etched into the surface of the tool, and there are counter holes, designed to accept the fiberglass counter registration pins.

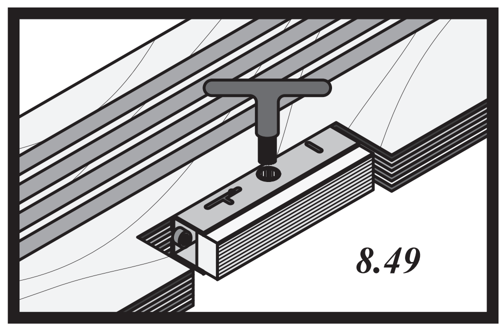
Illustration 8.47 shows that the design of each individual crease test die is perfectly square, so it can be rotated



8.48

through 90 degrees to enable testing of a different grain direction. Alternately, if the dimensions of the sheet make it possible, the sheet can be rotated through 90 degrees, and/or two of the four test stations can be oriented in one direction and two of the test stations can be oriented at right angles.

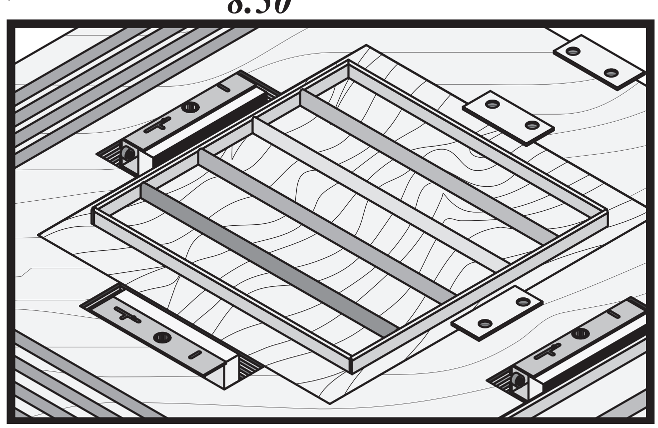
To enable the individual test dies to be exchanged and rotated, they are secured in the test die using ***Speed Quoins from the Bar Plate Company. See illustration 8.48.*** The Quoins are permanently bolted into a recess machined into two sides of each individual cavity, to enable fast changeover of individual test dies. ***See illustration 8.49***.



8.49

As a further safety precaution a security plate made from steel rule is attached to the surface of the dieboard so it overlaps the test die after it is inserted into the cavity. This adds a few minutes to the exchange of each test die, however it is designed to prevent the test die from falling from the dieboard if the quoin should become loose. These quoins are unlikely to work loose, but this is a sensible precaution. ***See illustration 8.50.***

8.50



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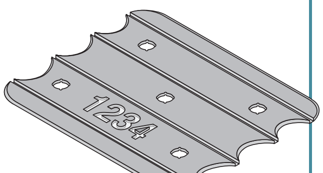
Crease Test Die Parameters

To accomplish a comprehensive range of testing it is necessary to set tool parameters to the caliper of the material being tested. In creasing the female tool is adjusted to the caliper of the material by being supplied in a range of thicknesses intended to match each caliper of material being used.



In most operations the range of fiberglass material thicknesses are ***approximately*** as follows.

❶ ***Counter Thickness: 0.017”***
❷ ***Counter Thickness: 0.020”***
❸ ***Counter Thickness: 0.024”***
❹ ***Counter Thickness: 0.028”***
❺ ***Counter Thickness: 0.032”***
❻ ***Counter Thickness: 0.036”***

Therefore, we have six thicknesses of counter, which sets the height of the creasing rule we can use. As a result, the creasing rule height to be used with these counter material thicknesses is as follows:

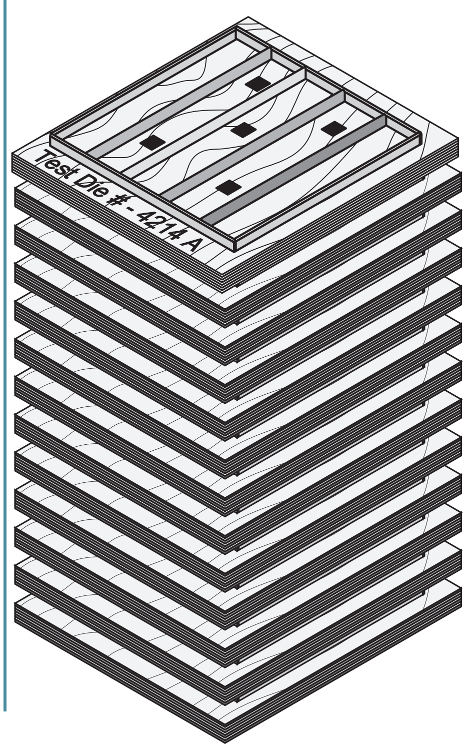
❶ ***Thickness: 0.017” - 0.918” Crease Height***
❷ ***Thickness: 0.020” - 0.915” Crease Height***
❸ ***Thickness: 0.024” - 0.911” Crease Height***
❹ ***Thickness: 0.028” - 0.907” Crease Height***
❺ ***Thickness: 0.032” - 0.903” Crease Height***
❻ ***Thickness: 0.036” - 0.900” Crease Height***

The next logical question is what channel parameters do we need to test? The range is as follows:

① ***Channel Widths: 0.045” 0.050” 0.055” 0.060”***
② ***Channel Widths: 0.065” 0.070” 0.075” 0.080”***
③ ***Channel Widths: 0.085” 0.090” 0.095” 0.100”***
④ ***Channel Widths: 0.105” 0.110” 0.115” 0.120”***

Of course, this approach does not preclude using different heights of crease rule or different widths of channel, or substituting Matrix or Vulcanized Fiber. However, this approach will provide a comprehensive foundation to implement the testing program.

The final piece in the puzzle is the pointage of the crease rule used in the test die. The most common thicknesses of crease pointage are 2 Point, 3 Point and 4 Point. It is my contention that 2 Point Crease Rule should not be used, however, many people still use this thickness so it is included in the die specification.



Test Die Design & Fabrication

Six heights of crease rule have initially been identified as the important test parameters. Therefore, 3 individual test dies are required for each height of creasing.

❶ ***3 Test dies 0.918” Crease Height***
- ***1 @ 2 Point +***
- ***1 @ 3 on 2 Point +***
- ***1 @ 4 on 2 Point***

❷ ***3 Test dies 0.915” Crease Height***
- ***1 @ 2 Point +***
- ***1 @ 3 on 2 Point +***
- ***1 @ 4 on 2 Point***

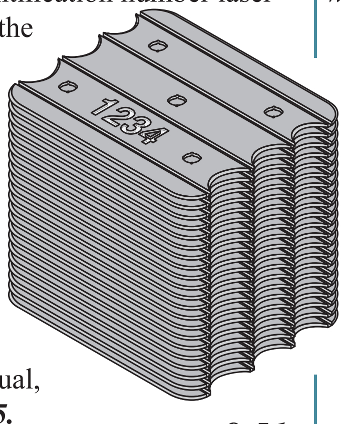
❸ ***3 Test dies 0.911” Crease Height***
- ***1 @ 2 Point +***
- ***1 @ 3 on 2 Point +***
- ***1 @ 4 on 2 Point***

❹ ***3 Test dies 0.907” Crease Height***
- ***1 @ 2 Point +***
- ***1 @ 3 on 2 Point +***
- ***1 @ 4 on 2 Point***

❺ ***3 Test dies 0.903” Crease Height***
- ***1 @ 2 Point +***
- ***1 @ 3 on 2 Point +***
- ***1 @ 4 on 2 Point***

❻ ***3 Test dies 0.900” Crease Height***
- ***1 @ 2 Point +***
- ***1 @ 3 on 2 Point +***
- ***1 @ 4 on 2 Point***

To cover all of the crease heights, it is necessary to fabricate ***18 individual test dies*** to the specifications above. Note: it is obviously important to add counter holes for transferring fiberglass counters on press, and each individual test die should have an identification number laser etched into the dieboard surface. Finally, each die should be rubbered using a slightly softer election than usual, such as ***T-65.***

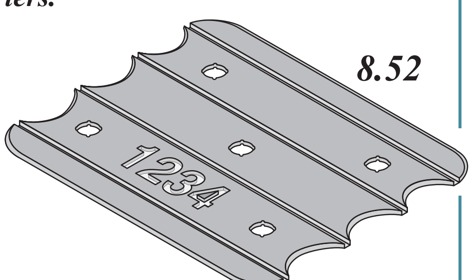


8.51

Counter Test Parameters

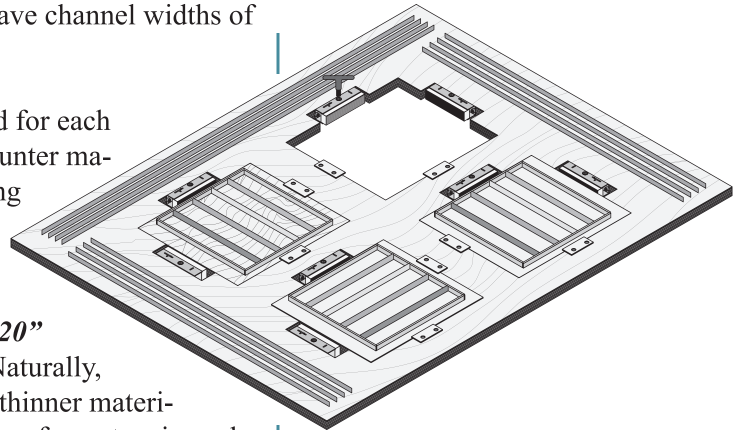
Now that we have specified the counter thicknesses, the channel widths, and the crease heights, it is relatively simple to specify the individual counters. For each height of creasing we need ***16 counters, see illustration 8.51,*** in the appropriate thickness. Therefore, as we have specified ***6 heights of crease rule*** in testing, we need a total of ***6 x 16, or 96 Counters.***

8.52



For example: for the ***Counter Thickness of 0.020"*** and the matching ***Crease Height of 0.915"***, we need 1 counter with channel widths of ***0.045"***, and 1 counter with channel widths of ***0.050"***, and 1 counter with channel widths of ***0.055"***, etc, all the way to the counter 16 in this set, which would have channel widths of ***0.120"***.

This is repeated for each thickness of counter material, generating ***16 counters with channel widths from 0.045" to 0.120" in each set.*** Naturally, when testing thinner materials the number of counters in each set can be reduced as the chance of using a ***0.120"*** wide channel with a ***0.017"*** counter and conversely, when testing thicker materials, the potential of using a ***0.045"*** channel with a ***0.036"*** counter are fairly limited.



Each counter program should be identical, however, it is critically important to rout an identification code for each thickness of counter material, and for each channel width into the surface of each counter. ***See illustration 8.52***. It is easy to get confused in the beginning!

The counters should be carefully cleaned and stored in a safe and secure location after each use. Any damage or problems should be reported and the counter replaced immediately.

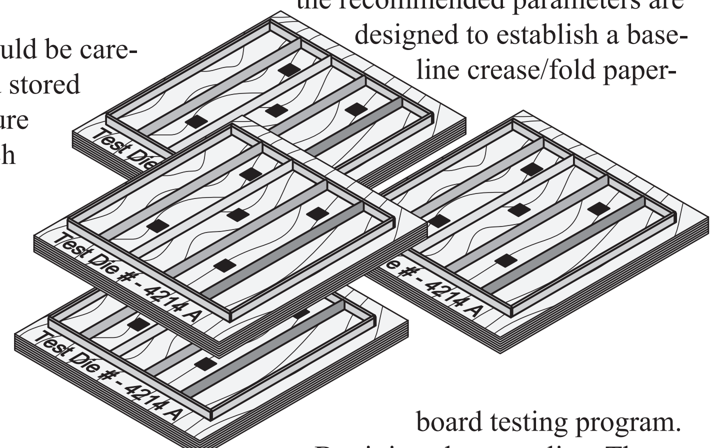
Counter Test Documentation

Diecutting - converting is always a race against the clock, and although this system of testing and evaluating crease parameters against different paperboards is fast and easy, there is a danger of neglecting the important documentation of results. This may be tedious, but it is critically important, and one member of the team must accept responsibility for both keeping samples and for recording the results from each test.

In this way, the team can evaluate results, choose the most effective parameters, and change the specification for subsequent production orders.

Counter Test Summary

This outline, of the testing tools and the recommended parameters are designed to establish a baseline crease/fold paperboard testing program. But it is only an outline. The team should evaluate these recommendations, and make changes to the tools and to the tool parameters, to more closely match the experiments and tests they wish to implement, to prove or disprove the theories and the practices outlined in this manual.



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Chapter 8:
The Specification & Design of Reduced Bead Creasing: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

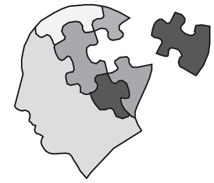
- ✓ There are four (4) key elements of Reduced Bead Creasing tool design. These are:
  - ✓ ***The Pointage of the Crease Rule***
  - ✓ ***The Thickness of the Counter/ Matrix***
  - ✓ ***The Compression Gap***
  - ✓ ***The Channel Width***
- ✓ We determined that a Tapered or Faceted male crease tool and a channel with matching angled walls would be a more effective male and female tool shape in creasing.
- ✓ We learned that 2-point creasing is almost entirely eliminated in Reduced Bead Creasing, apart from the thinnest of materials.
- ✓ One of the key decisions in setting up an effective crease tool design formula, is to define, at what caliper the pointage of the crease rule is increased. This seemingly unimportant selection is often overlooked as a potential problem in creasing performance.
- ✓ It is important to recognize that the specification charts are intended to be a balance between many different paperboard characteristics, and in practice it may be necessary to create a set of charts for each different paperboard!
- ✓ The use of a formula solely based upon the caliper of the paperboard, and not impacted by arbitrary decisions about the pointage of the crease rule is a significant advantage in Reduced Bead Creasing.
- ✓ One of the reasons the Compression Gap is specified for both Against and With the Grain creases, is the option of ***"mixing & matching"*** different Matrix thicknesses and types for each grain direction or each crease/fold.
- ✓ The Compression Gap is a key element of Reduced Bead Creasing, as it is an important buffer designed to compensate for over-pressurization and the progressive deterioration of the standard platen press make-ready.
- ✓ The goal of Reduced Bead Creasing is to produce a smaller, more evenly delaminated bead, which is flexible and elastic as the panels are folded. This requires concentrating the delamination force in a narrower band, and utilizing a ***Vertical Compressive Force*** for shearing, rather than the standard ***Lateral Draw Stress*** method of shearing.
- ✓ In practice, paperboard becomes more elastic as it is shrunk, and the increased elasticity is parallel to the grain. As elasticity is the enemy of delamination, it is necessary to make the parallel grain channels narrower than the cross grain channels.
- ✓ The adjustment in size between cross grain and parallel grain channel width is an important factor in tool design, but the difference between the cross grain channel width and the parallel grain channel width, must be predicated on the specific characteristics of the paperboard being converted!
- ✓ It is dangerous to categorize any material by a single attribute, however, for the basis of calculating channel widths, there are key characteristics, which can be assumed to be typical of each category of paperboard. In terms of creasing, Virgin Fiber Paperboard is generally a lower density, stiffer material, compared to Recycled Fiber, which is generally a higher density, more malleable material.
- ✓ These recommendations are effective and practical, but you must be willing and open to experimentation. It is vital to keep an open mind and to make changes and upgrades based upon your own and your colleagues experience.

Chapter 8:
The Specification & Design of Reduced Bead Creasing: Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ What are the six (6) methods of calculating crease tool parameters specified in this chapter?
- ✓ What are the four (4) key design parameters of Reduced Bead Creasing?
- ✓ How is the Against Grain Channel Width for Recycled Paperboard calculated in the Reduced Bead Creasing formulation?
- ✓ Name three (3) benefits of increasing the pointage of the crease rule, in the Reduced Bead method of crease formulation?
- ✓ Why is it effective to reduce the thickness of the female counter or Matrix strip in Reduced Bead Creasing?
- ✓ Name three (3) benefits of reducing the thickness of the female counter or Matrix strip?
- ✓ What is the purpose of the Compression Gap in Reduced Bead Creasing, and how does this adjustment positively impact pressure distribution in platen diecutting?
- ✓ Name three (3) benefits of integrating a Compression Gap into the creasing formulation?
- ✓ What is the primary purpose of reducing the width of the channel, and therefore the size of the bead in Reduced Bead Creasing?
- ✓ Name three (3) benefits of using a narrower channel in Reduced Bead Creasing?
- ✓ Why is it necessary to make the With Grain Channel narrower than the Against Grain Channel?
- ✓ What are the three alternatives to the Standard Creasing Formula, and what are the amounts used as multipliers?
- ✓ What is the Grain Allowance for a Reduced Bead Crease calculation, using 0.032” - 0.813 millimeter Recycled Paperboard?
- ✓ What is the counter thickness recommended for 0.023” - 0.584 millimeter paperboard and what are the key factors used to make the calculation?
- ✓ At what caliper is 6-point crease rule introduced into the Reduced Bead Creasing formula?
- ✓ If you were using counter material, which integrates a membrane forming the base of the counter channel, how would you adjust the counter thickness and crease height to compensate for the differences?
- ✓ What is the key difference in the applied shearing forces used to form a crease using the Standard Crease formulation in comparison to the Reduced Bead formulation?
- ✓ Which channels, Against Grain or With Grain, will abrade more quickly, and what approach could be used to compensate for the uneven wear?
- ✓ Which channels, Against Grain or With Grain, will require more pressure, and what approach could be used to compensate for the uneven pressure distribution?
- ✓ Do the charts presented in this chapter work for every type of paperboard?

Brainstorming, Notes & Ideas



"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

Chapter 9: *The Differences Between Paperboard & Fluted Creasing?*

Although paperboard and fluted or corrugated material are formed from cellulose fiber, in a papermaking process which shares more similarities than differences, the resulting materials are very different in all of the key converting properties. Paperboard is a homogenous material, while fluted material is an engineered, multi component, multi-layered, composition material.

Unfortunately, as paperboard was the first and the ***"original"*** container manufacturing material, the converting tools, and the method of creasing were designed to reflect the properties and the end-use packaging application of this material. The word ***"unfortunately"*** is used because although the male crease rule and the female channel shape used to form creases in paperboard has proved adequate for the application, it is hardly suitable for fluted material crease formation.

The chains of habit are difficult to break, and it is only in the last few years, converting companies are recognizing that current paperboard creasing methods are often less than adequate for the paperboard process. Furthermore, the creasing folding process for fluted material, should have been designed to reflect the specific needs of the diverse range of fluted materials, the challenge of generating an effective hinge, and the application the container is being put to.

It is long overdue to attack this problem, and to analyze and to recommend changes to a method of creasing, which is virtually unchanged since the inception of the business. This chapter is designed to explore the strengths and weaknesses of current methods and to suggest a series of tool modification to improve the performance of fluted material crease formation and folding.

What are the issues to be addressed?

1: What are the Key Differences?

2: What are the Folding Differences?

3: What are Formation Differences?

4: Fluted Creasing Development?

5: Reduced Bead Creasing & Fluted Creasing?

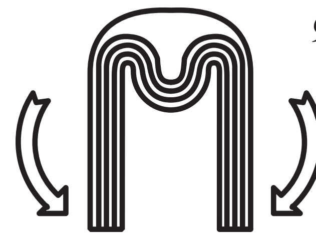
6: Summary

1: What are the Key Differences?

The key to ***paperboard creasing*** is the ability to shear a narrow,

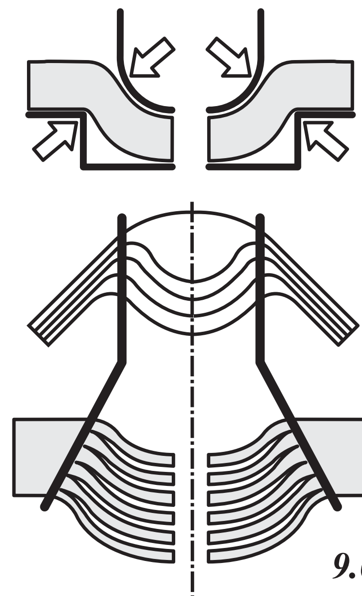
9.01

parallel strip of the material, and to generate sufficient shearing stress in this constrained area, to cause partial internal delamination of the paperboard. ***See illustration 9.01***. The subsequent act of folding the panels divided by this sheared strip, continue and magnify the shearing



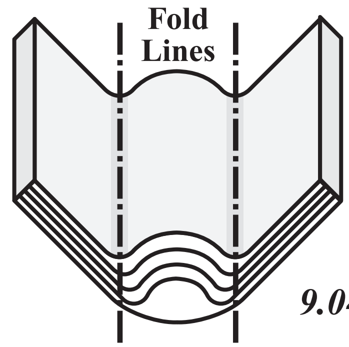
9.02

stress, to ensure the layers in this strip of material are fully internally separated. ***See illustration 9.02***.



9.03

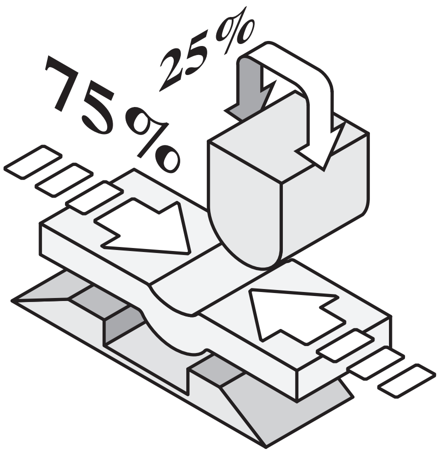
The delaminated section of material forms a flexible, compressive protrusion, which is defined by the two centers of shearing action, ***see illustration 9.03***, and which form the twin folds on either side of this ***"bead"*** of paperboard. ***See illustration 9.04***.



9.04

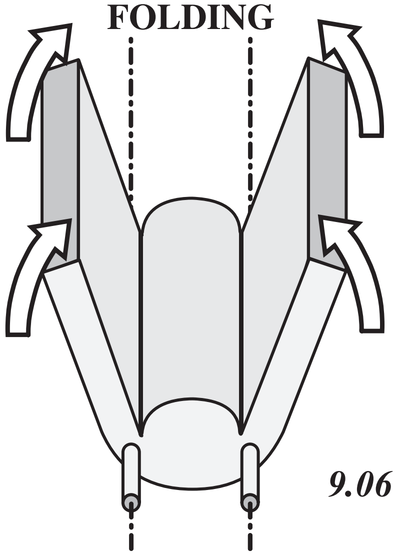
In the standard approach to paperboard creasing, the formation of the crease utilizes more than ***75% Lateral Draw force, and less than 25% Compressive force**. **See illustration 9.05***.

9.05



As the hinged sections are folded, the panels pivot around the two parallel shearing points, ***see illustration 9.06***,

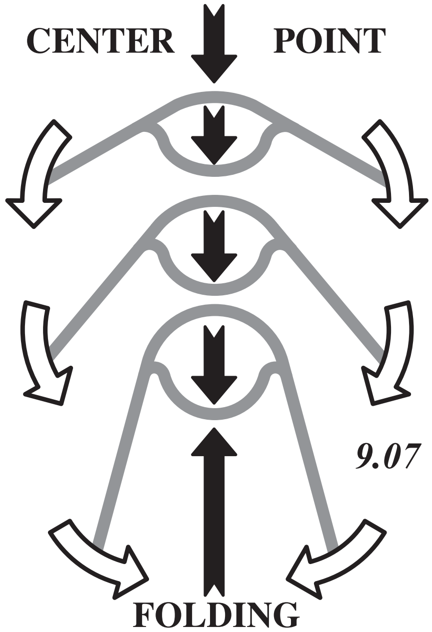
SHEAR POINT FOLDING



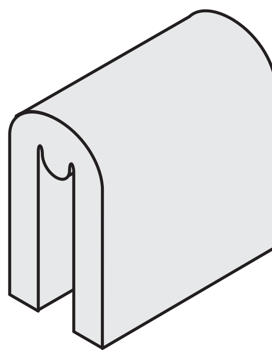
9.06

and rotate around the centerpoint of the crease bead, ***see illustration 9.07***, until they are fully closed. ***See illustration 9.08***.

To enable the crease bead to perform the function of a shock absorber, it must flex inward and then outward, ***see illustration 9.09***, as it absorbs the mounting tensile stress on the stretching spine of the crease. On

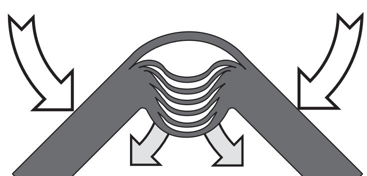


9.07



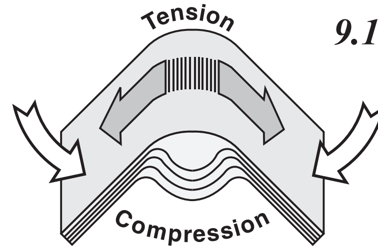
9.08

the outside of the crease/fold, the spine, which consists of less than 20% of the thickness of the material, has been transformed into a thin elastic film, which stretches around the panels as they are folded



9.09

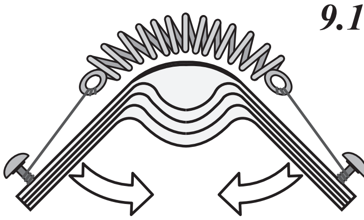
through 90 and then 180 degrees. ***See illustration 9.10***. If the spine is too thick, the folding of the creases is inhibited, ***see illustration 9.11***, however, if the spine is too thin, there is a danger of fracturing and failure, which undermines the aesthetic



9.10

impact of the folded container.

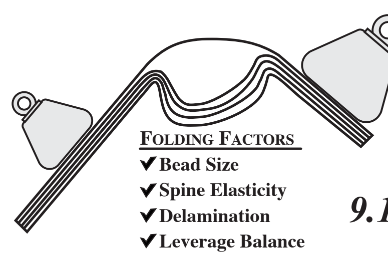
The amount of force required to fold the panels through 90 and then to a full closed 180 degrees is a function of the size of the bead, the degree of internal delamination, the elasticity



9.11

of the crease spine, and the leverage applied by the attached folding panels. ***See illustration 9.12***.

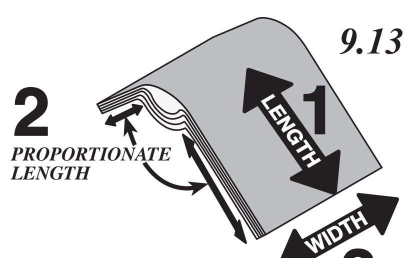
The folding action, which is necessary to complete the formation



9.12

of the crease, uses leverage to complete the internal separation of the fiber layers in the bead of the crease. ***See illustration 9.13***.

9.13

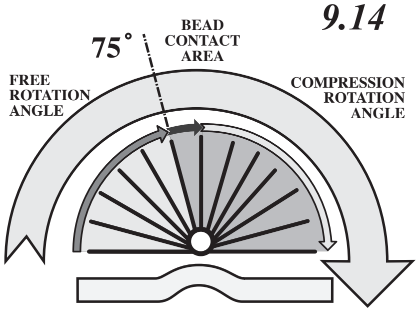


Folding Force is Proportionate to:

1: The Length of the Folding Lever
2: The Difference in the Length of the Levers.
3: The Width of the Folding Panels.

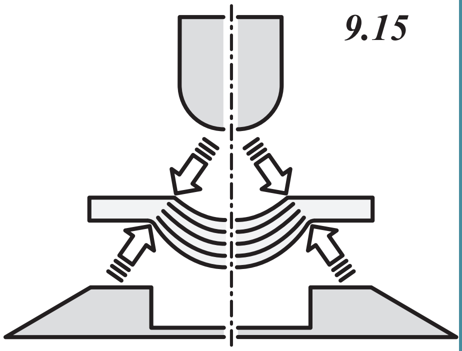
The generation of folding stress is experienced in two phases.

9.14



The first phase of folding is called, the ***"Free Rotation Angle"***, ***see illustration 9.14***, where the degree of generated stress and resistance is fairly minimal. The second phase of folding, is called ***"Compression Rotation Angle,"*** where the degree of generated stress, sharply increases

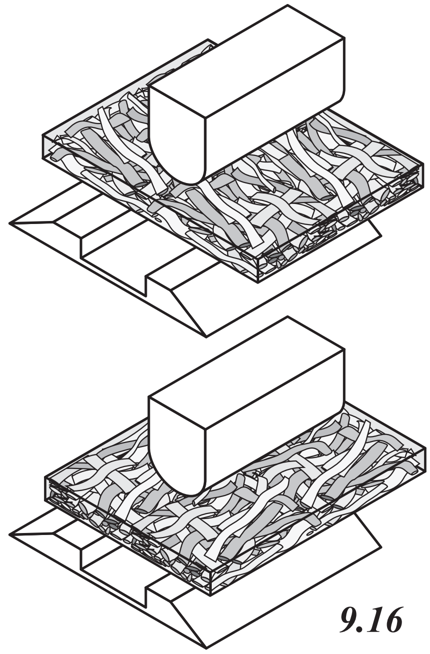
9.15



until the panels are folded through 180 degrees. Note when the crease is unfolded and then refolded through 180 degrees, the degree of pressure increase is minimal, as the first folding action completed the leveraged shearing of the layers in the bead.

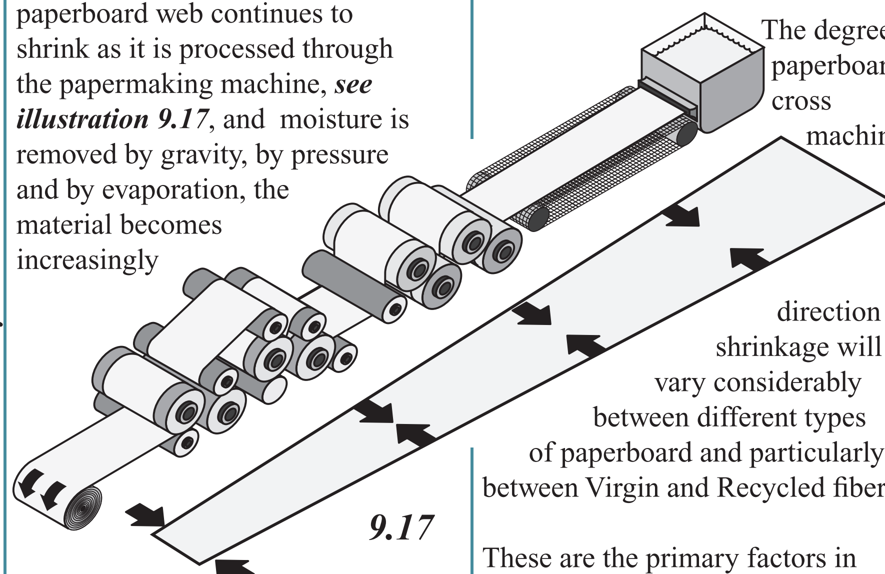
It is critical to this process that the degree of parallel shearing is identical, ***see illustration 9.15***, which requires precise alignment and travel distance control, between the male and the female tools.

The key feature and considerable variable in paperboard creasing is the grain direction of the material, and the orientation of the dominant grain direction to the crease/fold.



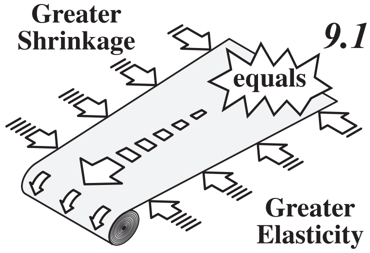
9.16

See illustration 9.16. As the paperboard web continues to shrink as it is processed through the papermaking machine, ***see illustration 9.17***, and moisture is removed by gravity, by pressure and by evaporation, the material becomes increasingly elastic, parallel to the paperboard grain. ***See illustration 9.18***.



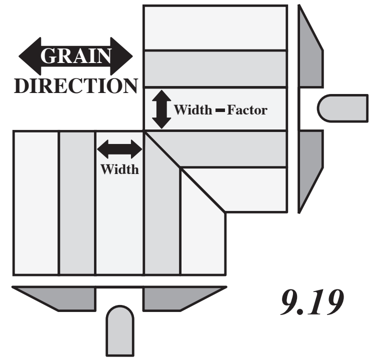
9.17

As paperboard crease formation relies predominantly upon shearing delamination of the material, the



9.18

elasticity of the paperboard makes this more and more difficult, parallel



9.19

to the paperboard grain. The result is the tools are designed to apply greater pressure in crease formation parallel to the grain, as opposed to the degree of pinching pressure at right angles to the paperboard grain. ***See illustration 9.19***.

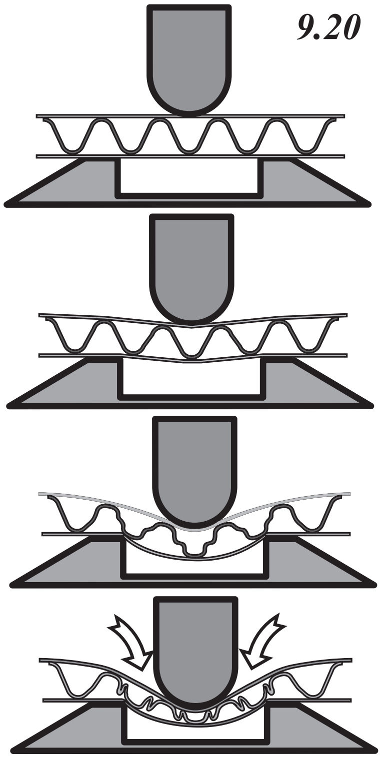
The degree of paperboard cross machine direction shrinkage will vary considerably between different types of paperboard and particularly between Virgin and Recycled fiber.

These are the primary factors in paperboard creasing, how do they compare with fluted paperboard creasing?

The paperboard crease and the fluted crease appear superficially to be very similar. This is natural as they are being converted/processed using almost identical male and female tooling.

But looks are deceiving in this case, as the fluted crease is very different in terms of formation and folding when compared to the paperboard crease. For example, we have described the paperboard crease as a delamination crease, as the formation action generates

9.20



separate layers in the bead. However, in stark contrast the fluted crease is a ***Deformation Crease***, in which the material is crushed and punched into the counter channel. ***See illustration 9.20***. This is particularly obvious when you examine the profile of the fluted material, when creasing at right angles to the flute direction, ***see***

9.21

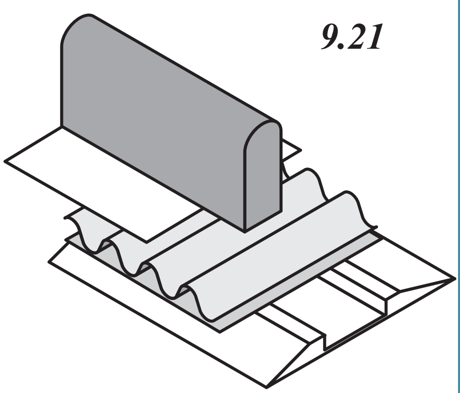
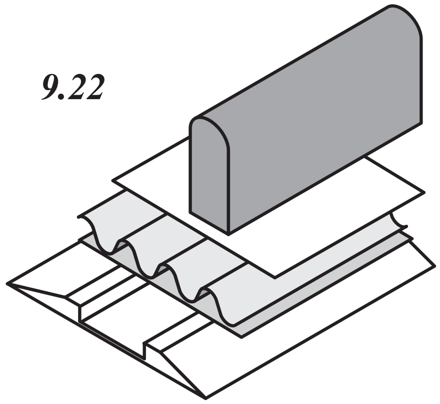


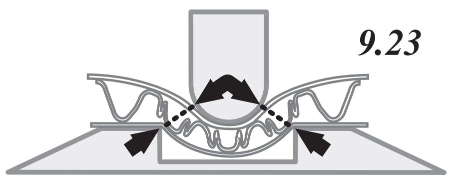
illustration 9.21, and when creasing parallel to the flute direction. ***See illustration 9.22.***

9.22



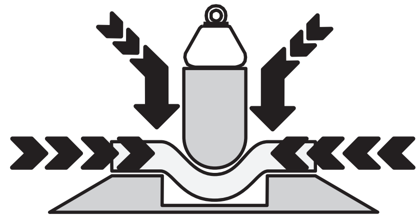
The first action of the male crease tool, usually in conjunction with surrounding ejection material, is to compress the fluted layer, until the outer layers and the fluted layer are virtually bonded together. In practice the design of the male and female creasing tool is built around a calculation of the ***"Crush-Thickness"*** of the material.

9.23



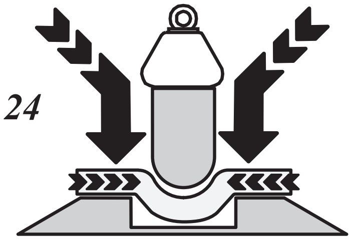
The fluted ***"bead"*** is still defined by the twin shear point lines as in paperboard creasing, ***see illustration 9.23***, which form the parallel fold points. However, because of the compression of the material, the uneven crush of the flutes and the stiffness of the three combined layers, they are less effective in controlling and regulating the symmetry of the folding action.

The forces used in crease formation are also quite different to the paperboard crease. While the traditional paperboard crease utilizes 75% Lateral Draw and 25% Compressive Force to form the bead, because the fluted material is trapped as it is crushed, the distribution of force is 25% or less Lateral Draw, and more than 75% of Compressive



PAPERBOARD CREASE
75% LATERAL DRAW
25% COMPRESSIVE FORCE

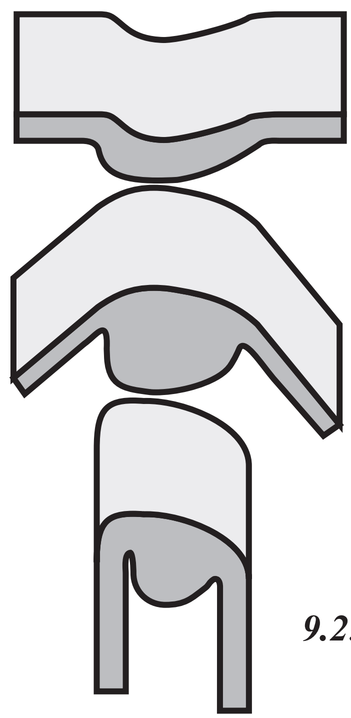
9.24



FLUTED CREASE
25% LATERAL DRAW
75% COMPRESSIVE FORCE

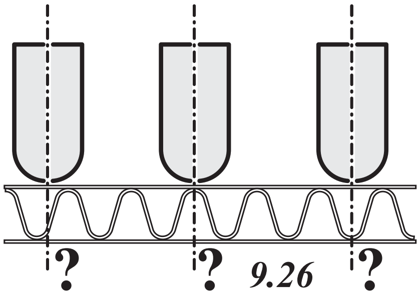
Force. ***See illustration 9.24***.

As the hinged sections are folded the hinge pivot points of the crease are not often cleanly defined, and as a result the crease will often fold slightly off-center. ***See illustration 9.25***.



9.25

When creasing parallel to the flutes this can obviously be caused by the inevitable inconsistent positioning of the male and female tool to the internal flute structure. ***See illustration 9.26***. The comparison between the delaminated paperboard

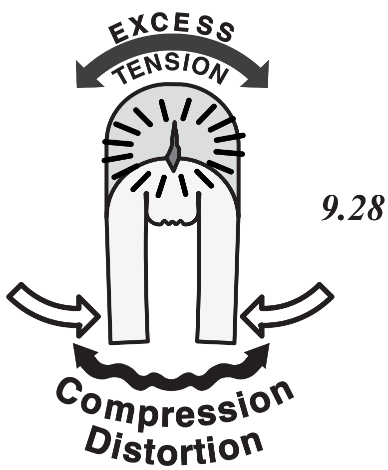


9.26

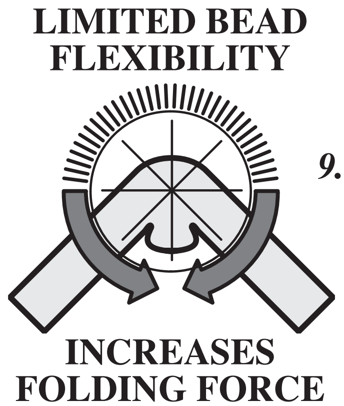
crease and the deformed fluted crease, is particularly evident in the role and the action of the bead during folding. The fluted bead has limited flexibility, and is not designed to compress as the stress of folding tries to squeeze the bead between the folding panels. ***See illustration 9.27***.

9.27

As a direct result the stress normally absorbed by the bead in paperboard creasing is transferred to the spine of the crease in fluted creasing. ***See illustration 9.28***. This degree of spine tensile stress is more acute at right angles to the flutes, and the bead parallel to the paperboard flutes has a better ability to compress and deform.



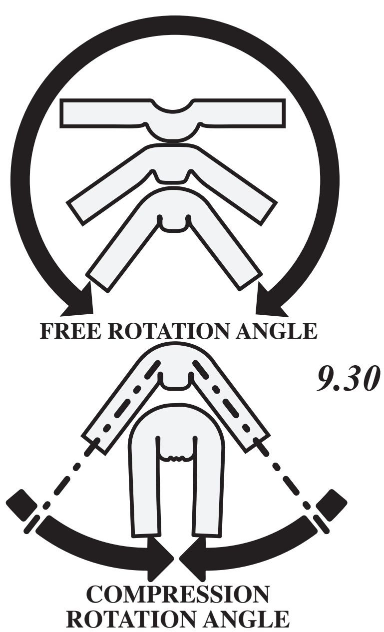
9.28



9.29

In the paperboard crease, the folding action or the pivoting of the panels around the centerpoint of the bead converts the partial internal delamination of crease formation into full internal delamination, under the leverage stress of the folding panels. However, in the fluted crease the folding action of the panels has the same dynamic impact on the bead, the bead has limited ability to compress, and therefore the force required to fold is far higher. ***See illustration 9.29***.

We still experience the two phases of folding. The ***"Free Rotation Angle,"*** up to approximately 75 to 85 degrees of rotation, and the ***"Compression Rotation Angle." See illustration 9.30.*** The folding force required is higher during the free rotation angle, and significantly higher at the conversion point to the compression rotation angle.



9.30

This entire description is of the formation of fluted creasing utilizing identical tooling to the tools used for paperboard crease formation. It is my experience this is a mistake, as the formation of a crease and the parameters of the tools do not reflect nor do they accommodate the dynamic structure of fluted composition material.

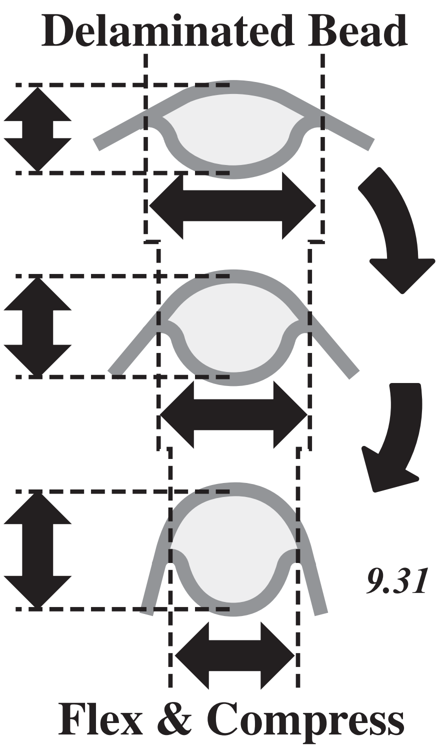
Before we discuss solutions to this dilemma, it is worth examining the difference in folding attributes, and how this undermines carton and container performance.

2: What are the Folding Differences?

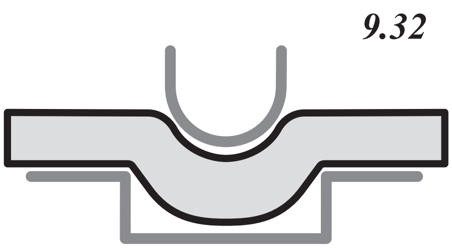
In a logical converting progression, Formation Differences, should come before Folding Differences? However, to be able to respond to the challenges posed by folding, it is easier to define both the problem and potential solutions, in the formation of the crease.

The primary difference, which is obvious is the increased amount of force required to fold a fluted crease through 90 and 180 degrees. However, this often masks fundamental flaws in the methods and practices used to form fluted creases.

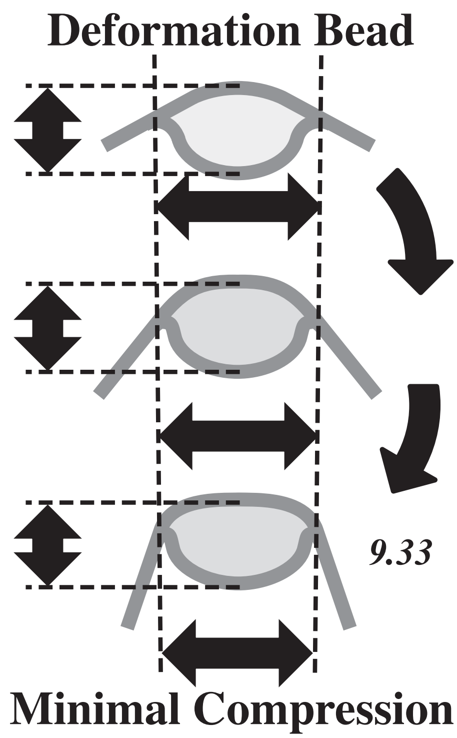
The bead has been defined as the engine room of the paperboard crease, as it is the delamination and the ability to flex and compress



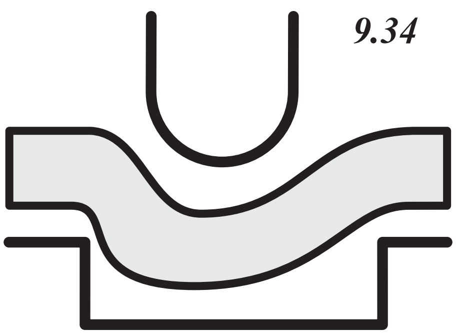
during folding, which enables the folding action to take place. This means we have an ***"adjustable"*** bead, which compresses and changes shape at different angles of folding. ***See illustration 9.31***. The fluted crease is a ***"Deformation Crease"*** in which the various layers of material are crushed, and form a shape, defined by the channel they are punched into. ***See illustration 9.32***.



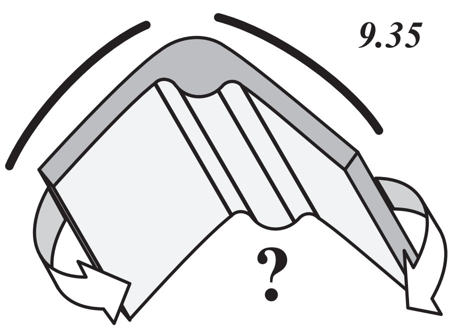
Although slightly more flexible when the bead is formed in line with the flute direction, the bead is basically unable to compress or flex out of the way during folding. See the comparison between the fluted and the paperboard crease in ***illustration 9.31 & 9.33***. As you can see, while the fluted bead is not completely resistant to flexing and compression,



the degree of adjustment is minimal by comparison with the delaminated bead shown in ***illustration 9.31***.

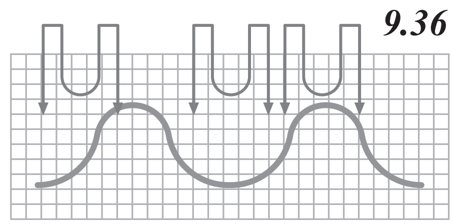


Compounding the problem is the high resistance of fluted material to compressive deformation. In the paperboard crease the twin parallel shear lines are the pivot points of the crease, and this is also the same in fluted creasing, however, if the



compression between the faces of the crease rule and the upper corners of the channel are too wide, or are inconsistently formed, or are not even, ***see illustration 9.34***, the crease has the ability to fold in several difficult to control and variable ways. ***See illustration 9.35***.

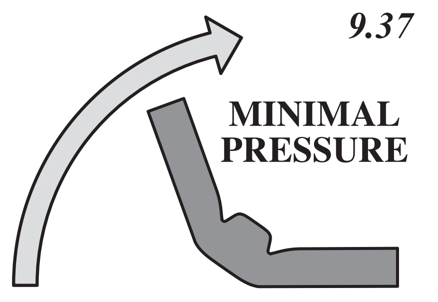
This could be caused by the folding of the inner fluted as they are compressed. Some may fold to the left of the centerline and some to the right of the crease centerline. Which means there is more material to be sheared on one side of the channel than on the other, and inevitably this



FLUTE & CREASE ALIGNMENT?

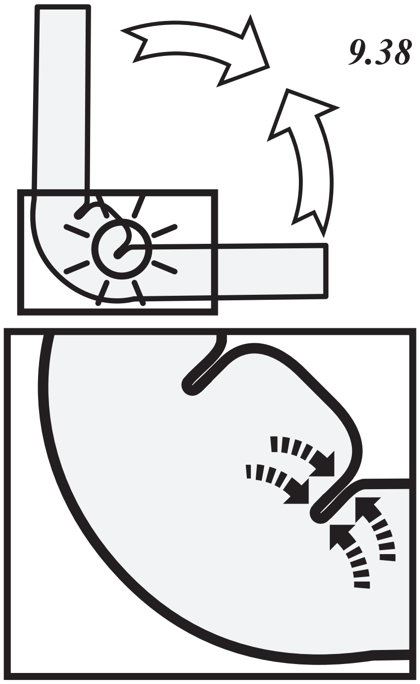
results in different punch and Critical Distance gaps.

When the variation of fluted to the centerline of the crease formation is factored in, ***see illustration 9.36***, consistent folding becomes a complex challenge. In addition, as the rotation of the folding panels, in the angle between 0 degrees and 75 to 85

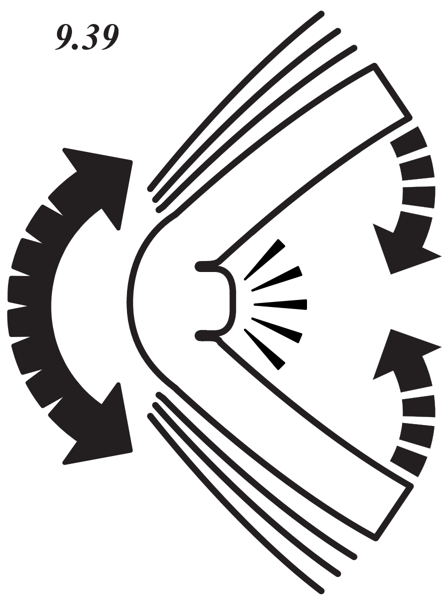


degrees, is entirely dependent on the double shear lines, the effort to fold is not that difficult. ***See illustration 9.37***.

Unfortunately at the point where the

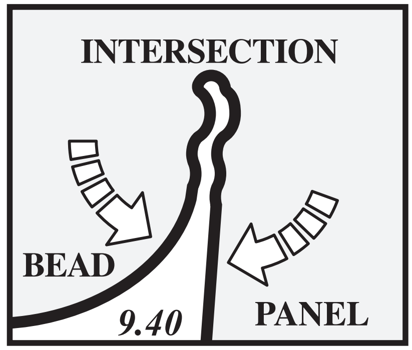


rotation of the folding panels cause the inside surfaces to compress the bead of the crease, ***see illustration 9.38***, as the bead is not compressible, the effort to fold becomes excessive. ***See illustration 9.39***.



As the force continues to fold the panels, the bead is under so much compressive force, the material at the intersection of the bead and the inside wall of each panels begins to bind and distort. ***See illustration 9.40***.

Simultaneously the panels begin to bow and occasionally buckle, and the



spine of the crease is under excessive tensile stress.

When the creased panels are unfolded, the material on both sides of the fold intersection point, on both sides of the bead, show surface depression and ridging damage. ***See***

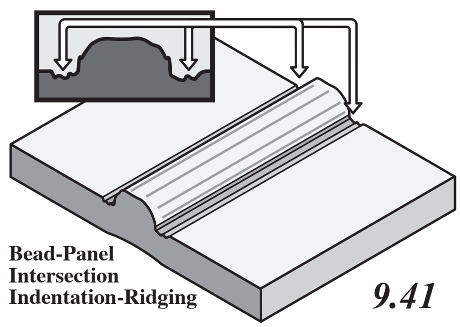
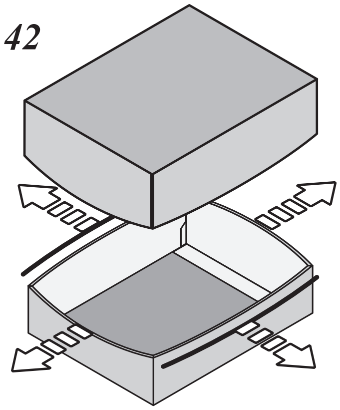


illustration 9.41. Even if folding is accomplished in this manner, and the spine does not fracture, these folding characteristics make life extraordinarily difficult for the folding gluer operator and the cartoning technician. Simply stated, the finishing and packaging process is slowed as the panels must be ***"guided"*** rather than ***"folded."***



This is also evident in the bowing of panels which are folded through 90 degrees, as this degree of distortion is an obstacle to filling and packaging. ***See illustration 9.42.***

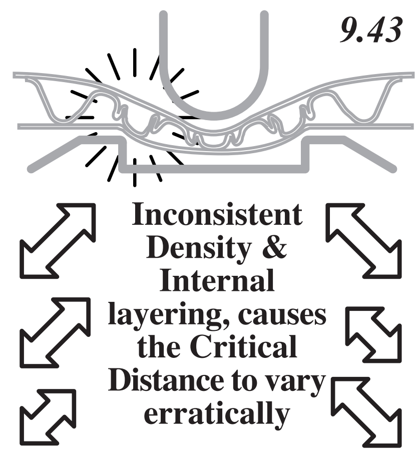
Furthermore, these folding characteristics result in the virtual elimination of fluff and resilient opening force, as it is almost essential to pinch and crush the bead to get the containers to fold effectively.

What have we discovered?

1: The fluted bead is highly resistant to compression.

2: This results in the fluted bead being too large for the folding application.

3: The twin fold lines of a crease are often poorly defined in fluted creasing. See illustration 9.43.

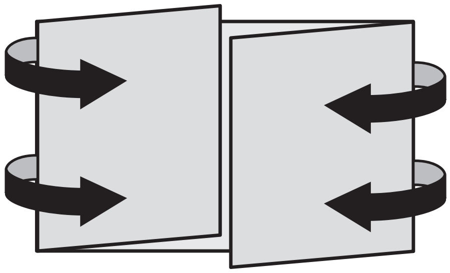


4: Bead Binding inhibits the ability to consistently generated aligned or square folding. See illustration 9.44.

5: Bead Binding generates excess stress on the spine of the crease, generating spine fracturing

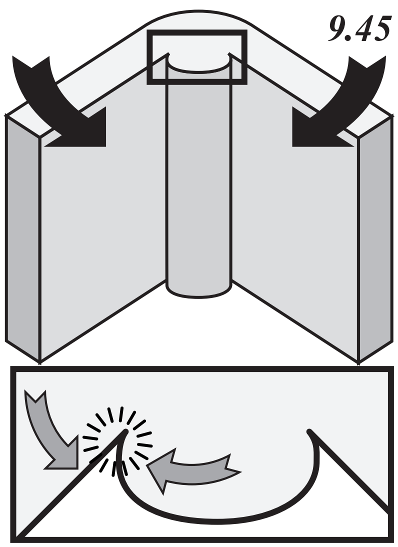
and excess folding force. See illustration 9.45..

9.44



6: Resistance to folding requires excess leverage, which makes it difficult to fold narrow panels.

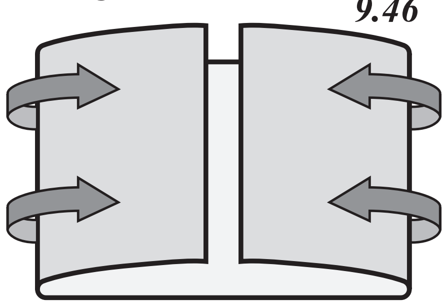
9.45



7: Resistance to folding requires excess leverage, which causes panel bowing. See illustration 9.46.

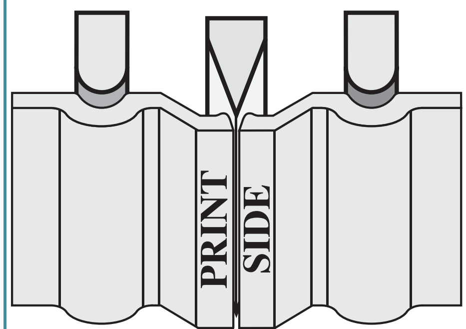
8: The thickness of the fluted composition material, makes crease formation and folding very different from paperboard creasing.

9.46



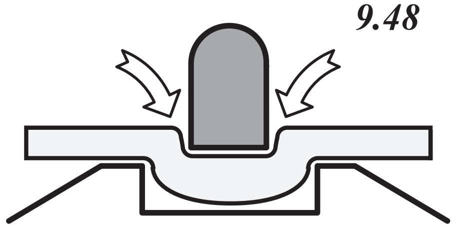
These are problems, which primarily stem from using a system of creasing, which does not reflect nor take advantage of the dynamic structure of fluted paperboard.

9.47



One of the methods used to overcome some of these problems, and particularly the pressure required for effective bead and shear line formation, is to cut and crease from the ***"inside"*** of the fluted material. ***See illustration 9.47***. In this scenario the ***"bead"*** is now the ***"spine"*** of the crease, and the folding action is now centered on a ***"channel"*** formed by an inverted creasing rule. ***See illustration 9.48***.

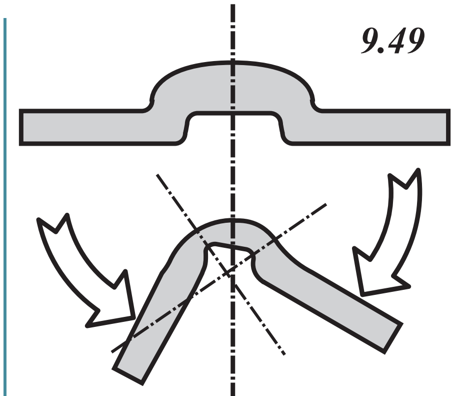
9.48



This is effective in certain circumstances, but the phenomena which often undermines folding performance in this method of crease formation is ***"Channel Binding."*** Therefore there are two key problems with this approach to crease formation. The first is controlling the symmetry or the centrality of the fold. ***See illustration 9.49***.

The advantage of using an inverted crease in this type of application is ***one***, it creates the folding indentation on the inside of the material; ***two***, it applies more force to punch the material into the crease channel; and ***three***, it reduces the Critical Distance, ***see illustration 9.50***, to increase shear force and improve folding definition.

9.49



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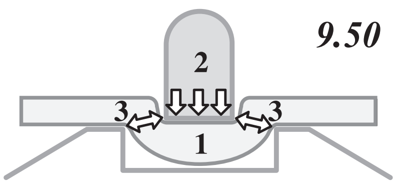
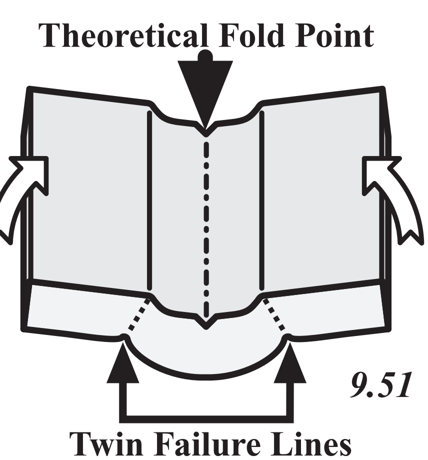


Channel Creasing Benefits?

1: A Deep Channel Indentation
2: Greater Compression Force
3: Reduced Critical Distance

The disadvantage in folding around a channel, is it difficult to control the alignment of the fold to the centerline of crease formation. ***See illustration 9.51***. In practice there is nothing to prevent the fold point being on one side of the channel indentation or the other.

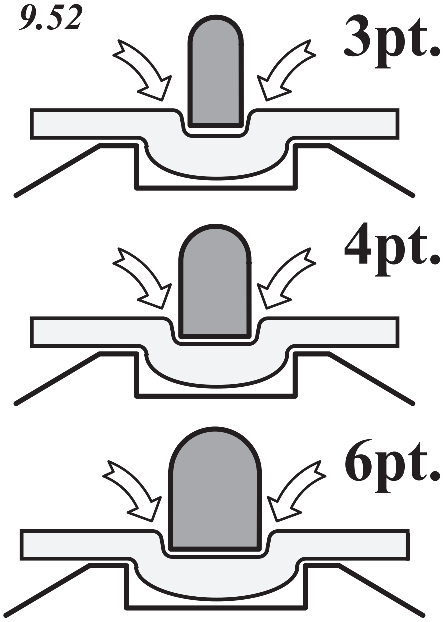
This task becomes even more



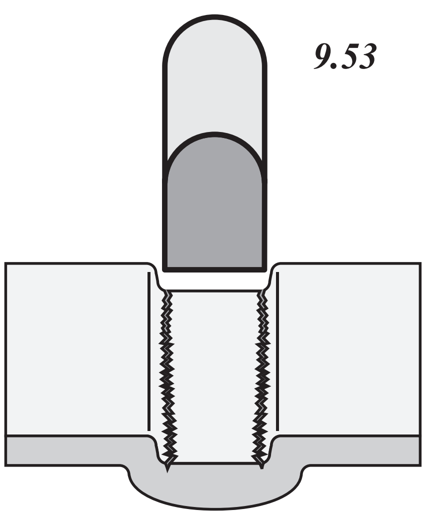
9.51

difficult as the pointage of the crease is advanced from 3-point to 4-point, to 6-point. ***See illustration 9.52***.

9.52

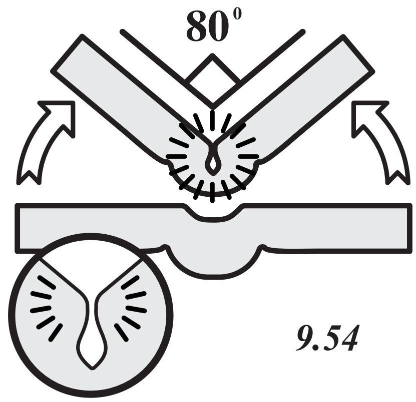


The obvious question at this point, is if it is easier to fold with a narrower channel, why not use 3-point creasing every time? The secondary challenge is the danger of bursting through the liner of the material with a narrower crease rule, ***see illustration 9.53***, and as a result the limitation on applying sufficient pressure to form an effective crease.



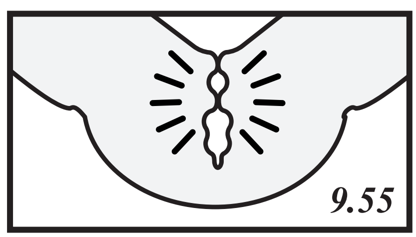
9.53

The primary problem is channel binding. This means as the panels are folded and rotated the upper corners of the channel are also rotated closer together. ***See illustration 9.54***. Unfortunately, the corners begin to make contact, and are therefore



9.54

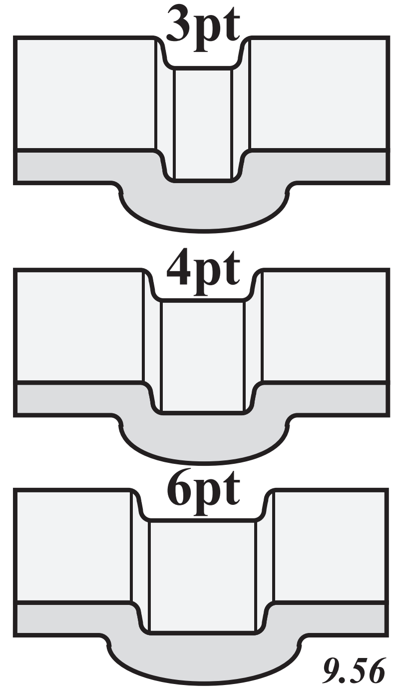
required to crush and deflect, before the panels have reached 90 degrees of rotation. ***See illustration 9.55***. This of course, leads to all of the other folding issues we described earlier when evaluating the impact on bead binding on folding performance.



9.55

Naturally, moving from a 3-point to a 4-point and then to a 6-point depressed channel, ***see illustration 9.56***, reduces the degree of channel binding, however, it does not eliminate it. And we still have the problem of folding alignment, in which variation in folding control and centrality is an increasing problem.

There are certainly more issues to consider in creasing and folding fluted material, however, it is my contention, when we start with incorrectly designed or applied tooling, it is difficult to fine tune the folding process.

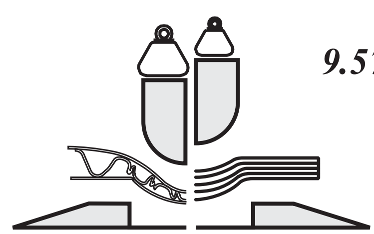


9.56

So what are the differences we would recommend adopting in changing from paperboard creasing tools to fluted creasing tools?

3: What are Formation Differences?

Stating that current materials, tools and methods of creasing for fluted materials are not effective is not just based upon traditional converting, but upon an industry in which material and container design diversity, are setting higher standard of quality,

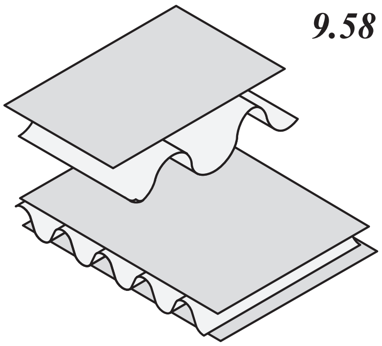


9.57

of productive performance, and of application innovation. Therefore, to form an effective hinge and a reliable and consistent folding action, Fluted Deformation creasing requires greater formation pressure than a Paperboard Delamination crease. ***See illustration 9.57***.

In addition, because fluted material is a diverse, multi-layer, multi-component composition substrate, ***see illustration 9.58***, and it is necessary to compress the material as part of the formation action, deformation pressure must be applied in a different manner than the paperboard crease.

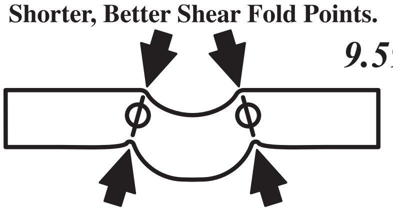
9.58



However, simply adding pressure to the existing tools is not an effective solution. The limitation imposed by the use of current tool materials and methods, constrains the ability of the male and female tooling, and of the diecutting press, to deform a fluted material, to enable consistent formation and folding performance.

The most effective manner of describing the different techniques and methods required, is to examine each technical option, and describes the formation advantages and the folding benefits each alternative provides.

9.59



Before we begin to describe these technical options, it should be stated, they are all based upon the principles of Reduced Bead Creasing. The reason the selection of Reduced Bead Formulation Parameters is important is the more efficient concentration of force applied in this method provides a smaller, more precise bead, which makes folding around a central focal point easier.

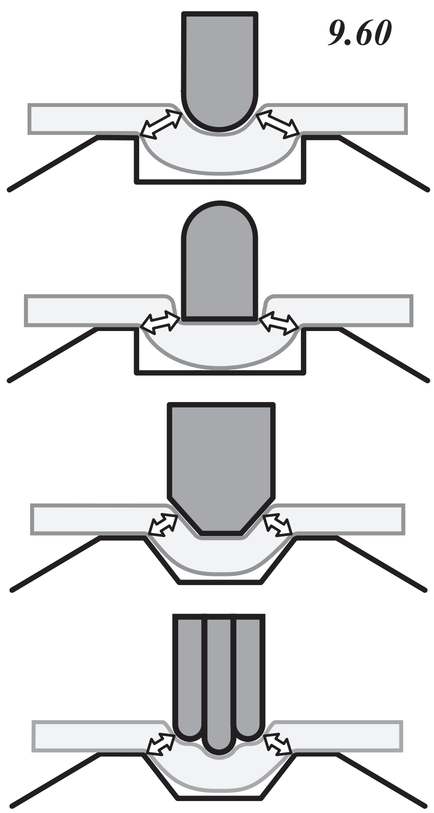
Further Reduced Bead Creasing provides greater precision in fold point formation, which enables the twin, parallel fold lines of a crease to provide more controlled and smoother panel rotation. ***See illustration 9.59***.

This will be reinforced as we describe the four methods of crease formation. The four methods of forming creases in fluted material, both from the ***printed surface and from the inside of the material*** are:

1: Standard Creasing
2: Channel Creasing
3: Tapered Creasing
4: Tier Creasing

See illustration 9.60.

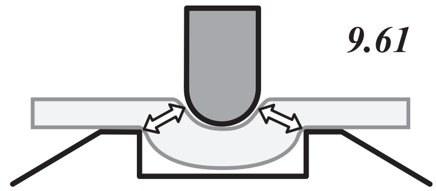
9.60



1: Standard Creasing

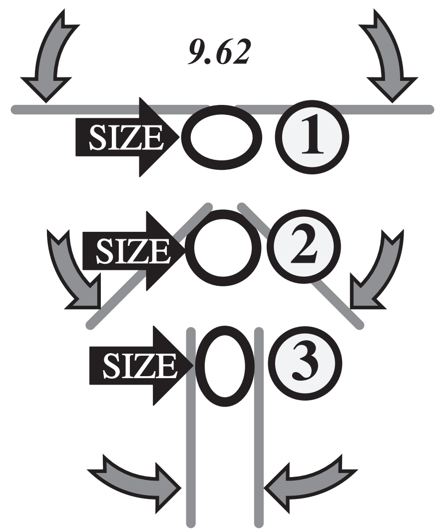
For the thinner flute materials the Standard Creasing Formulation and tool set-up is often used. ***See illustration 9.61***. This will generally provide adequate performance, however, it will not provide optimal creasing and folding performance.

9.61



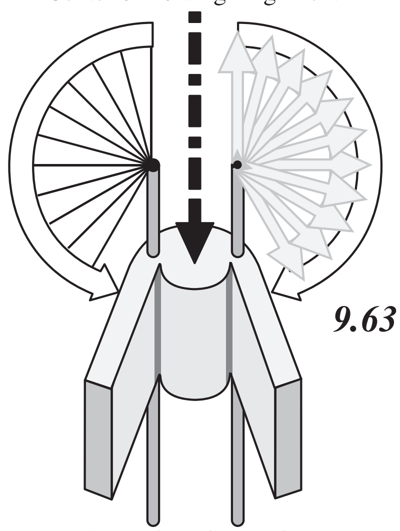
There are two primary problems when using the standard creasing approach. These are Bead Size, and Shear Point Definition.

9.62



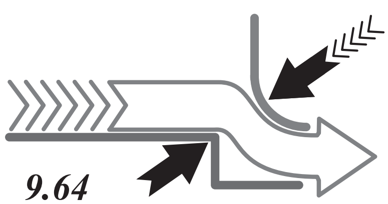
In terms of the bead size we know from describing the compression and flexing of the bead during Paperboard Delamination crease folding, ***see illustration 9.62***, that the bead assumes three shapes and sizes. (In reality the bead is continually changing shape as it is compressed by the action of rotating the attached panels from 0 to 180 degrees, however, 90 and 180 degrees are key folding destinations in carton and container erection.)

This is not a matter of conjecture but the simple dynamic of folding paperboard material. Unfortunately, the fluted bead has limited ability to flex and get out of the way of the folding action. This ability for the bead to change size is more and more important as the caliper of the material increases.



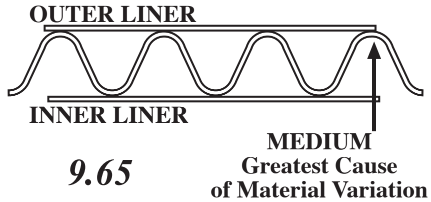
9.63

The second key weakness, is the lack of effective definition of the twin shear points, around which the panels will pivot as the crease is folded. ***See illustration 9.63***.



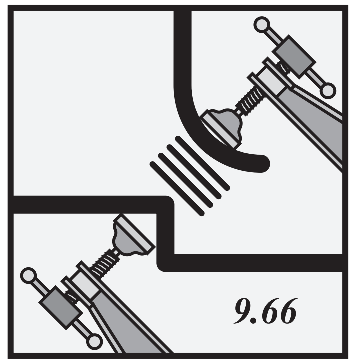
9.64

The traditional crease set-up generates the required shearing forces by pulling the material across the upper corners of the female crease channel, while it is simultaneously being compressed by the male creasing rule. ***See illustration 9.64***. However, given the many different types and configurations of fluted material, ***see illustration 9.65***, and the necessity of pinching the Medium of the material, this is not an effective



9.65

way to control shearing pressure at the important Critical Distance crease pinch point. ***See illustration 9.66***.



9.66

So how do we modify the Delaminated Crease Set-up to be more effective in Fluted Crease formation?

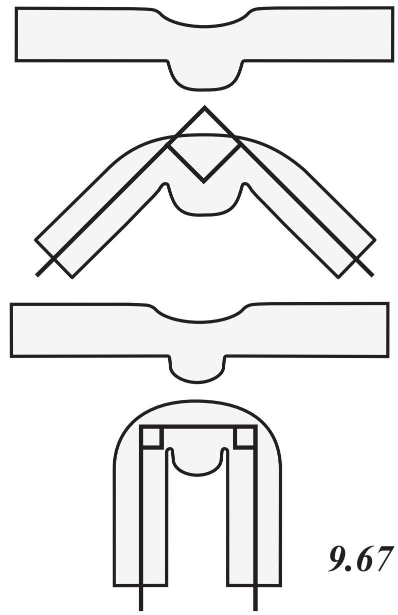
There are three interesting conclusions or guidelines, which should impact all design of tooling for fluted creasing.

A: The Bead Size & Shape are "Different" at 90 and 180 degree of folding!

B: The Bead must be "Pre-Shaped" for the angle of folding, in "all" of fluted creasing. See illustration 9.67.

C: Concentrated Pinching Force is required to create functional shear line pivot points in fluted creasing.

D: The degree of applied pinching force is a function of the length of the attached levers or panels. See illustration 9.68



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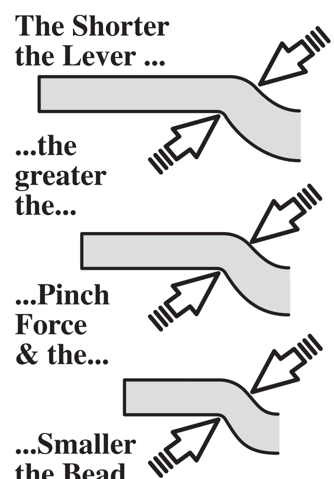
Note in ***illustration 9.68,*** that as the pinching force is increased it is also an advantage to reduce the



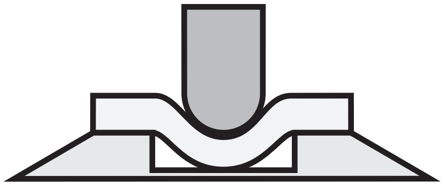
9.68

size of the bead. It is also possible to simply increase the pinching force without changing the size of the bead, however, changing both simultaneously is a far simpler and generally more effective option.

In the use of Standard Crease tooling in fluted converting, it is obvious these guidelines demand the use of Reduced Bead Parameters to set the tool parameters.

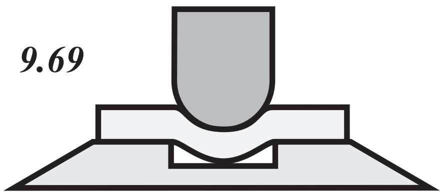
In summation, if standard creasing tools, utilizing a round tip crease rule and a rectangular channel, are being used, ***see illustration 9.61***, then it is essential to use Reduced Bead Creasing Parameters. ***See illustration 9.69***.

STANDARD CREASING



REDUCED BEAD CREASING

9.69

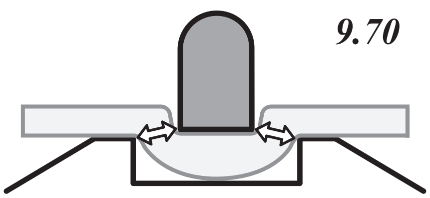


THICKER CREASE NARROWER CHANNEL

2: Channel Creasing

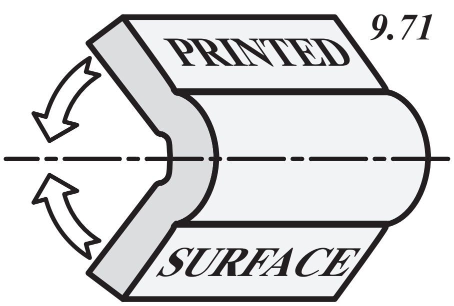
The Channel Creasing technique, ***see illustration 9.70***, was primarily developed for reverse folding of higher caliper fluted material. ***See illustration 9.71***.

9.70



This decision was probably the result of unsuccessful attempts to crease and fold fluted material using traditional tool materials and settings.

9.71

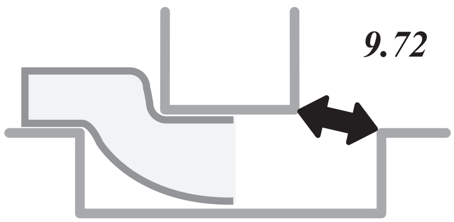


However, as we will see later when we review Tapered Creasing, and Tier Creasing it is possible to successfully crease these higher thicknesses of fluted material by applying pressure in a progressive manner.

What are the advantages of this approach to creasing?

The primary advantage is the critical distance, ***see illustration 9.72***, where a square crease profile, to a square channel profile, provides maximum compression and shearing force. Clearly given the density and the layering of the thicker fluted material, this is an important advantage.

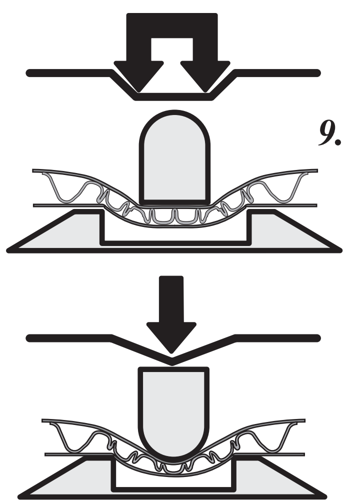
9.72



"Sharply" defined Critical Distance

This orientation of the crease rule provides more effective ***"bridging"*** of flutes and a broader ***"crush"*** capability, ***see illustration 9.73***, and

9.73

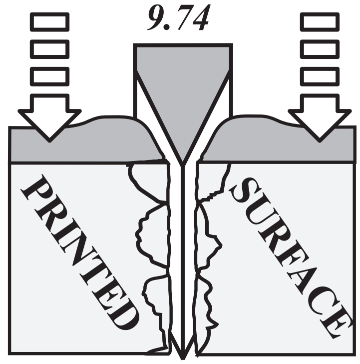


there is less chance of the crease bursting through the inner liner.

Unfortunately, even though this is currently perceived as the most effective crease formation option of thicker fluted material, the disadvantages outweigh the advantages.

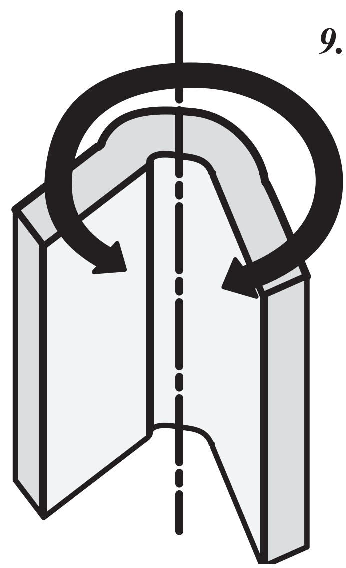
What are the disadvantages of this approach to creasing?

9.74



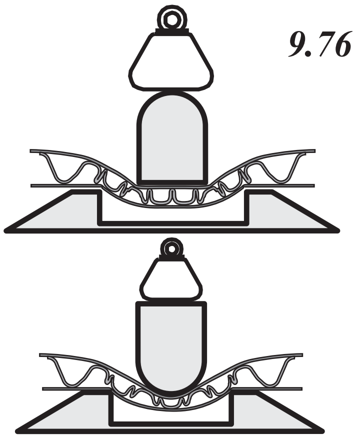
The primary disadvantage is not specifically directed toward creasing as it is the flaking and the chipping of the diecut edge, because of the excess displacement impact of knife penetration. ***See illustration 9.74***.

9.75

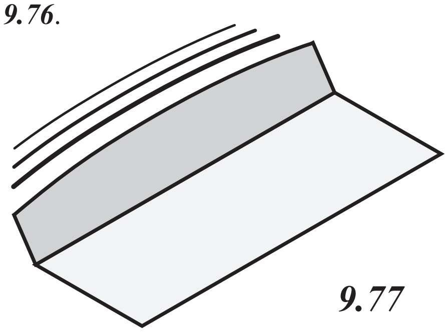


The second major flaw in this method of creasing, is the difficulty of controlling the centrality and/or the consistency of folding alignment. ***See illustration 9.75***. The obvious problem of creasing parallel to the flute direction is an issue, however, even when creasing at right angles to the flute direction, poor alignment is always a potential problem.

9.76



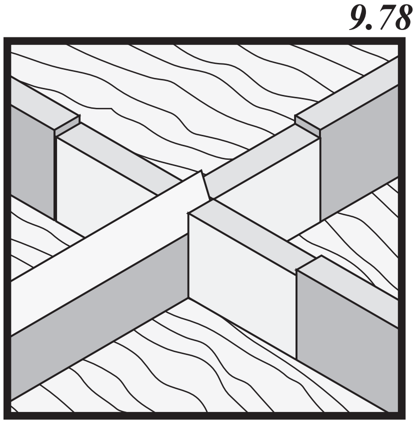
Unfortunately, the earlier advantage of the ability to crush a broader section of the fluted structure of the material is also a major disadvantage, as this form of creasing requires significantly more pressure than the traditional approach. ***See illustration 9.76***.

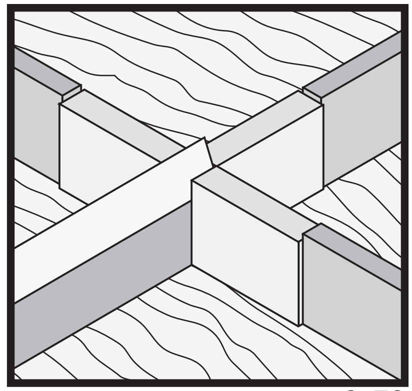


9.77

This leads to a number of related problems as the accumulated pressure of crease formation in a long panel makes it difficult to complete crease

9.78



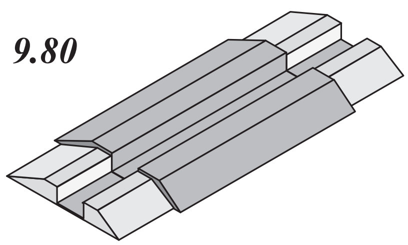


9.79

formation, and panel bowing is often an outcome. ***See illustration 9.77***.

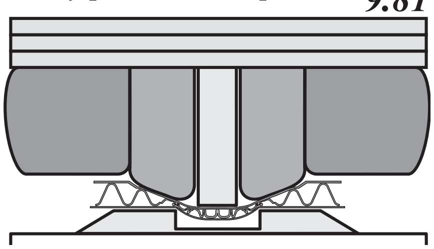
This disadvantage is often minimized by using different heights of crease rule in a single fold, ***see illustration 9.78***, and/or a combination of pointages. ***See illustration 9.79***.

9.80

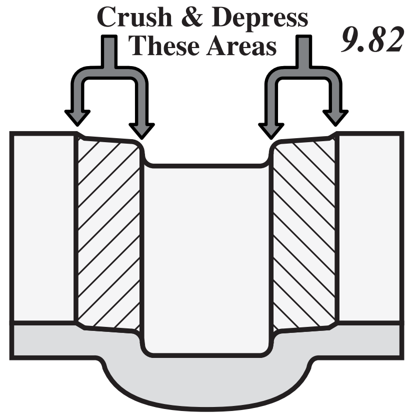


Obviously, this can be accomplished by changing the width and the height of different sections of Matrix Strip, ***see illustration 9.80***, however, this is a rarely practiced discipline.

9.81



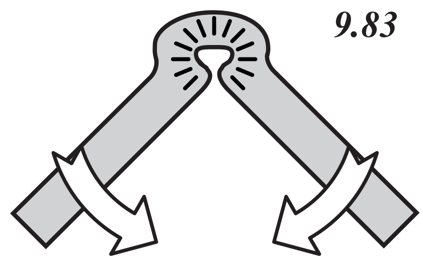
Even though it is not often practiced in platen fluted crease formation, there is an advantage to adding ejection material to the crease rules, parallel to the flute direction. To prevent or to minimize the potential for making marking or surface indentation of the material worse, the ***"rubber-supporting rubber"*** technique is used, as this will add compressive force within the width of the matrix strip. ***See illustration 9.81***.



9.82

This technique is particularly useful when crushing the material immediately bordering the indentation channel, ***see illustration 9.82***, to prevent or at least to minimize the common problem of

9.83

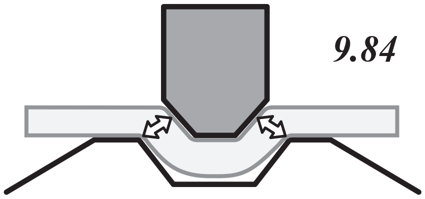


bead binding. ***See illustration 9.83***.

In summary, Channel Creasing is a method narrowly applied to crease formation from the ***"inside"*** of a fluted material. While it provides adequate performance, it is not consistent and it generates a variable crease and a poorly formed folding container.

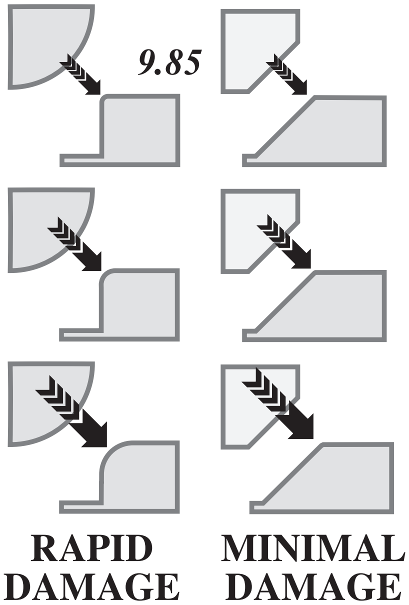
3: Tapered Creasing

The third type of crease to be reviewed, the Tapered Crease, ***see illustration 9.84***, brings together a matched male and female tool, which represents the most effective shape for fluted crease formation.



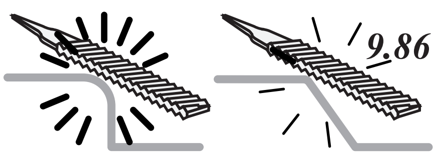
9.84

Let us begin by examining the female tool which is the optimal shape for crease formation, both for



9.85

Delaminated Paperboard Crease converting and for ***Deformation Fluted Crease*** converting.

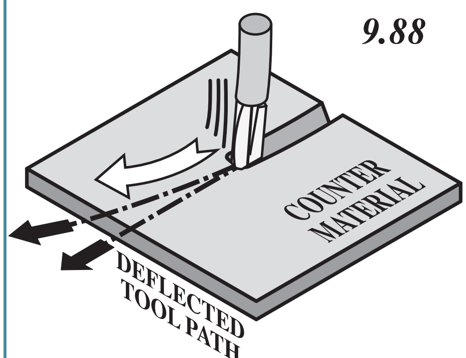


9.86

The channel with an angled wall, provides several important and complimentary benefits. The ***first,*** is the increased strength of the upper corner of the channel wall,

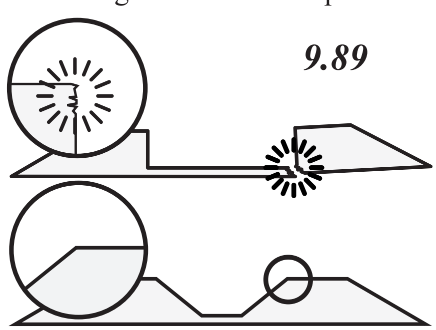
9.87

see illustration 9.85, which is also highly resistant to abrasive wear. ***See illustration 9.86***. This means the Critical Distance, ***see illustration 9.87***, the most important measurement/setting in crease formation will last several times longer than the traditional square channel shape. This translates into higher quality, greater consistency, increased repeatability, reduced waste and lower costs.



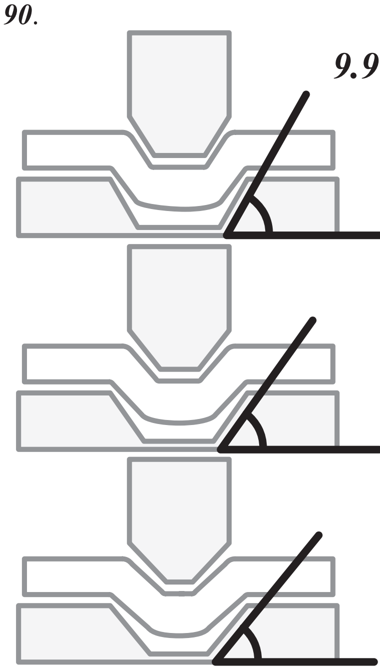
9.88

The ***second*** benefit is simpler, faster machining of fiberglass counters, and the elimination of tool deflection. ***See illustration 9.88.*** In addition, because of the tapered channel walls, and the angled intersection with the base of the channel or the membrane of the counter, the counter tool is much stronger and resistant to fracturing in handling or in use on the press.



9.89

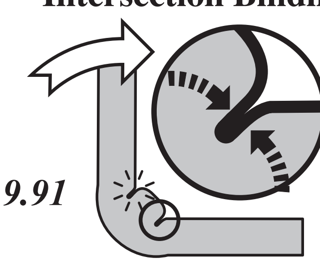
See illustration 9.89. It is simply a stronger, more effective creasing tool. The ***third*** advantage of a tapered wall channel, is the ability of this shape to change the profile of the crease bead. As fluted crease is a Deformation Crease, and we have determined it is important to ***"pre-shape"*** the crease for the folding action, the creased bead will have the same profile as the tapered channel. ***See illustration 9.90***.



9.90

This technique provides the ability to vary the angle of the channel wall to crease a bead with specific folding characteristics, for example folding through 90 or 180 degrees, and it enables a simple adjustment for crease formation parallel to and at right angles to the flute direction.

Inner Bead Wall & Inside Panel Surface Intersection Binding!



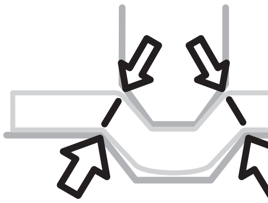
9.91

Obviously an important benefit of this ***"pre-shaped"*** bead is the elimination of Bead Binding. ***See illustration 9.91***.

The ***fourth*** benefit is related to the importance of creating precise definition of the ***Crease Shear Lines***.

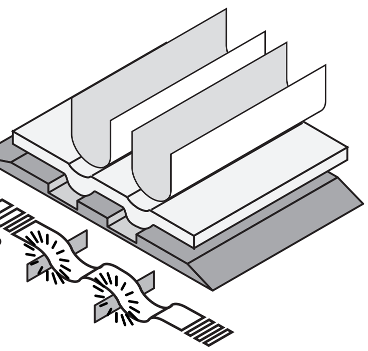
This feature enables precise folding, particularly in fluted creasing, where the bead has limited ability to flex and act as a part of the folding process. ***See illustration 9.92***.

9.92



TWIN CREASE SHEAR LINES

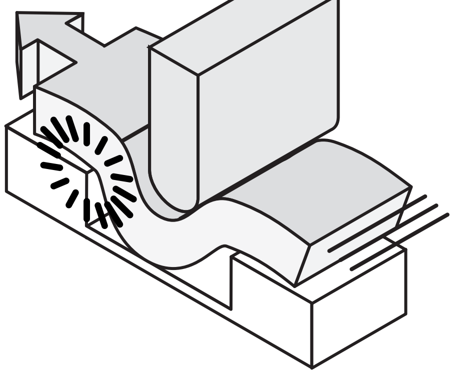
We will address this issue in more detail when we consider the tapered crease rule.



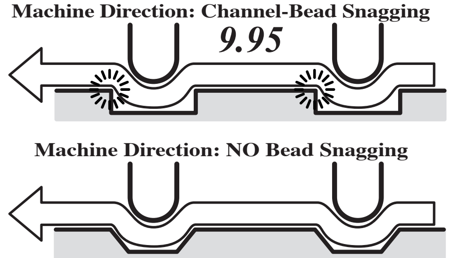
9.93

The ***fifth*** benefit of a tapered channel relates to sheet break-up and bead snagging. All of the crease channels oriented at right angles to the machine direction of the diecut sheet, ***see illustration 9.93***, have a tendency to catch and temporarily snag the leading edge of the bead. ***See illustration 9.94***.

9.94

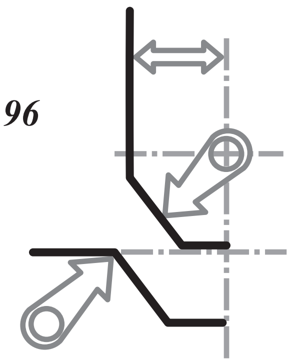


Even though this is a minor stress point undermining the integrity of the diecut sheet, the combination of all of the beads catching on each channel, can break the sheet apart. Therefore, the tapered channel can reduce the stress on the diecut sheet and has been proven to increase press speed. ***See illustration 9.95***.



In conjunction with the female channel a crease rule with angled

9.96

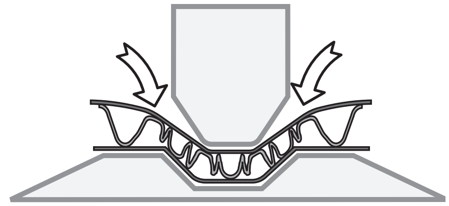


or faceted walls is used to complete the male-female tool system. ***See illustration 9.96***. The primary feature of this steel rule is the faceted tip, which provides the option of changing the angles of the faceted face. ***See illustration 9.97***.

9.97

The angle of the facets is important for several reasons.

9.98



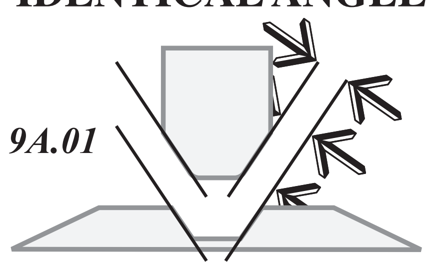
The first reason is to enable a more efficient method of compressing and driving a fluted material into the female channel, without bursting the surface of the material, or in developing an excessive amount of pressure. ***See illustration 9.98***. This can be described as a progressive crease, as it gradually increases compressive force on the fluted material as it is driven further toward the female tool.

9.99

The second reason is the necessity of creating a deformation bead. This requires driving the material into a channel to permanently deform the material to the shape of the female channel. ***See illustration 9.99***. If the

IDENTICAL ANGLE

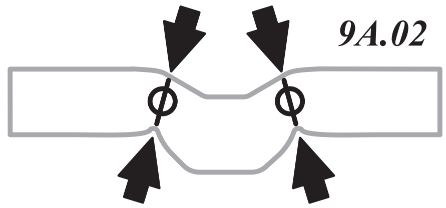
9A.01



BALANCED PRESSURE

angle of the facets and the angle of the channel wall are identical, the degree of pressure is applied evenly to the material to create the optimal

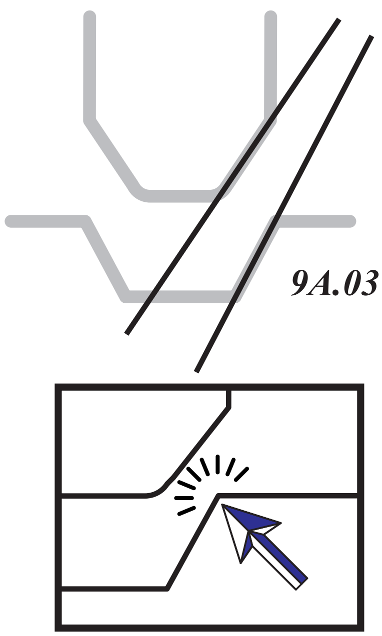
9A.02



Precise Fold Points.

bead shape. ***See illustration 9A.01***.

However, in addition to deforming the material to follow the profile of the female channel, it is important to apply higher pressure between the male crease rule and the upper corner of the female channel, to precisely define the crease fold points. ***See illustration 9A.02***.

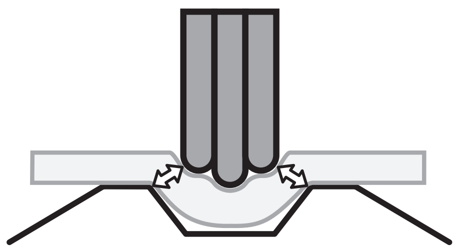


9A.03

Therefore, if the angle of the crease rule facet is slightly greater than the angle of the channel wall, the crease rule will adopt a ***"wedging"*** action, to apply greater and greater pressure at the Critical Distance pinching point. ***See illustration 9A.03***.

This will both ensure the bead is deformed to the shape of the female channel, and it will ensure the crease shear points are well defined. ***However, what is really important about this method, is as the crease is driven further toward and into the female channel, the usual wear is compensated for by the increased "wedge" pressure on the upper corner of the crease channel! In other words, this set-up automatically compensates for make-ready pressure changes and progressive female upper corner channel tool wear, to maintain the pinching force and to ensure consistent crease formation and folding.***

9A.04



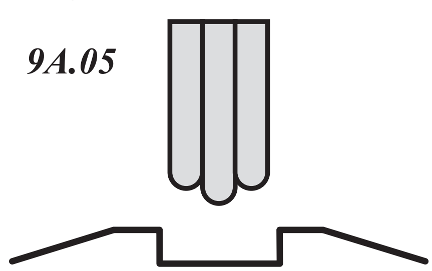
Naturally, the angles of the crease rule facets can be varied for different effects and to achieve different folding outcomes.

Testing this method of creasing has proved to be remarkably effective in fluted crease formation, and it has demonstrated unique abilities to create precise, consistent and repeatable folding performance.

4: Tier Creasing

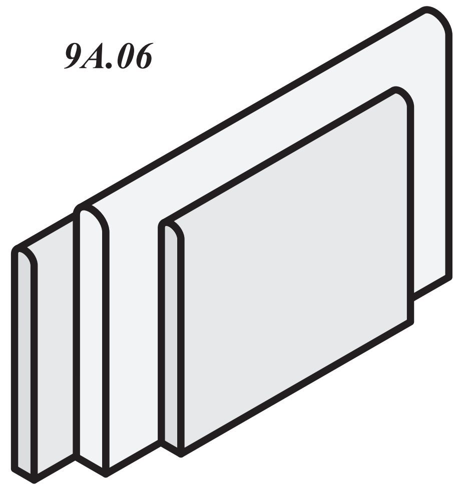
The fourth, and final set of tool parameters for fluted crease formation is the creation of what we call a Tier Crease set-up. ***See illustration 9A.04***. As in the previous example, the Tier Crease is matched with a Tapered Channel, however, for Reverse Folding the standard rectangular channel will work also.

9A.05



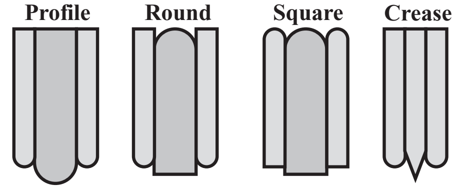
See illustration 9A.05.

9A.06



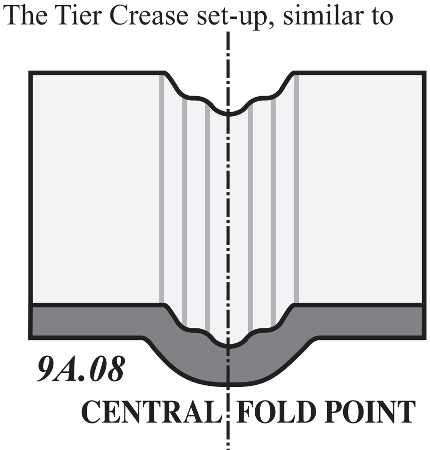
The crease is formed from three pieces of steel rule, ***see illustration 9A.06***, which can be individually varied in height and in pointage to provide a multitude of crease formation options. ***See illustration 9A.07***.

9A.07



The distinct advantage this provides in Reverse Creasing/Folding, is the higher center crease forms a deeper central indentation, ***see illustration 9A.08***, around which the folding action will automatically align.

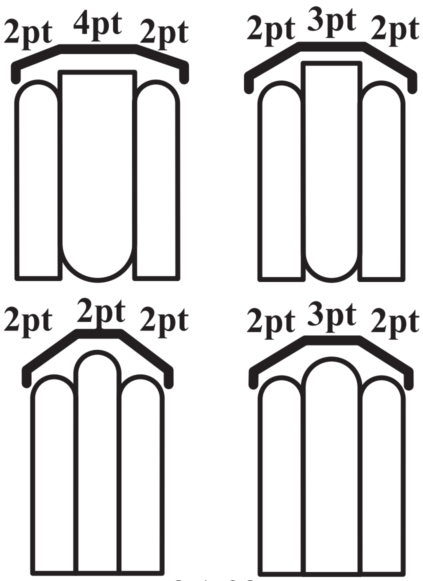
The Tier Crease set-up, similar to



9A.08

CENTRAL FOLD POINT

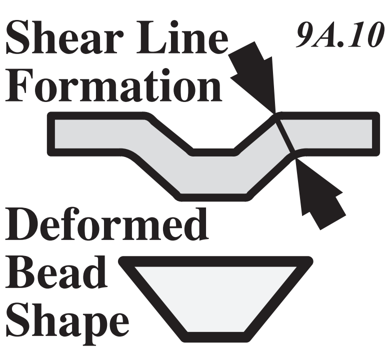
the Tapered Crease set-up, lowers the pressure required for crease formation. Also, as with the Tapered Crease, the Tier Crease is very effective at deforming the fluted material to conform to the shape of the female tapered channel.



9A.09

This is particularly important as it enables the higher flute thicknesses to be converted from the ***"normal"*** printed side of the material.

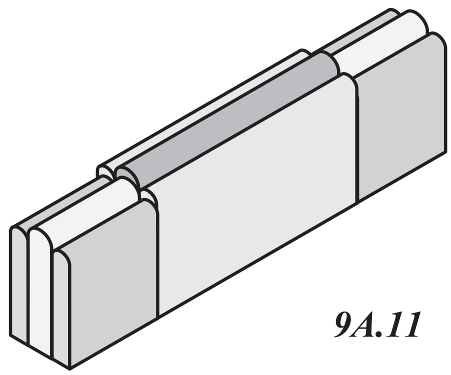
The pressure can be adjusted to give a more ***"progressive"*** crease profile, or a ***"flatter"*** crease profile, by simply manipulating the combinations of crease rule height and pointage. ***See illustration 9A.09***. These techniques are particularly important when changing crease formation based upon a 90-degree or a 180-degree fold; and in adjusting formation parameters parallel to the flute direction and at right angles to the flute direction.



9A.10

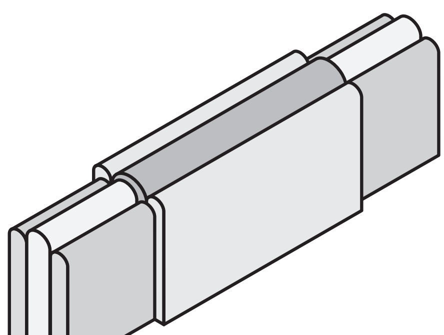
The degree of critical distance pinching force and the shape of the bead, ***see illustration 9A.10***, can be further tuned for specific folds and for specific applications, ***"Mixing & Matching"*** Tier Crease components.

For example, it is useful to change the height of the central portion of the tier crease to reduce panel bowing, and/or to lower or to increase the overall folding force as the container is erected. ***See illustration 9A.11***.



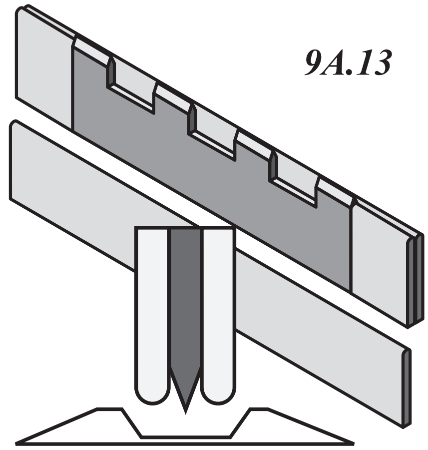
9A.11

In a similar fashion the pointage of the central section of the tier crease can be increased or decreased to generate specific folding characteristics. ***See illustration 9A.12***.



9A.12

Finally, the tier crease set-up can be modified to integrate Cut-Crease attributes by changing the central crease to a perforation knife/score,



9A.13

and or a bridged cutting rule. ***See illustration 9A.13***. This is particularly effective as the cut or score penetration depth can be precisely controlled and crease/spine splitting is eliminated.

Tier Crease set-up, just as the Tapered Crease set-up is highly effective, and although it was originally developed for Reverse Creasing, it is equally adept in forming creases in the traditional manner.

5: Fluted Creasing Development?

In addition to the Tapered Crease and the Tier Crease techniques, which are already being used in the industry, there are two further innovations which are worth considering. These are:

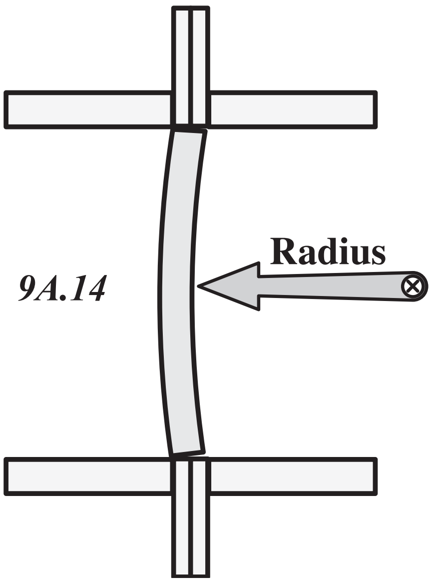
1: Curved Creases
2: Compression Creasing

Curved Creases

It is slightly unfair to classify Curved Creases as an innovation, as the technique has been applied successfully to solve a number of difficult folding challenges. However, the point is, it is seen as an effective problem solving tool, but it has not yet become established as a proven and reliable creasing option.

This is a pity, as the benefits of using Curved Creases in Fluted Folding applications are difficult to ignore. Some of these technical advantages include:

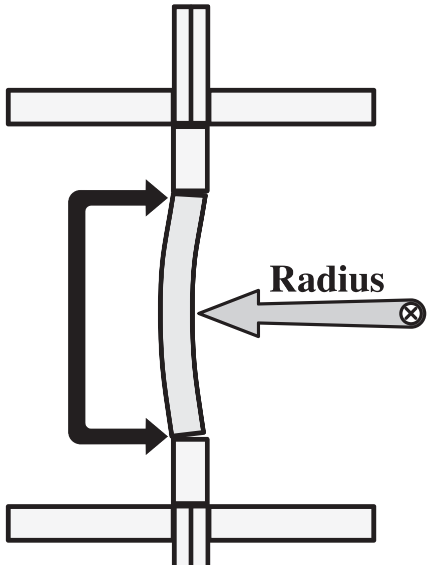
- ➔ ***A Positive "Snap" Fold***
- ➔ ***A Directionally Aligned Fold***
- ➔ ***Reduce Leverage Constraints***
- ➔ ***Minimize Panel Bowing***
- ➔ ***Increase Crush Protection***
- ➔ ***Bridge & Integrate Flutes***
- ➔ ***Control Folding/Opening Force***
- ➔ ***Improve Parallel Folding***
- ➔ ***Improve Structural Design***
- ➔ ***Increase Finishing Speeds***



9A.14

So what is a curved crease? A crease is a curved crease when it forms an arc from the start to the end of the crease, ***see illustration 9A.14***, or from the start and the end of a section of a crease. ***See illustration 9A.15***.

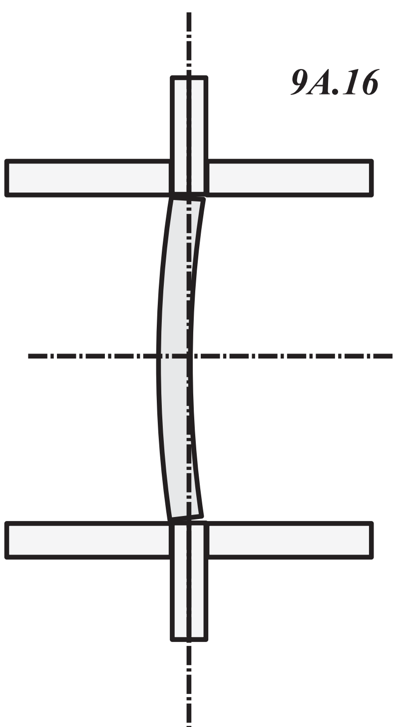
(Note: In all the Curved Crease illustrations, the curved creased sections are drawn with an exaggerated curvature. This is to make the diagram understandable, however, in practice, the degree of crease curvature is so slight it is invisible to all but the structural designer, the diecutter, and the diemaker. It is rare for an end user of a container to even notice the curvature of key crease/folds.)

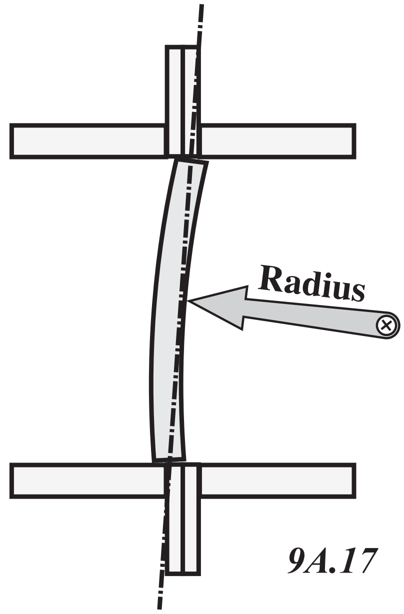


9A.15

For most applications the degree of curvature is balanced around a centerline, at 90 degrees to the start and end point of the crease. ***See illustration 9A.16***. However, there are applications where the crease is both curved and skewed, ***see illustration 9A.17***, and/or forms part of an ellipse. ***See illustration 9A.18***.

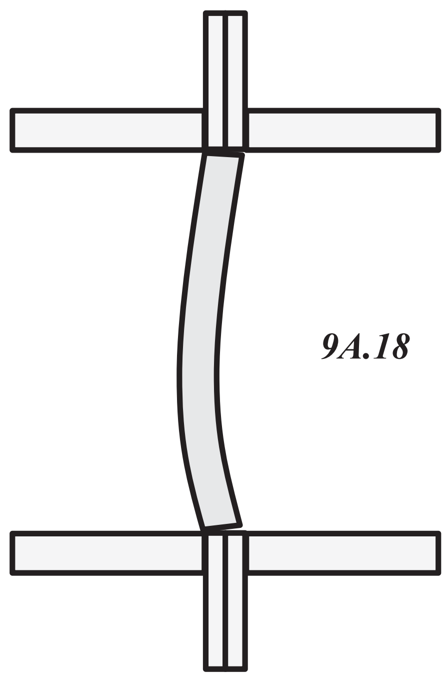
9A.16





9A.17

There are many technical advantages and a solid argument for integrating some form of Curved Crease folds into every design! In chapter 4 some of these advantages were discussed,

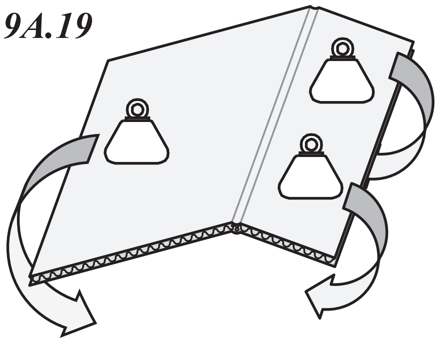


9A.18

however, to reinforce the importance of curved creases, let us examine just one facet of this innovative option.

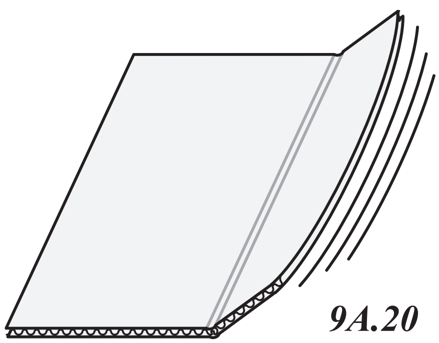
Reduced Leverage Constraints, is focused on the problem of a hinge intersection, combining a wide panel with a very narrow panel.

See illustration 9A.19. Experience demonstrates that it is difficult to get this fold to be aligned correctly,



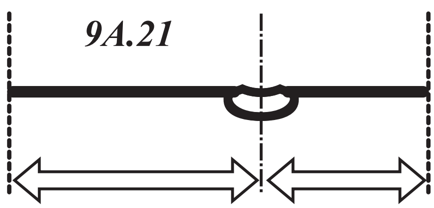
9A.19

and the amount of force required to fold the narrower panel, will result in severe bowing, and in practice eliminate this type of structural design feature. ***See illustration 9A.2***0.



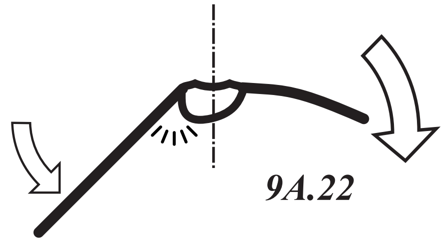
9A.20

The term ***Leverage Constraint*** is defined as an imbalance in leverage between two connected/hinged panels of unequal length. ***See illustration 9A.21***. Because the longer lever



9A.21

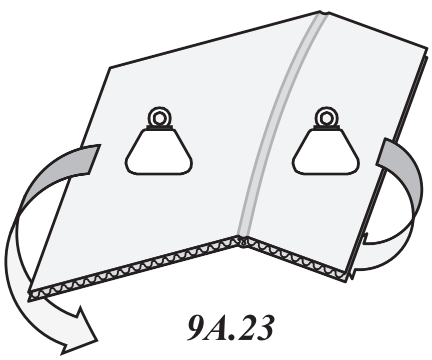
can apply more force to the bead intersection, the crease generally folds on the shear line adjacent to the long lever. ***See illustration 9A.22***. This causes bead binding at the junction of the long lever and the bead, which translates to even greater pressure on any attempt to fold the narrower panel, around the shear



9A.22

pivot point, on the short lever side of the bead.

The use of a curved crease between these panels of unequal leverage, changes the balance of power. By curving the crease we are both reducing the degree of resistance and we are tensioning the shorter panel so it will fold square and without bowing. ***See illustration 9A.23***.



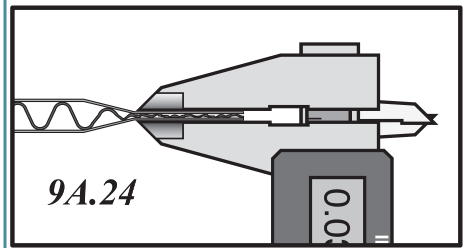
9A.23

To summarize, Curved Creases are an important and an unfortunately under utilized option in the designer toolbox. Curved Creases provide unique folding attributes and they solve complex structural performance problems in carton folding, in gluing, and in automated packaging.

Compression Creasing

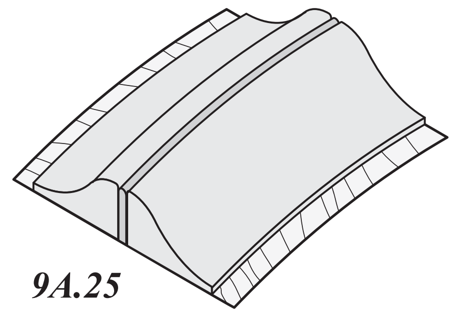
Compression Creasing is a technique designed to crush the fluted material as part of the crease formation process, and to ensure precise and balanced folding around a central bead.

The majority of formulas used in fluted crease calculation, use the crushed dimension of the inner and outer liners and the central fluted medium to calculate female channel width. ***See illustration 9A.24***.



9A.24

This is based upon the practical reality, that crease formation and bead deformation take place ***"after"*** the materials is almost fully compressed. This is accomplished in Rotary Diecutting by adding tapered resilient crush zones to either side of the crease rule. ***See illustration 9.25***.



9A.25

This works well in Rotary processing because the added pressure this requires is ***"incrementally"*** applied. This means only part of the material is being compressed at any given time, as the steel rule die rotates trapping the fluted material against a rotary soft anvil.

By comparison platen diecutting is a simultaneous process, where everything happens at the same time. As a result, the added pressure generated by increasing the compression force beside each crease, using dense enough ejection material would result in an excessive amount of resistance.

As a pragmatic alternative, a method of compressing a limited area of the fluted material, from the ***"inside"*** of the material, using specially shaped

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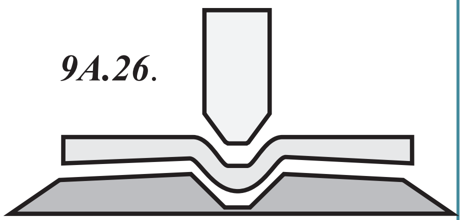
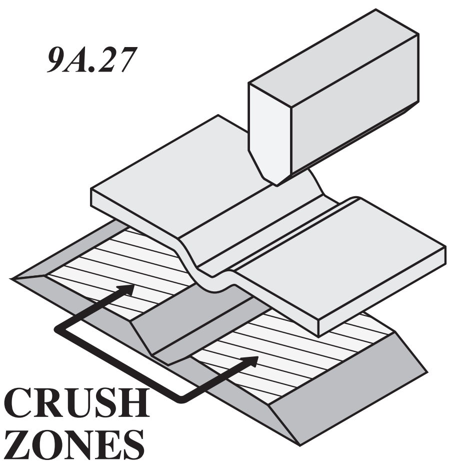
Matrix Channels, is an innovative alternative. ***See illustration 9A.26***.

9A.26.

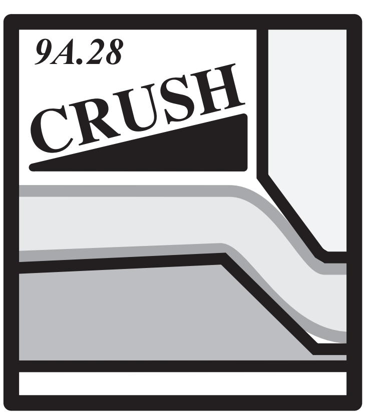


In this method of creasing, the fluted material is crushed from the underside or the inside surface of the fluted material. The crushing effect relies primarily on the action of the crease punching the material into the channel.

9A.27

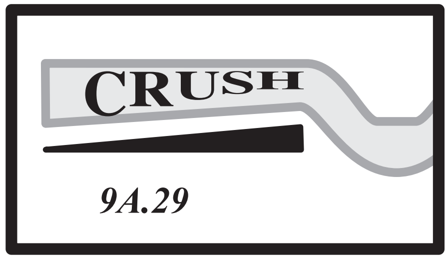


The combination of crease rule debossing pressure, and the tapered crush zones of the surface of the matrix, ***see illustration 9A.27***, minimize marking to the printed surface of the container.



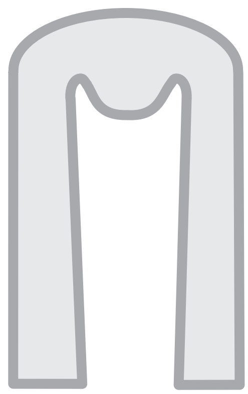
9A.28

The tapering also has the advantage, just as the rotary counterpart, of concentrating the degree of crush close to the channel edges, and to the eventual bead. ***See illustration 9A.28***.



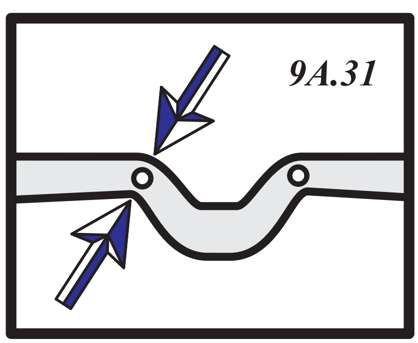
9A.29

Another key advantage of this approach is by crushing the material on the inside of the fold, ***see illustration 9A.29***, clearance is provided when folding through 180 degrees. ***See illustration 9A.30***.



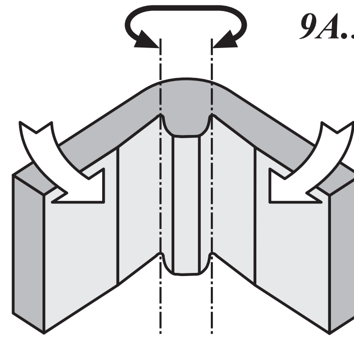
9A.30

This helps to eliminate any possibility of Bead Binding, and the progressive crush of the ***"inside"*** of the material helps to cleanly define the twin shear lines. ***See illustration 9A.31***.



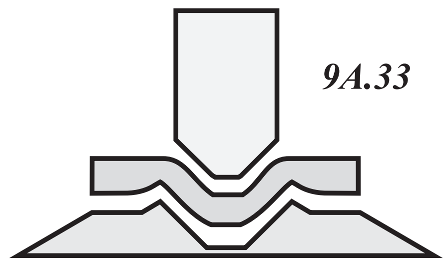
9A.31

To further improve the definition of the twin shear lines, around which the panels will rotate, ***see illustration 9A.32***, a variation on this matrix design was tested which ***"exaggerated"*** the upper channel corners. ***See illustration 9A.33***. The difference between this channel



9A.32

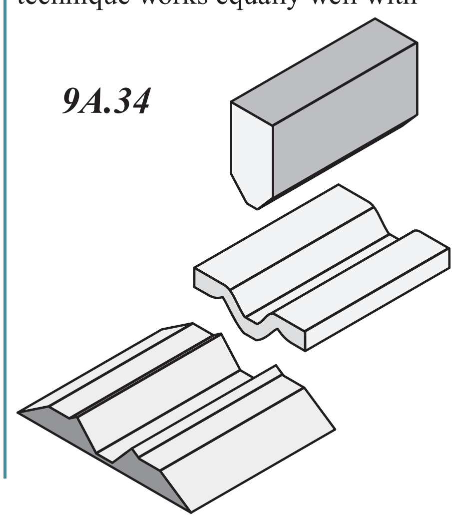
profile and the standard profile is the upper channel corners have been raised to form ridges. In the illustration these are shown as sharp



9A.33

corners, but they could also have a slight radius. The goal is to create deeper parallel indentations at the shear point lines on both sides of the bead. The illustration also shows the combination of the tapered channel with a tapered crease rule, ***see illustration 9A.34***, however, this technique works equally well with

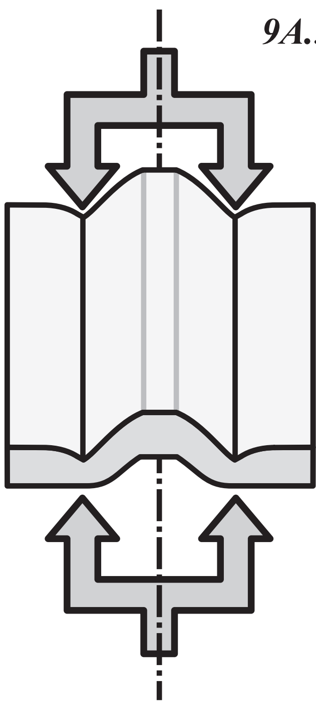
9A.34



a standard crease rule and the Tier Crease rule method.

The objective of this approach is to overcome the inherent resiliency of fluted materials by creating two deep parallel grooves, ***see illustration 9A.35***, which will force the material to fold evenly around the bead, and the centerline of the crease.
The twin deep indentations are designed to force folding around

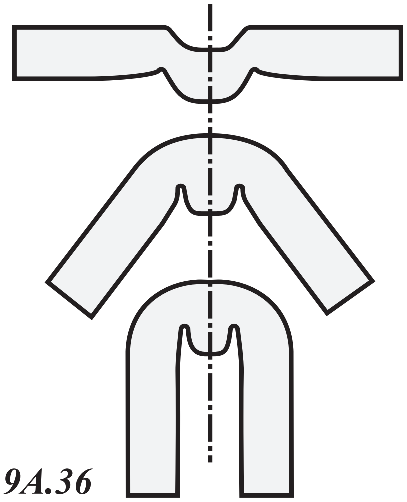
9A.35



these points, but they also serve another important purpose. The clearance provided by these grooves is effective in eliminating bead binding, when folding through 180 degrees. ***See illustration 9A.36***.

Compressing the material from the ***"inside-surface"*** using a specially shaped matrix strip is an interesting approach as it serves the essential purpose of partially crushing the material as part of the crease formation action.

In addition, the integration of raised



9A.36

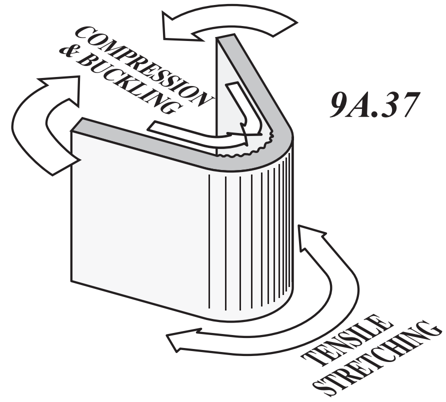
ridges on the upper corners of each channel, provides a more effective method of forming shear line crush points. This improves folding alignment and symmetry, and it eliminates bead binding.

The Tapered Crease and Tier Crease Methods, and the use of Curved and Compression Creasing provides an interesting array of additional tools for the structural container designer.

As the degree of innovation in the construction of fluted materials continues, and the development of more and more complex diecut products accelerates, it is critical to test, to evaluate and integrate these options into standard operating procedures.

6: Reduced Bead Creasing & Fluted Creasing?

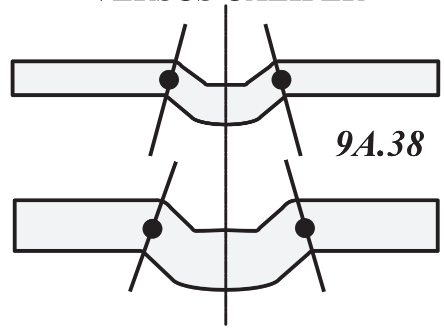
When materials are creased and folded through 90 and then 180 degrees, the material on the ***"inside"*** of the fold, at the junction between the two folding panels, must compress as the material is forced together. Simultaneously, the ***"outside"*** surface of the fold, centered on the fold point, must stretch to absorb the tensile strain. ***See illustration 9A.37***.



9A.37

As the material gets thicker the degree of compression increases, as does the tensile stress on the outer surface or ***"spine"*** of the fold. The creation of a central deformation bead in fluted creasing, bounded by two pivot shear lines, ***see illustration 9A.38***, is designed

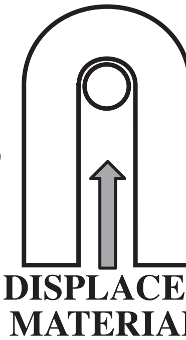
SHEARING POINTS VERSUS CALIPER



9A.38

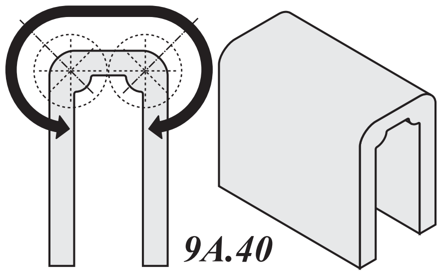
to allow the material to fold at the pivot points with sufficient space between the folding panels to allow an unobstructed expansion of compressed material. ***See illustration 9A.39.***

9A.39



DISPLACED MATERIAL SPACE

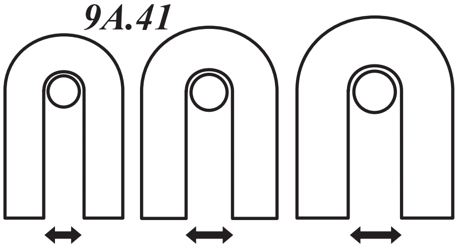
As material thickness increases it becomes necessary to form two parallel creases, to create enough space between the panels to enable folding. ***See illustration 9A.40***.



9A.40

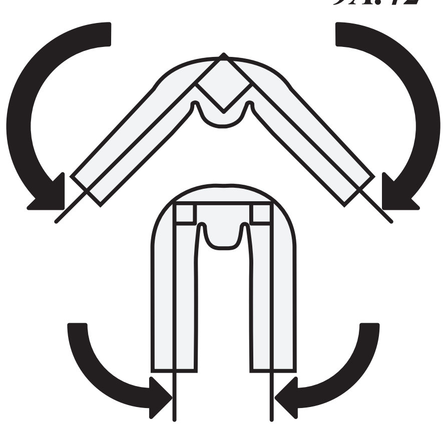
Therefore, what is important in fluted creasing is to reduce the size of the bead to allow folding without binding between the bead and the inner surface of the folding panels. (The thicker the material, the larger the bead, the greater the gap between the materials, and unfortunately, the greater the stress on the outer spine of the fold. ***See illustration 9A.41.***)

9A.41



The second key requirement is to shear, pinch and indent the material, in two parallel lines, on either side of the central bead, and with sufficient force, to cause a balanced folding action as the panels are rotated. ***See illustration 9A.42***.

9A.42



In summary, every type of creasing specified in this chapter, is far more effective, when the crease formation and folding application, and the tools are designed using a clear understanding of how the paperboard and the fluted hinge are formed.

7: Summary

It is our contention that the development of the principles, the practices, and the design of male and female tooling for Fluted Converting, has been compromised by integrating, methods and practices designed for Paperboard Converting.

While the paperboard crease and the fluted crease fulfill identical roles, the key differences in the structure of each material demand a different approach to creasing formation based upon the critical folding characteristics of each material.

In paperboard, creasing the flexible, delaminated bead, is the engine room of the folding action. However, in fluted creasing the pre-formed, deformation bead, plays a secondary role to the twin parallel shear lines, which control folding.

The most effective method of generating a pre-formed, correctly shaped bead, and precisely pinched twin shear lines, is to adopt Reduced Bead Creasing Parameters.

Chapter 9:
The Difference Between Paperboard & Fluted Creasing: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ The major difference between a Paperboard Crease and a Fluted Crease is the Paperboard Crease utilizes a flexible, Delaminated Bead, which will compress and change shape as the panels are folded.

- ✓ The major difference between a Paperboard Crease and a Fluted Crease is the Fluted Crease utilizes a Deformation Bead, which must be ***"pre-shaped"*** as it is unable to change shape under the stress of folding.

- ✓ In Paperboard Creasing Folding Force is proportionate to:
  1: The Length of the Folding Lever
  2: The Difference in Lever Length
  3: The Width of the Folding Panels

- ✓ The key feature and considerable variable in paperboard creasing, is the grain direction of the material, and the orientation of the dominant grain direction to the crease/fold.

- ✓ The paperboard crease and the fluted crease appear superficially to be very similar. However, in stark contrast the fluted crease is a ***Deformation Crease***, in which the material is crushed and punched into the counter channel.

- ✓ While the traditional paperboard crease utilizes 75% Lateral Draw and 25% Compressive Force to form the bead, because the fluted material is trapped as it is crushed, the distribution of force is 25% or less Lateral Draw, and more than 75% of Compressive Force.

- ✓ In the paperboard crease the folding action or the pivoting of the panels around the centerpoint of the bead converts the partial internal delamination of crease formation into full internal delamination, under the leverage stress of the folding panels. However, in the fluted crease the folding action of the panels has the same dynamic impact on the bead, however, the bead has limited ability to compress, and therefore the force required to fold is far higher.

- ✓ What is critical in Fluted Creasing?

  1: The fluted bead is highly resistant to compression.
  2: This results in the fluted bead being too large for the folding application.
  3: The twin fold lines of a crease are often poorly defined in fluted creasing.
  4: Bead Binding inhibits the ability to consistently generate properly aligned or square folding.
  5: Bead Binding generates excess stress on the spine of the crease, generating spine fracturing and excess folding force
  6: Resistance to folding requires excess leverage, which makes it difficult to fold narrow panels.
  7: Resistance to folding requires excess leverage, which causes panel bowing.
  8: The thickness of the fluted composition material, makes crease formation and folding very different from paperboard creasing.

- ✓ The primary problem with Channel Creasing is channel binding. This means, that as the panels are folded and rotated the upper corners of the channel are also rotated closer together, and if there is insufficient clearance they will bind together.

- ✓ There are three interesting conclusions or guidelines, which should impact all design of tooling for fluted creasing.

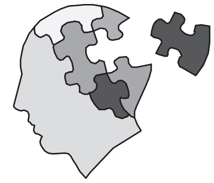
  A: *The Bead Size & Shape are* ***"Different"*** *at 90 and 180 degree of folding!*
  B: *The Bead must be* ***"Pre-Shaped"*** *for the angle of folding, in* ***"all"*** *of fluted creasing.*
  C: *Concentrated Pinching Force is required to create shear line pivot points in fluted creasing.*
  D: *The degree of applied pinching force is a function of the length of the attached levers or panels.*

Chapter 9:
The Difference Between Paperboard & Fluted Creasing: Questions?

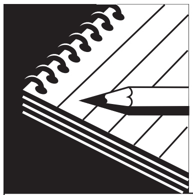
The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ What is a Delaminated Crease, and what is being delaminated, and why is it important?
- ✓ What is a Deformation Crease, and why is it vital to set-up the male and female tooling to "pre-shape" the bead?
- ✓ What is the percentage of Lateral Draw Force in Paperboard Creasing Compared to the Compression Force?
- ✓ What is the percentage of Lateral Draw Force in Fluted Creasing Compared to the Compression Force?
- ✓ Why is it necessary to make the parallel grain channel narrower in Paperboard Creasing?
- ✓ What is the percentage of Lateral Draw Force in Paperboard Creasing Compared to the Compression Force?
- ✓ What is Folding Force proportionate to?
- ✓ What is the first action of the male creasing rule in Fluted Creasing?
- ✓ Why is the alignment of the crease rule a critical issue when creasing parallel to the flutes?
- ✓ What is the difference in the reaction of the bead to folding in Paperboard Creasing as opposed to the reaction of the bead in Fluted Creasing?
- ✓ What are some of the folding problems that can occur when folding creases formed parallel to the flute direction?
- ✓ What are the Five things we learnt that were critical in Fluted Creasing?
- ✓ Why are thicker fluted materials converted from the ***"inside"*** of the material?
- ✓ What is ***"Channel Creasing,"*** how is it used, and why is it used?
- ✓ Why is it necessary to make the fluted bead different for folding through 90 degrees and when folding through 180 degrees?
- ✓ What does "Pre-Shaping" the bead mean in Fluted Creasing?
- ✓ What is Tapered Creasing, and why is it so effective in Fluted Creasing?
- ✓ What is Tier Creasing, and what specific application was it originally designed for?
- ✓ What is Compression Creasing, and how is the ***"underside"*** of the fluted material compresses or pre-crushed?
- ✓ How does diecutting from the ***"inside"*** surface of fluted material undermine the cleanliness of the diecut edge?
- ✓ What are some of the important benefits gained by using a tapered or a faceted male creasing rule in fluted crease formation?
- ✓ What are some of the important benefits gained by using a tapered female matrix or counter channel in fluted crease formation?
- ✓ What are some of the important folding benefits gained by using Curved Creases in fluted crease formation?

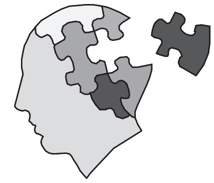
Brainstorming, Notes & Ideas



"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*



Brainstorming, Notes & Ideas

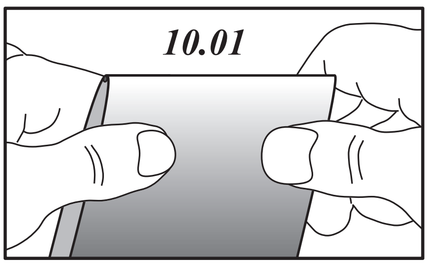


"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

Chapter 10:
The Keys to Optimal Crease Formation

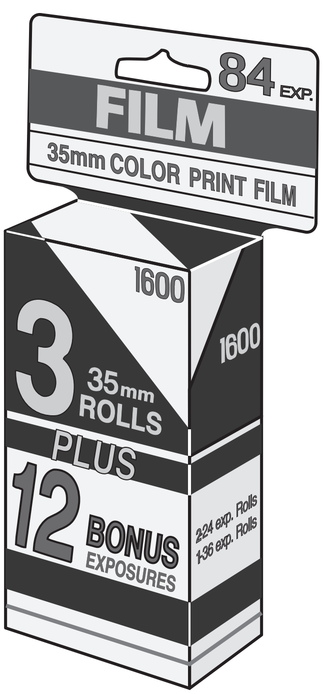
Ultimately, there are a number of valid tests designed to assess the performance and the acceptability of the folding action. All of these techniques provide important and valuable diagnostic tools, which help determine what caused a specific carton or container construction/ erection problem. The feedback of information is vital to problem solving, to ongoing education, and to progressive improvement.

10.01

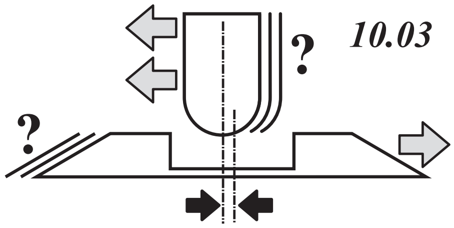


The dilemma for the diecutter is many of these tests are post process, and provide little direction in improving immediate on-press performance.

10.02

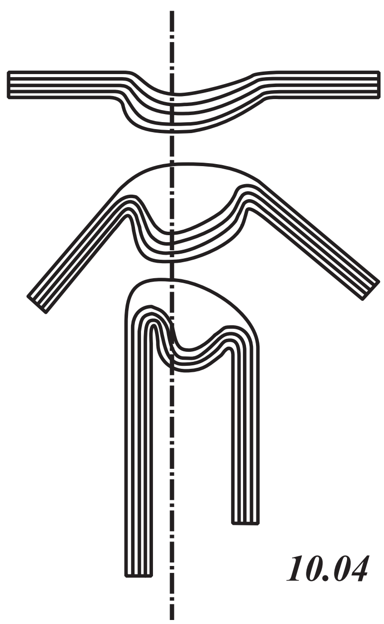


10.03



LATERAL TOOL MISALIGNMENT

The most common on-press test is to fold the panels through 180 degrees and to examine the spine of the crease for failure. ***See illustration 10.01***. While this is important to the aesthetic impact of a point-of-purchase sales tool, ***see illustration 10.02***, and it will demonstrate extreme problems in crease formation, it is a poor diagnostic tool in determining the relative health of crease formation performance.

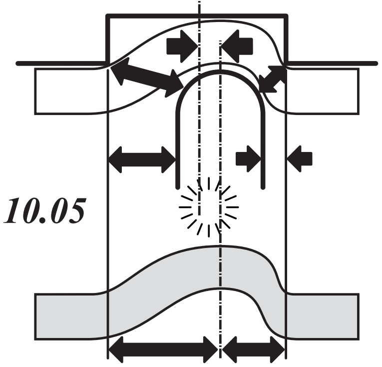


10.04

For example, the Achilles Heel of diecutting is a lateral misalignment between the male steel rule die, and the female channel matrix or counter. ***See illustration 10.03***. Even the slightest misalignment will generate asymmetric crease formation, and asymmetric folding. ***See illustration 10.04***.

The problem is often referred to as ***"One-Sided-Creasing," see illustration 10.05***, and it is the most common failure in crease formation.

10.05



There are three questions to be answered in solving these problems:

1: What Causes the Problem?
2: What are the Consequences?
3: How is the Problem Detected?

1: What Causes the Problem?

The are a number of potential causes of one sided creasing. They include:

- ***→: Inaccurate Tool Alignment***
  - ***→: Steel Rule Die Location***
  - ***→: Counter Plate Location***
  - ***→: Excess Pressure Lock-Up***
- ***→: Inaccurate Tool Fabrication***
  - ***→: Laser Verticality***
  - ***→: Dieboard Shrinkage***
  - ***→: Steel Rule Dish***

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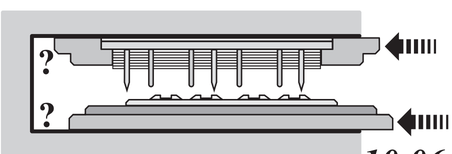
➔*: Tool Register Variation*

- **➔*: Worn Pins-Register Holes***
- **➔*: Adhesive Application***
- **➔*: Matrix Movement***
- **➔*: Counter Movement***
- **➔*: Crease Competition***

➔*: Inaccurate Tool Alignment*
Steel Rule Die & Counter Plate Location

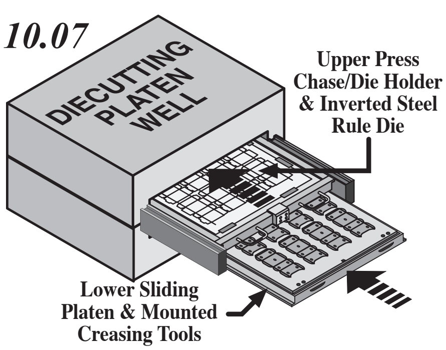
In the majority of platen diecutting systems, the steel rule die is slid into place and locked into an inverted position. The cutting plate, or the entire lower bed of the press, is also slid into position and clamped to provide perfect alignment between the upper male tool and the lower female tool. ***See illustration 10.06***.



10.06

This is an effective system if maintained & cleaned regularly. However, progressive wear, mechanical heat, and the accumulation of cutting debris, mixed with machine oil, demand this become a critical check point in diecutting. Unfortunately both the steel rule die and the lower sliding bed are frequently unlocked and slid out on the support arms, ***see illustration 10.07***, for inspection & rework, and for clearing sheet break-up.

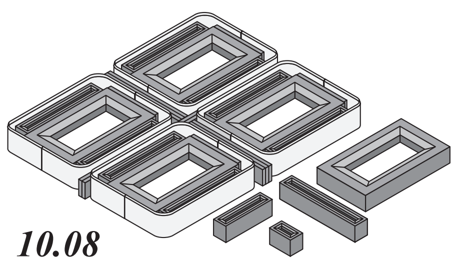
10.07



Tool-to-tool alignment must be checked by examining the rear of the first diecut sheet produced after the tools are re-secured in the press. Different press technology employ different methods, however, the male and female tool have to be unlocked, removed, reinserted, and re-locked into position many times per production order. Therefore, it is vital to perform a simple and easy alignment check after every change in the original tool position.

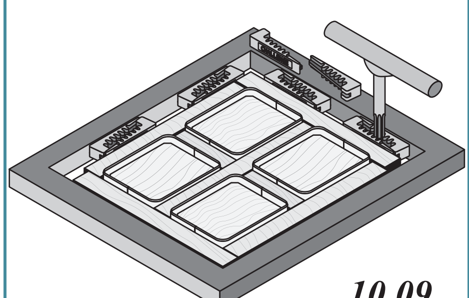
➔*: Inaccurate Tool Alignment*
Excess Pressure Lock-Up

The original steel rule die system was made by utilizing existing *Composing & Typecasting Metal* from the ***Letterpress Printing Process***. ***See illustration 10.08***. This was quickly superseded by the use of individual sawn blocks, which



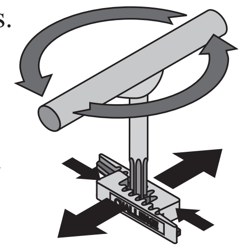
10.08

were assembled to form a steel rule die. ***See illustration 10.09***. To clamp these individual blocks and steel rule together, and to provide a method of inserting them into the Cylinder



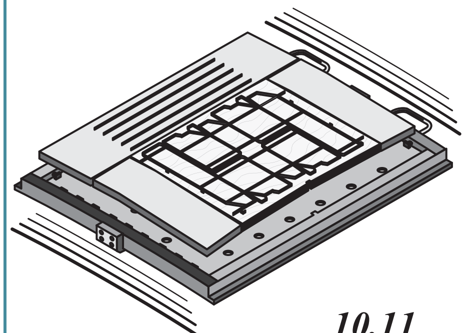
10.09

Presses, used at this time, required a steel frame and the use of Toothed Quoins or wedges. ***See illustration 10.10.***



10.10

This combination enabled the die and the chase to be ***"locked or clamped"*** together, under considerable pressure. When the high speed platen press came on the scene, which required the steel rule die to be inverted, locking the die into the ***"chase"*** used by these presses, it often resulted in ***"loose-rules!"***



10.11

This prompted the use of excessive pressure, which with the advent of Jigged, Lasercut, and Routed one-piece dies, was rendered unnecessary.

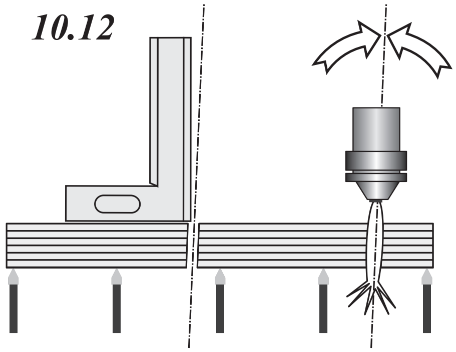
Unfortunately, the continued practice of over-pressurization warps the steel rule die and chase combination. ***See illustration 10.11***. This will result in counter and matrix movement, uneven channel wear, and one-sided creasing!

➔*: Inaccurate Tool Fabrication*
Laser Verticality.

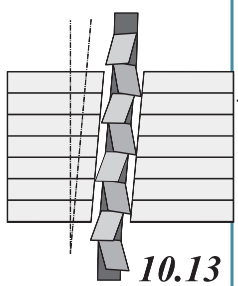
One of the dangerous assumptions in toolmaking, is to make assumptions! A common misconception is the advanced technology of lasercutting automatically ensures a perfect slot cut into the perfect tool.

A laser is an optical system, and if the optics are not regularly cleaned, or are in marginal condition, or are not properly aligned, then the beam used to cut the dieboard kerf may not be vertical to the base of the dieboard material. ***See illustration 10.12***.

10.12

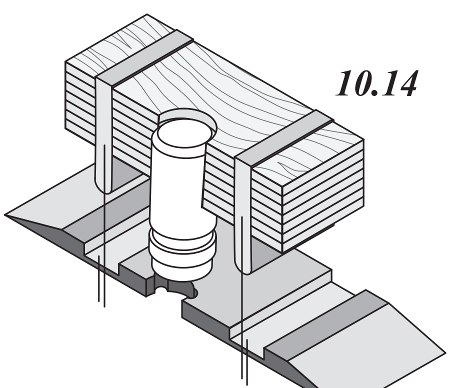


This can also be caused by the bed of the machine not being perfectly level and at 90 degrees to the emitted laser beam.



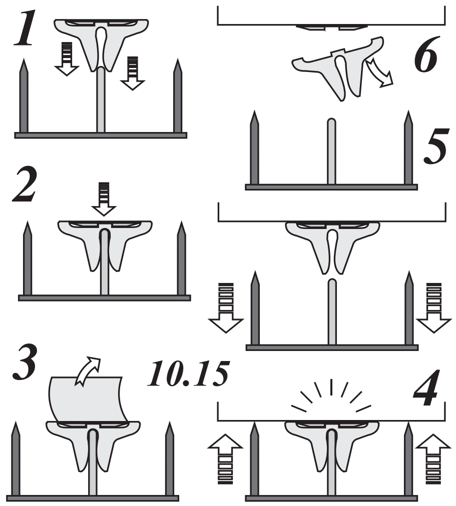
10.13

The same result can be generated in Jig Sawing and in Routing if the tools are not properly aligned, or the tools are not sharp, and/or the speed of cutting is such to cause deflection of the tool. ***See illustration 10.13***. In terms of male and female crease tool alignment, this can specifically cause a problem with fiberglass counters. ***See illustration 10.14***.



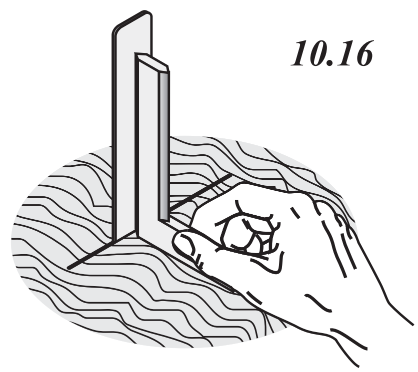
10.14

This is less of a problem with Matrix Strips as the strips are attached to the crease rule in the die, and transferred to the cutting plate. ***See illustration***



10.15

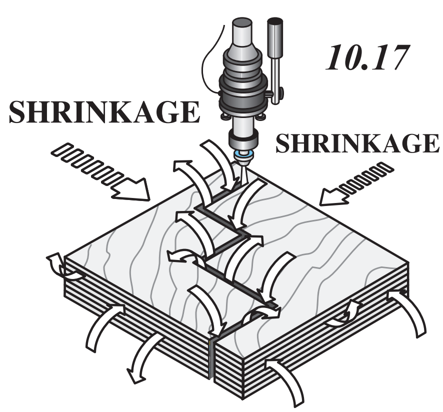
***10.15**. (Note: Even though the problem of one sided creasing is eliminated the misalignment of the tool will cause the subsequent crease/fold to be out of position.)*



10.16

To avoid any assumptions it is important to check the verticality of every dieboard produced, whether lasercut, jigged or routed. ***See illustration 10.16***.

10.17

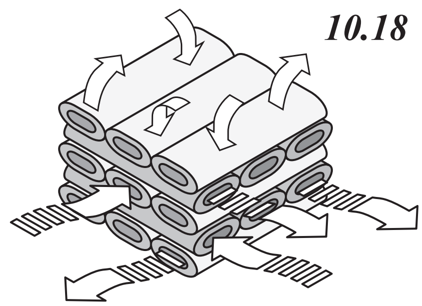


➔**: *Inaccurate Tool Fabrication***

Dieboard Shrinkage

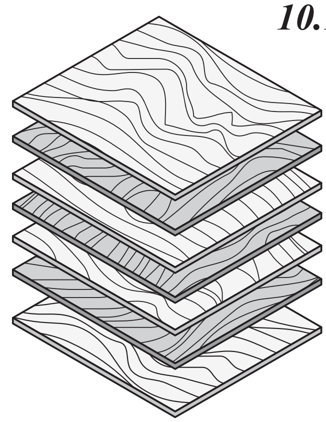
One of the common sources of tool-to-tool misalignment is dieboard shrinkage. Every dieboard shrinks during machining, as the inner veneers of the plywood panel

10.18



are exposed to the surrounding environment. ***See illustration 10.17***. As the moisture content of plywood is almost twice that of the average manufacturing operation, the flow of air around and through the dieboard removes/leaches moisture from the wood veneers.

10.19



As plywood is made from cellulose fiber, s***ee illustration 10.18,*** and cellulose fiber shrinks when the moisture content is reduced, the dieboard will shrink. However, because of the veneer structure, and the rotation of each veneer sheet, ***see illustration 10.19***, shrinkage will be twice as much parallel to the top and bottom veneer layer grain direction, as it will be to the cross machine grain direction. ***See illustration 10.20***.

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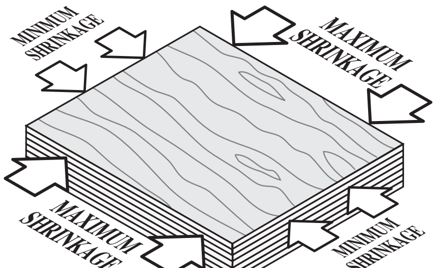
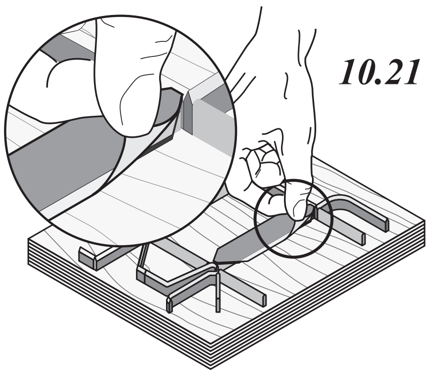


10.20

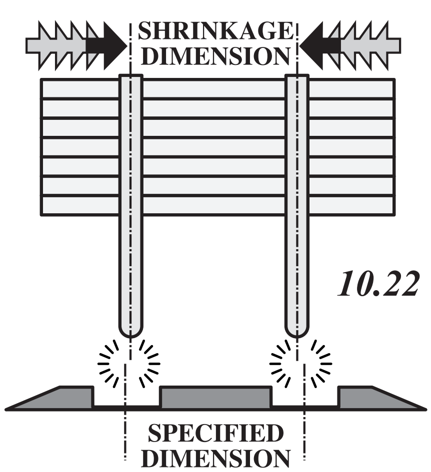
As before, this shrinkage will not impact the matrix strips, as they are located directly from the crease rule mounted in the finished, shrunk dieboard. ***See illustration 10.21***. (This does not mean however, the



10.21

diecut carton or container matches the original customer specification, and there may be folding alignment, gluing and cartoning issues, because of steel rule die shrinkage!)

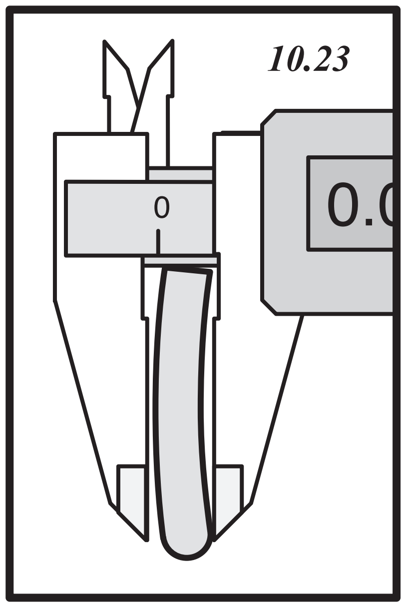
Unfortunately, the fiberglass counter, which was machined to the original dimensions of the design, will now be out of alignment with the shrunk steel rule die. ***See illustration 10.22***.



10.22

Naturally, the larger the counter, the greater the misalignment offset, and the smaller the counter, the less tool-to-tool registration will be affected.

A check of finished dieboard shrinkage must be a part of any effective tool inspection program, before the die is accepted for diecutting.



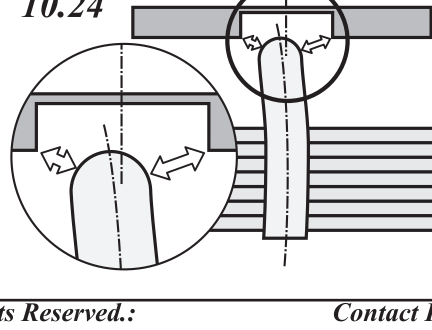
10.23

➔: *Inaccurate Tool Fabrication*

Steel Rule Dish

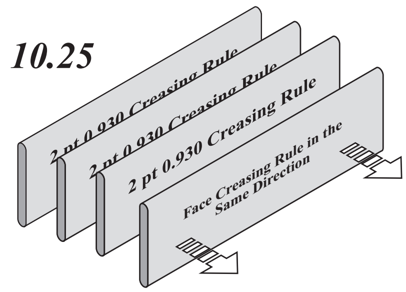
A not uncommon source of tool-to-tool misalignment is the Dish or the Concavity of the Crease Rule strip. ***See illustration 10.23***. This curvature from the base of the rule to the tip of the crease will cause a misalignment with the fiberglass counter, ***see illustration 10.24***, and result in generating a one-sided crease bead.

10.24

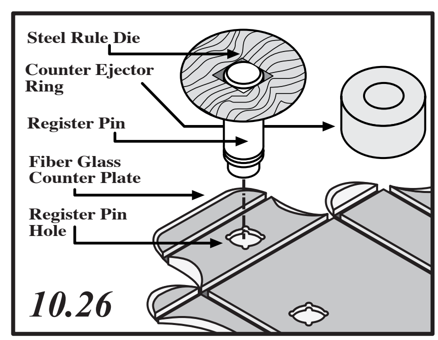


It is obviously important to avoid any assumption about any material used in either of the tools. Therefore, determining the degree of dish in creasing rule must become a standard operating procedure, before the steel rule is accepted into inventory.

10.25



It is also a useful practice to face all of the creasing rule in the same direction from one side of the die to the other. ***See illustration 10.25***. This technique will prevent a slight amount of dish on one crease rule, combining with a slight amount of dish on an adjacent crease rule, to increase the degree of misalignment.



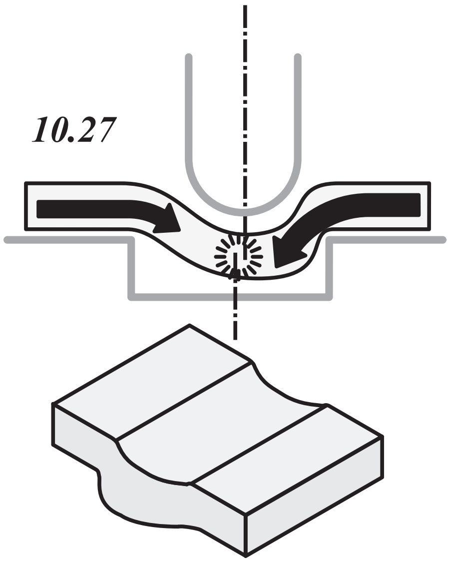
10.26

➔: *Tool Register Variation*

Worn Register Pins & Holes

When using fiberglass counters the integrity of tool-to-tool alignment is dependent on the accurate integration of a register pin, and a corresponding register pin hole in the fiberglass counterplate. ***See illustration 10.26***.

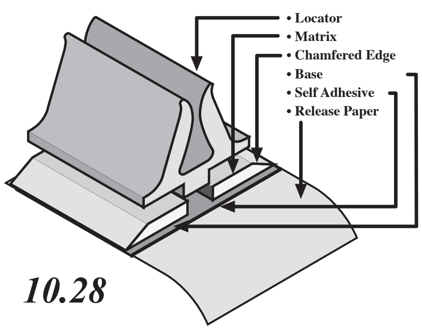
If the pins are damaged, if they are dirty or are they are inserted incorrectly, the alignment of the steel rule die crease rule, and the fiberglass



10.27

counter channel, will generate a one sided crease. ***See illustration 10.27***.

The counter register pins should be inspected, cleaned and replaced regularly, and the counter holes must be verified for the size and the cleanliness of the register pin hole.



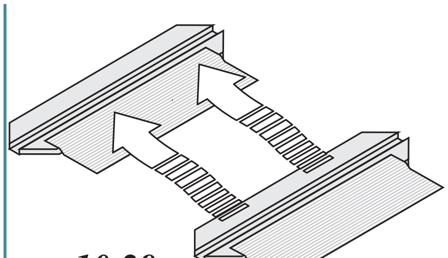
10.28

➔: Tool Register Variation

Adhesive Application

The Matrix Strip has a Self Adhesive layer, which is activated by peeling away the cover. ***See illustration 10.28***. This is generally very effective, however, it is important to clean the cutting plate thoroughly.

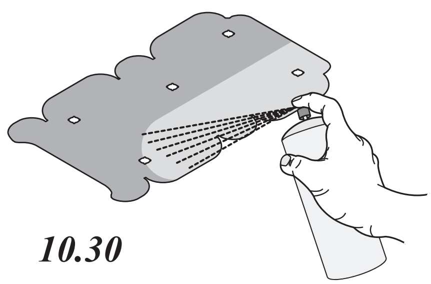
As an added precaution it is a sensible security measure to tape the leading edges of the matrix strips to the cutting plate surface to ensure the adhesive is supported, and to provide a smoother flow/ramp for



10.29

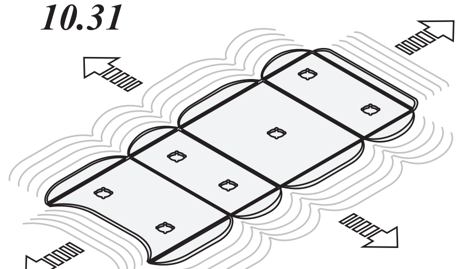
the oncoming diecut sheet. ***See illustration 10.29***

The fiber glass counter has a far greater surface area to apply adhesive to, however, although self adhesives are available, the preferred method is to spray the back of each counter with a contact adhesive. ***See illustration 10.30***.



10.30

This is generally effective, however, if the adhesive coat is uneven, if there is too much adhesive applied, and if the cutting plate is greasy or dirty, there is a strong possibility the counter will move. ***See illustration 10.31***.



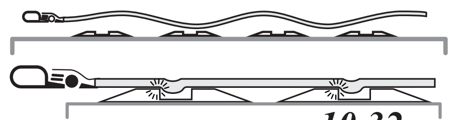
10.31

Obviously, even if there is a slight misalignment during transfer or the counter moves under the stress of diecutting, this will result in one-sided creasing.

➔: Tool Register Variation

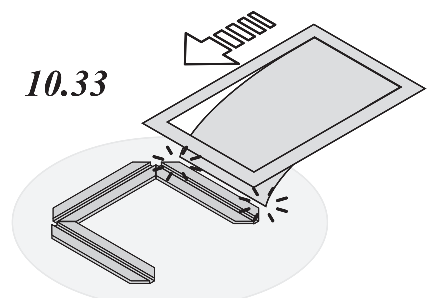
Matrix Movement

The greatest challenge to matrix tool-to-tool registration integrity, is the small footprint for secure adhesion of each strip to the cutting plate. This is often undermined by the impact of repetitive bead snagging, ***see illustration 10.32***, in the machine



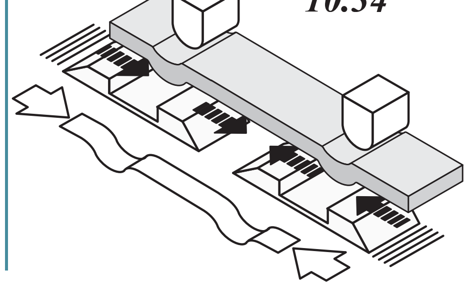
10.32

direction; diecut part snagging, ***see illustration 10.33***, again in the machine direction; and crease to crease competition, where draw forces pull the matrix strips together, which can happen in any direction. ***See illustration 10.34***.



10.33

This can be a severe problem on web diecutting presses, where the diecut sheet is pushed forward, and the paperboard and the press become relatively hot. This can rapidly undermine the adhesive bond and drive the matrix out of position.



10.34

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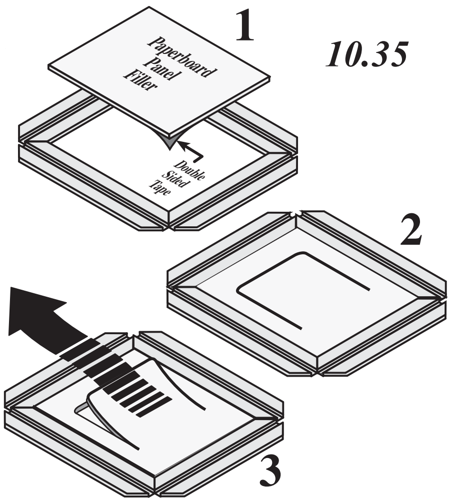
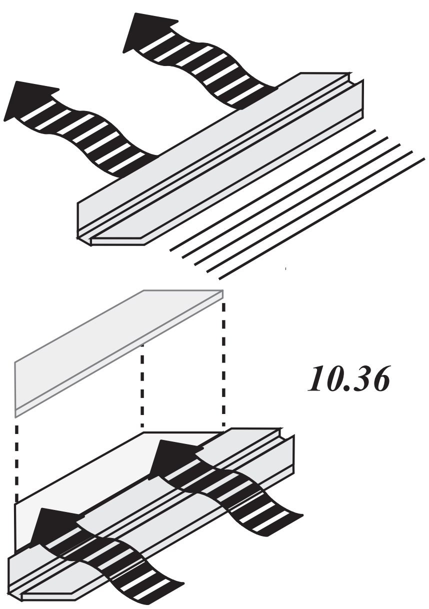
There are several remedial steps, including pre-cut fillers integrating a resilient ramp, ***see illustration 10.35***, which are cut accurately to size using a tangentially controlled plotting table. Taping as shown in ***illustration 10.29***, and the integration of a trailing edge filler. ***See illustration 10.36***. To save on-press time these are all pre-cut using a plotting table.



10.35

While all of these precautions add time to make-ready and press down time, if they are pre-organized effectively, the small amount of lost productive time pays benefits in optimal tool-to-tool alignment and stability for the length of the production run.



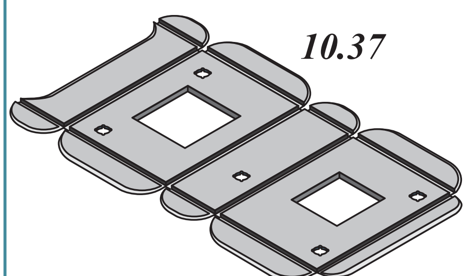
10.36

➔: *Tool Register Variation*

Counter Movement

If counters are transferred correctly, it is unusual that they will move or creep across the cutting plate. The exception to this is when there are higher temperatures generated in the platen. This is usually when a Web Fed Press is integrated in-line with printing, and heat is a primary by-product of accelerated drying.

To stabilize the fiberglass counter in these circumstances a heat resistant contact adhesive is selected rather than the standard adhesive. This type of adhesive will actually increase bond strength as the temperature rises.

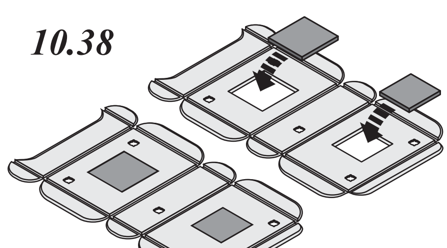


10.37

To stabilize counters, special rectangular apertures are cut in the center of the larger panels of the design. ***See illustration 10.37***. When the installation is complete special ***"stabilization-fillers"*** made from the same fiberglass material, and made to be an exact fit to the aperture in the counter, are glued directly to the cutting plate using an epoxy adhesive. ***See illustration 10.38***.

This is fast, simple and effective, and it ensures the counter is unable to move to create tool-to-tool misalignment.

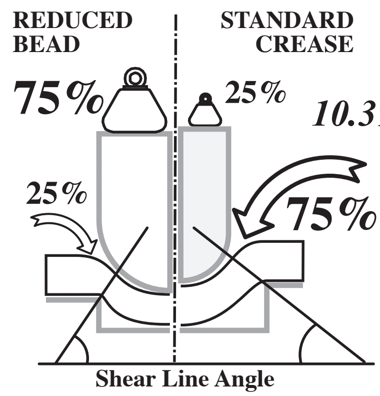
10.38



➔: *Tool Register Variation*

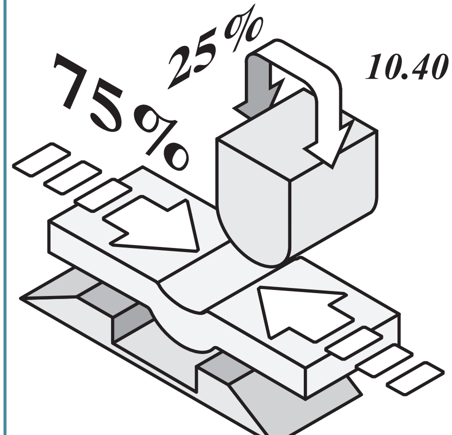
Crease Competition

One of the primary characteristics of traditional creasing is it relies heavily on lateral tensile pull or stress to shear the paperboard and form a delaminated bead. The balance between the lateral tensile force and the vertical compression force is approximately 75% to 25%. ***See illustration 10.39*** This



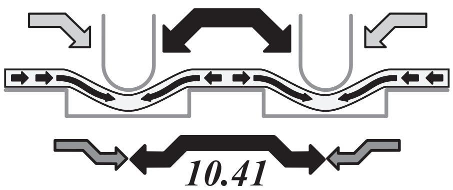
10.39

means that every crease is applying significant lateral stress on the material immediately adjacent to the formation of the crease. ***See illustration 10.40***



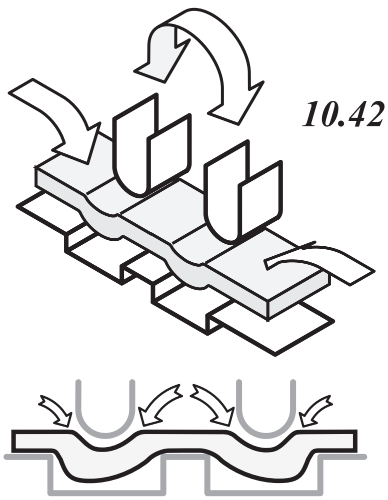
10.40

Unfortunately, if another parallel crease is brought into close proximity to the first crease, not an unusual event in carton and container design, the two creases compete with one another for the material between the creases. ***See illustration 10.41***.



10.41

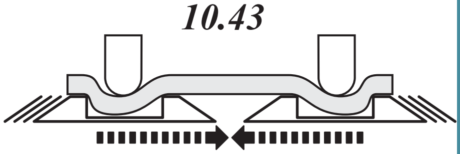
This is called crease competition, and the levels of competition can climb to the point that neither crease can be formed effectively, and both crease beads are asymmetric, or one-sided. ***See illustration 10.42***.



10.42

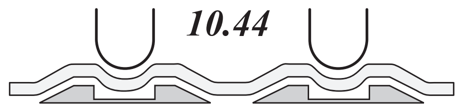
In a similar fashion, if the creases are formed using matrix, there is tremendous lateral pull on each strip, every time the press goes on impression. This gradual but persistent tensile pull can loosen the

10.43



adhesive bond and pull the matrix strips out of position, and toward each other. ***See illustration 10.43***.

The obvious solution is to adopt Reduced Bead Creasing, because it is primarily a Compression Crease rather than a Draw Crease. This will both enable each parallel crease to form with a symmetric, perfectly formed bead, and it will minimize crease to crease competition, which pulls the matrix strips out of position. ***See illustration 10.44.***



10.44

The reason it is important to understand the multiple causes of one-sided creasing is this category of failure undermines the majority of converted cartons and containers. Unfortunately, the standard on-press methods of checking and approving the performance of a crease/fold generally overlook the obvious signs of this misalignment. It is only when the spine of a crease splits or fractures, that further analysis is pursued. And even then, the key cause of the problem is poorly diagnosed.

Even a slight deviation in tool-to-tool alignment has an impact on crease formation and on folding performance, therefore, it is important to recognize how one-sided creasing undermines key features of the folding carton and fluted container.

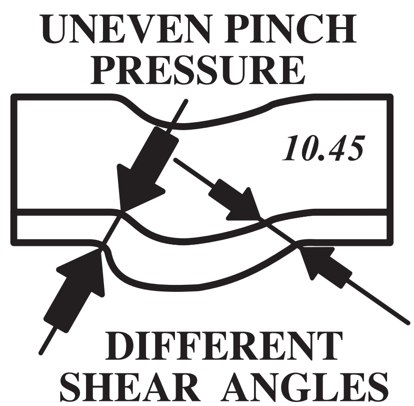
2: What are the Consequences?

There are several sources for the problem of bead binding, unfortunately, it is not uncommon for a number of failures to develop simultaneously. This will lead to a number of creasing and folding problems, whose severity will vary based upon the combination of cause factors.

To help with problem solving it is useful to examine the symptoms of the one-sided creasing problem. There are eight areas of potential failure:

- ***Bead Binding***
- ***Spine Failure***
- ***Skewed Folding***
- ***Misaligned Folding***
- ***Opening Force Variation***
- ***Diecutting Pressure Spike***
- ***Rapid Tool Wear***
- ***Slow Finishing Processes***

Bead Binding is a very common problem in crease formation, which is often generated by the selection

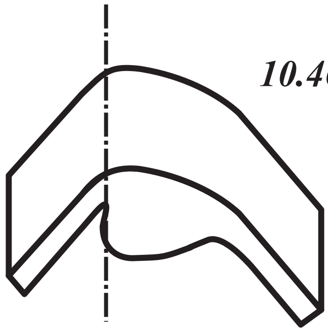


10.45

of incorrect tooling parameters. The majority of bead binding occurs where the bead binds on both sides of the fold.

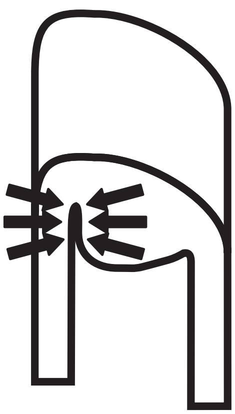
However, in one-sided creasing the offset between the male crease rule and the female channel generates an asymmetric bead, with greater pinching force on one side of the bead and less on the other. ***See illustration 10.45***. Note the angle of shearing, is another factor contributing to the degree of delamination and to the shape of the bead.

10.46



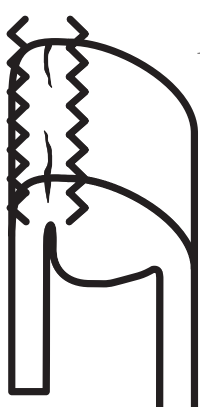
This is obviously the point at which rotation of the panels will fold first, ***see illustration 10.46***, and continued folding through 90 and 180 degrees will increase the degree of bead

10.47



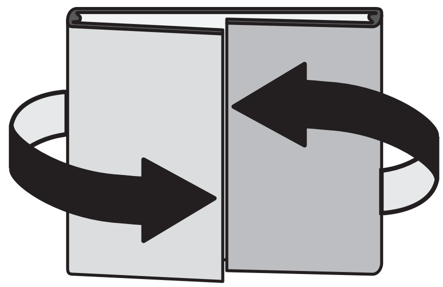
binding. ***See illustration 10.47***. This has a number of repercussions, which undermine other critical features of ongoing crease formation and folding.

10.48



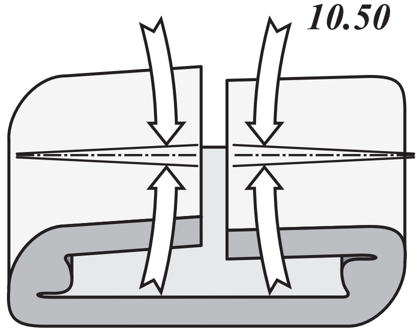
The most severe problem would be crease ***Spine Failure, see illustration 10.48***, which would be centered on the area of greatest tensile stress, which would be on the side of the fold with bead binding.

10.49



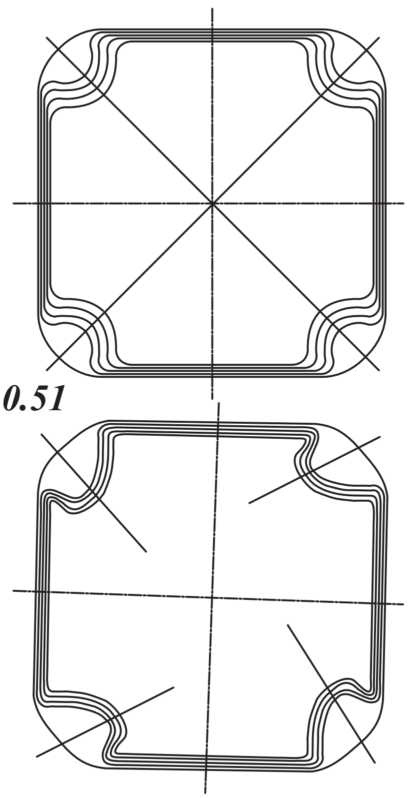
The next problem is ***Skewed Folding***, ***see illustration 10.49***, which is related to bead binding, generated by a one sided crease. The problem is in folding one-sided creases, with the primary fold on one side of the bead, bead binding, and the incomplete delamination of the other side of the crease, sets up a conflict which is difficult to resolve. The off centered folding causes the folding panels to ***"pivot"*** at right angles to the 180 degree folding action, with the result, the panels pivot in opposite directions. ***See illustration 10.50***.

10.50



The degree of misalignment will be greater if the panels are very long, where reliance on the centrality of the twin folds is vital for faster, square folding. Similarly, if the carton and the panels are long and narrow, it is difficult to control folding alignment with one of the twin folds more resistant to folding than the other.

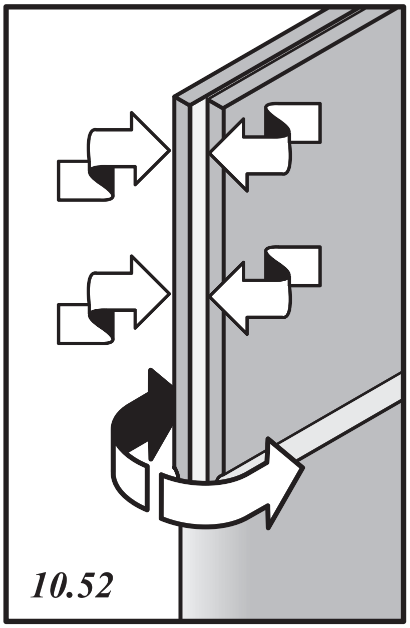
The gluing operator or the cartoning line technician can often overcome these alignment problems by slowing the process down to give more time to ***"guide"*** the folding panels into the correct position. However, this can also lead to bowing and distortion of the finished erected container.



10.51

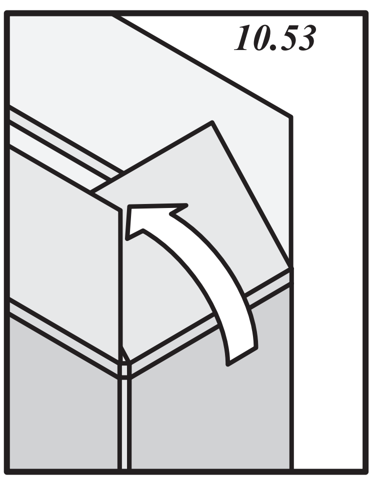
A similar folding problem is ***Misaligned Folding***. In this situation the folding is actually making the carton larger than it was intended to be, ***see illustration 10.51***, and the folding action with the intersection knife, results in an misaligned fold. ***See illustration 10.52***.

A good example of how this misalignment will effect high speed packaging is the closing of the end of a simple Plain End Carton. If the



10.52

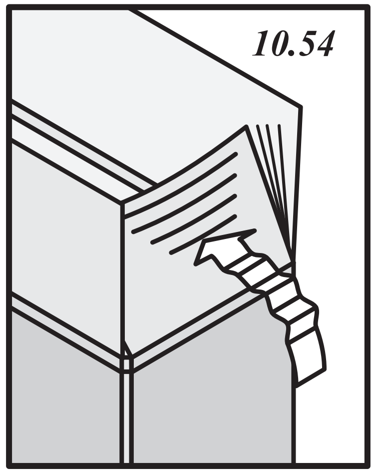
creases were formed in a balanced fashion, the end panel flap would fold down with minimal problems. ***See illustration 10.53***. However, if the sleeve crease are misaligned, one side of the flap will snag and bind on the top flap as it is folded into position. ***See illustration 10.54*** The degree of binding will be a function of the degree of misalignment of the male and female tool.



10.53

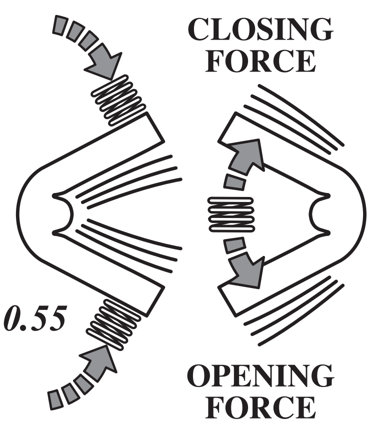
This can be a serious problem, because where folding alignment is critical and where the carton or container will be used in a high speed packaging line, any binding of carton components can spell disaster.

For example, if designs are rotated in a layout, the one sided crease on one carton will be in the opposite direction to the next inverted carton in the layout.



10.54

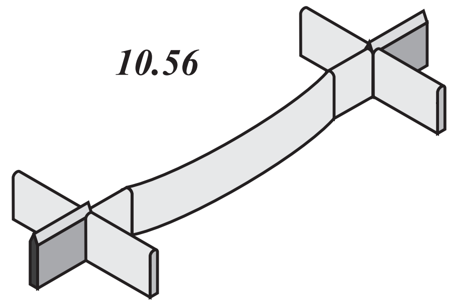
Most automated packaging systems are predicated and set-up based upon a carton or a container meeting exacting, but not excessive performance criteria. One of the key problems generated by One-Sided creasing is ***Folding Force Variation***.



10.55

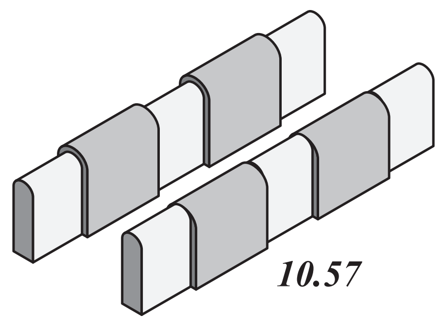
One of the important elements of the specification of folding cartons is the requirement for a specific degree of Folding Force and of Opening Force for key folds and carton features. ***See illustration 10.55***

This is quite difficult to control precisely in folding carton and container manufacturing, however, with a well thought out specification of crease tool parameters, and careful control of diecutting pressure, it is possible to achieve remarkable consistency in meeting the needs of the customer process.



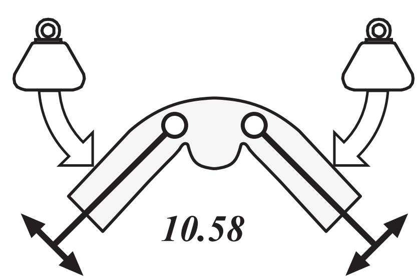
10.56

Earlier in ***Chapter 4*** we discussed ***How to Control Crease Folding and Opening Force.*** Some of the recommendation for finding more



10.57

bullet proof methods involved introducing Curved Creases, ***see illustration 10.56***, and Combination Creasing, which integrates different heights and pointages of crease rule. ***See illustration 10.57***.



10.58

All of these innovations are based upon a centralized bead and balanced twin folding shear lines, around the center of folding effort. ***See illustration 10.58***. There is obviously

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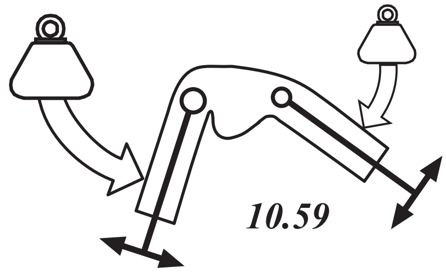
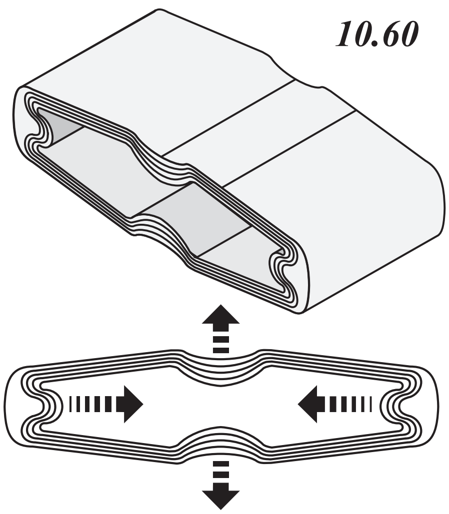


10.59

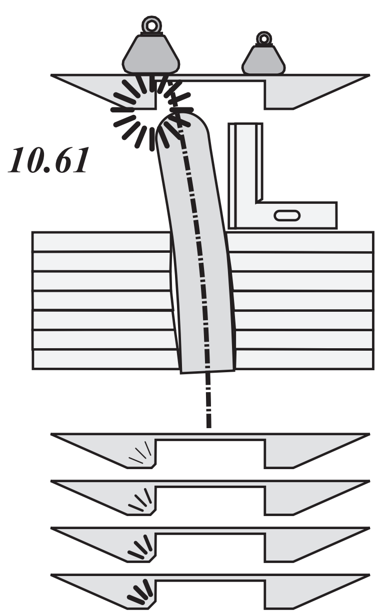
little point making these innovations and changes, if we allow the tools to be out of alignment.



10.60

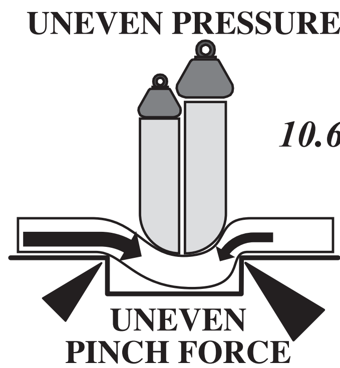
Unfortunately, when this balance is lost, the bead is asymmetric and it is not evenly delaminated, therefore it is almost impossible to control folding force. ***See illustration 10.59***.

In terms of opening force, as the



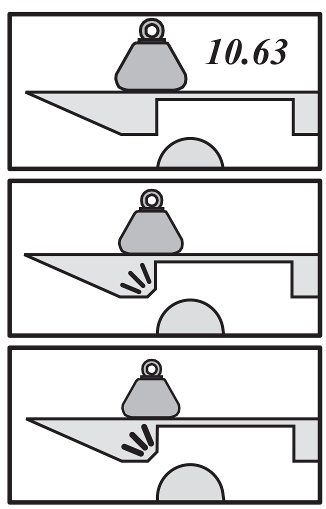
10.61

fold is centered around only one of the twin folds, and the bead has unbalanced delamination, the resilient opening force of the fold is completely undermined. ***See illustration 10.60***.



10.62

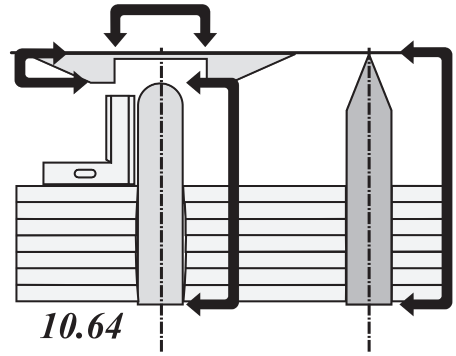
Finally, adding insult to injury, because the tool misalignment, which causes a one-sided crease, hits harder on one side of the upper crease channel than the other, the key upper corner of the channel suffers rapid and excessive abrasive failure. ***See illustration 10.61***.



10.63

Now we have lost control of folding and opening force, and we have a crease tool set-up which is degrading rapidly!

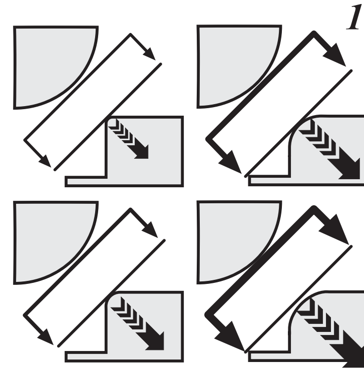
In addition, the unbalanced pinching force, which is the source of the one-sided problem, ***see illustration 10.62***, represents a high ***Diecutting Pressure Spike***, at the start of the



10.64

press make-ready, and a gradually changing pressure point as the tools progressively wear. ***See illustration 10.63***.

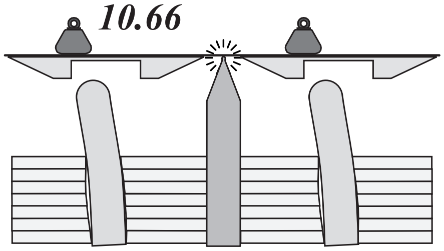
As the tools are specified around the tolerances of knives and creases in the steel rule die, and channel dimensions in the fiberglass counter or matrix strip, ***see illustration 10.64***, any high pressure point will create problems in setting and in sustaining a kiss cut impression.



10.65

These high pressure points make it difficult for the surrounding knives to cut cleanly, and the diecutter responds by adding patch-up tape, to force the issue. While this helps to solve the pre-eminent problem of cutting, it does so at the expense of the female crease tool. This added pressure leads to excessive wear, greater crease formation instability, and variation in the performance of the folding action.

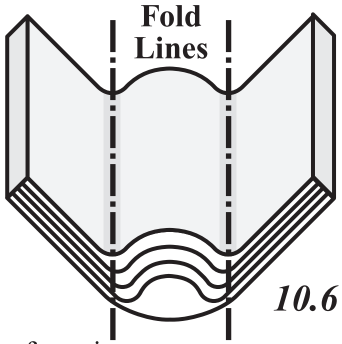
This inevitably leads to ***Rapid Tool Wear***, in terms of the female counter channel, ***see illustration 10.65***, and the knives in close proximity to the crease channels. ***See illustration 10.66***.



10.66

Even if everything is specified, fabricated and set-up perfectly, the output from the platen diecutting process will progressively degrade as tools wear and get damaged.

However, allowing the male steel rule die and the female crease tool to miss-align, accelerates the degree of deterioration; it shortens the productive life of the tools; it makes the diecutting process complex and difficult to control; it produces poor quality diecut products; and it significantly increases the cost of manufacturing.



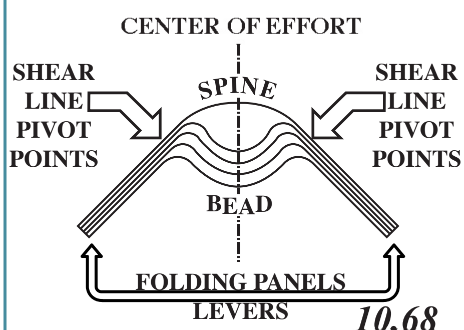
10.67

One-Sided Creasing is the primary factor undermining the performance quality of folding cartons and fluted containers, to a greater or a lesser extent.

It is important to implement simple and practical tests, which will detect the problem and provide a guide to ensure the success of the original set-up and any remedial steps required to eliminate the problem.

3: How is the Problem Detected?

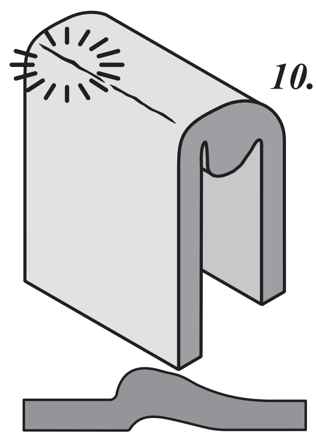
The formation of a paperboard crease is a combination of stress induced partial internal delamination, as the male and female tools convert the material on-press, to full internal delamination, as the crease is folded through 90 and/or 180 degrees. As the material is pinched between the male creasing rule in the die and the upper corners of each counter channel, the bead is separated into individual layers, which are fully separated, as the crease folds and the bead compresses inwards.



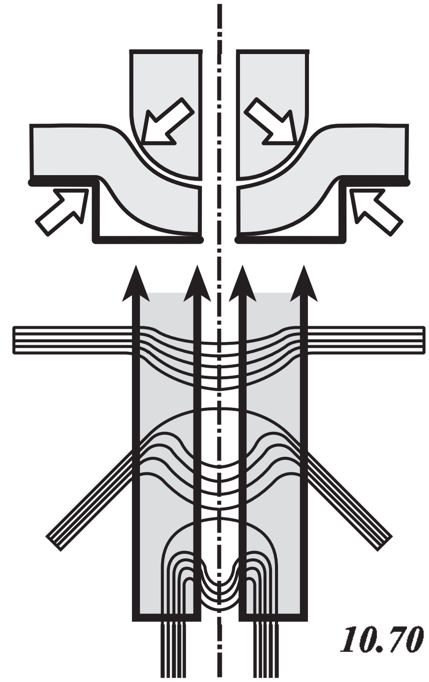
10.68

However, what is most critical in a crease is a double fold, and the folding action is dependent on balanced delamination on both sides of the bead. ***See illustration 10.67***. This clearly defines the crease as twin parallel lines of failure, corresponding to the failure line pinch point between the creasing rule and the upper corner of each counter channel. ***See illustration 10.68***.

This accurate picture of crease formation demonstrates the importance of balanced formation, as if one side of the crease is delaminated and pinched with more force

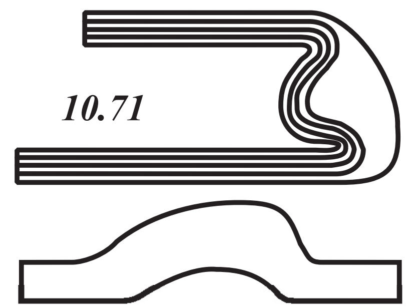


10.69



10.70

than the other, the crease will fold out of alignment, and the outer spine may fail. ***See illustration 10.69***.

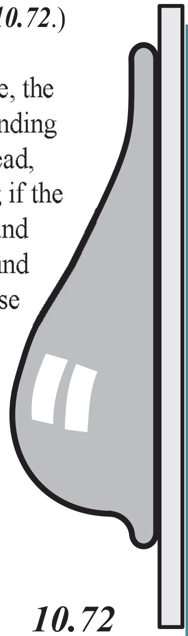


10.71

Therefore, in making an assessment of crease performance, the first and the most important criteria is to evaluate the crease/tool alignment or centrality. This simply means the crease is tested to determine if the mechanics are identical on both sides of the crease.

If the bead were properly formed it would be perfectly symmetric around a centerline, ***see illustration 10.70***, however if the male and female tooling were miss-aligned, the bead would be asymmetric. ***See illustration 10.71.*** (The bead in profile would look similar to the shape of a bead of water running down a flat surface. ***See illustration 10.72***.)

In evaluating performance, the focus of attention is the ending room of the crease, the bead, with the goal of assessing if the bead is properly formed and is perfectly balanced around the center line of the crease intersection. There are three basic tests used to determine acceptability. These are:



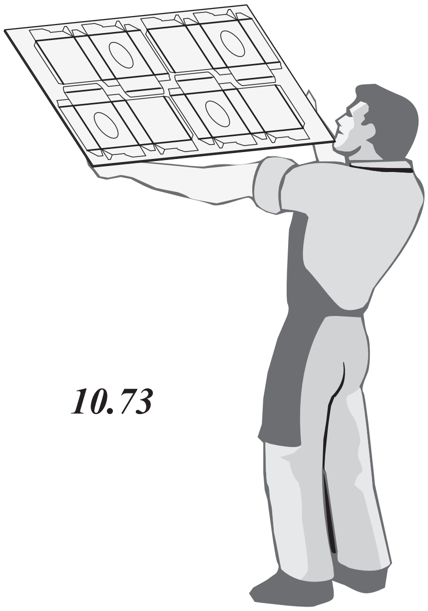
10.72

- ☑ ***The Light Test***
- ☑ ***The Folding Test***
- ☑ ***The Pencil Test.***

The Light Test

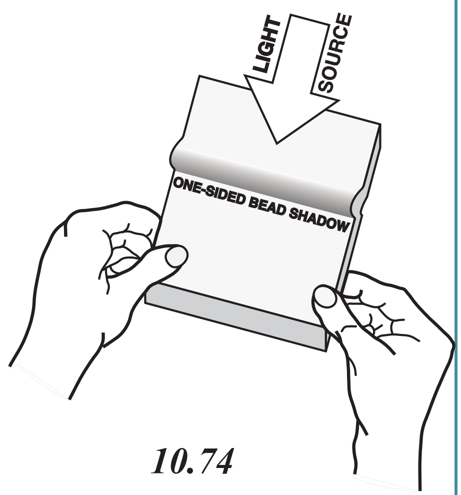
The first step in the Light Test is executed by holding the complete diecut sheet at an angle to a strong light source, with the bead facing the observer and the crease parallel to the light source. ***See illustration 10.73***.

This simple test will have to be repeated in each direction, grip-to-back edge, and side-to-off lay, to get an accurate picture of the centrality of the beads and the alignment of the complete diecut sheet.



10.73

The light will create a distinct shadow under any bead, which has a greater amount of delamination on the side of the crease bead pointing away from the light. ***See illustration 10.74***.



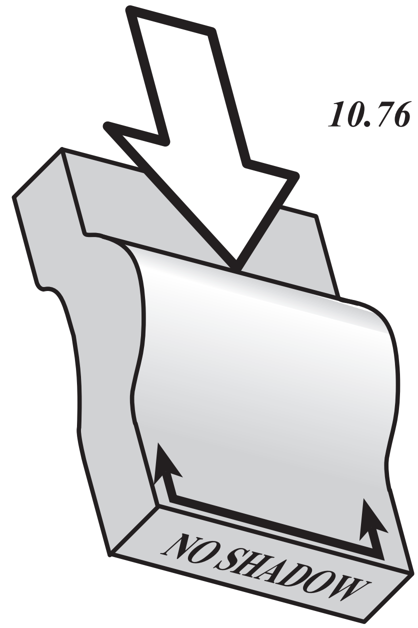
10.74

By examining the profile of the crease bead, with the carton or the diecut sheet held at an angle to a light source, light and shadow will become more pronounced. It will be immediately apparent where the sharp edges are in the design, as these will show a dark shadow at the junction of the crease bead and the attached panel.

To verify the initial diagnosis, which shows a distinct shadow on the side of the bead nearest to the observer, the carton, container or complete diecut sheet is rotated through 180 degrees, and by examining the same bead using the identical procedure, there should be no shadow. ***See illustration 10.75. & 10.76.***

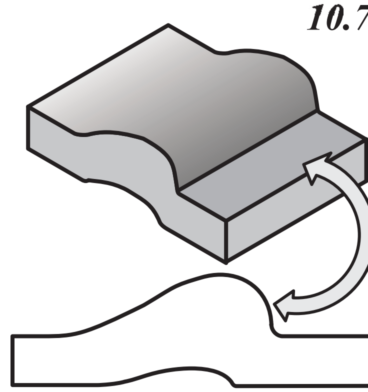
10.75

10.76

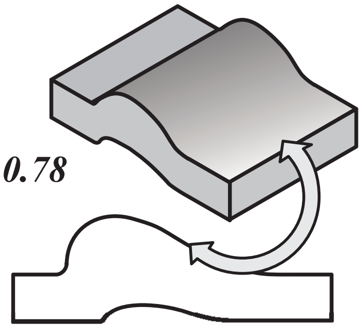


This simple but effective test is using the offset shape of the one-sided bead, to illuminate the problem, by using light and the shadow it casts to magnify a problem. For example, when the sharp ridged profile of the one-side crease is closest to the observer, direct light is unable to reach the junction between the bead and the panel. ***See illustration 10.77***.

10.77



However, when the carton or the diecut sheet is rotated through 180 degrees the light can flow over the smooth ramp formed by the poorly formed side of the one sided crease, and the junction between the bead and the attached panel will be difficult to detect. ***See illustration 10.78***.



10.78

These simple principles of light and dark are even effective in poor lighting conditions, however, by using the light and the shadows thrown by a normal room light, a key creasing problem can be illuminated.

The ***Light Test*** is used during make-ready to quickly assess if there is a precise alignment up between the steel rule die and the complete set of counters or matrix strips. The second part of the test is used to determine if individual cartons/die stations are aligned, as it is always possible that one counter or a key matrix strip was transferred out of position. The third part of the test is to verify the individual carton to see if the steel rule die and the counter match, and there are no alignment problems in terms of steel rule die shrinkage

The ***Light Test*** is also performed when the die or the lower sliding bed has been removed and reinserted into the platen well during the production run.

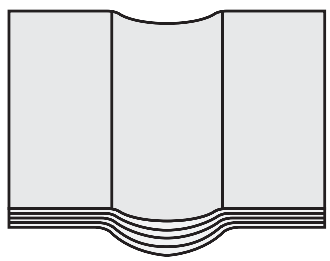
The ***Light Test*** is fast, simple and very effective, as any deviation from centrality is immediately obvious

Although this may appear to be imprecise and difficult to quantify, a short period of practice will quickly enable the tester to detect the smallest amount of variation. This should become an important standard operating procedure in folding carton and fluted container converting.

The Folding Test

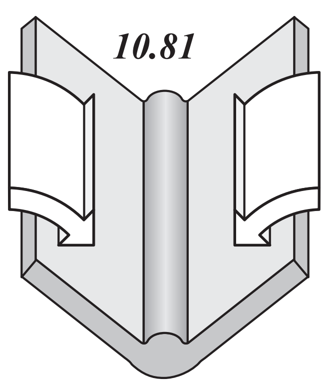
The Folding Test is as the name suggests, simply the action of folding the crease panels to determine which of the two attached panels starts to fold first. The important difference from the standard test, is the panels are grasped with the bead facing the observer, and the panels are simultaneously folded lightly inward, toward the observer. ***See illustration 10.79***.

10.80



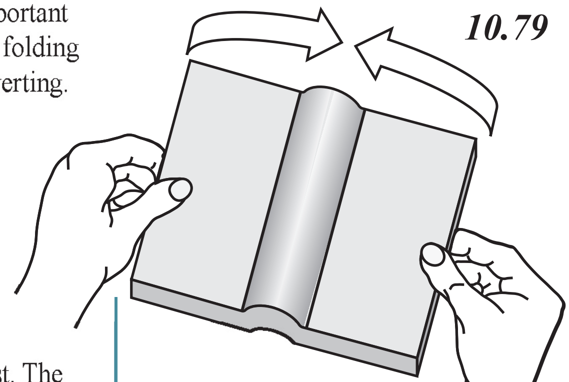
If the bead and twin shear lines are generated by balanced parallel internal delamination, ***see illustration 10.80***, the panels will fold around the center of the bead at the same time and the bead has a crisp well-defined profile. ***See illustration 10.81***.

10.81

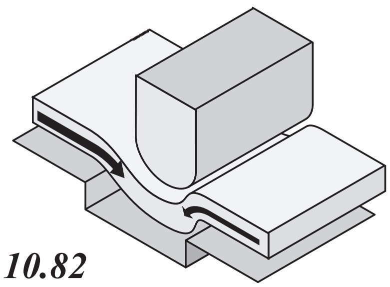


This is the goal of the entire process, unfortunately, because even a slight amount of tool-to-tool misalignment will compromise every feature of a crease, the performance sought is rarely realized.

10.79



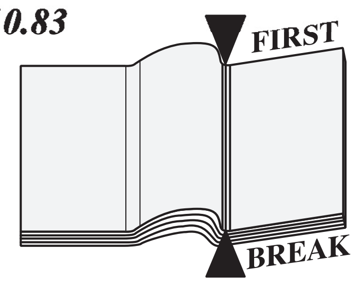
Fortunately, the ***Fold Test*** will demonstrate with remarkable consistency, if the crease has been formed to the specification required.



10.82

Inevitably, when the bead is one-sided, ***see illustration 10.82***, or there is an unbalanced amount of delamination, the panel on the side of the bead with the greater amount of delamination, will begin to fold first. ***See illustration 10.83***.

10.83

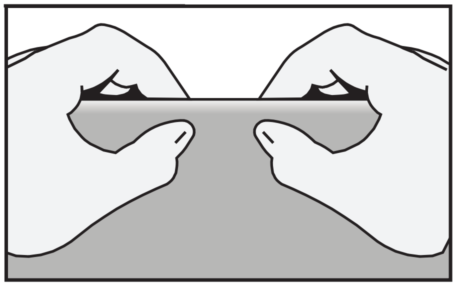


This technique or method of crease testing is called looking for the first break, as it is clearly an indication of a side of the crease which requires less force to fold, and it clearly demonstrates the crease bead is not formed with parallel lines of balanced delamination.

Generally, most crafts people check

crease performance incorrectly by folding the panels with the crease spine toward them and the bead, or the engine room of the crease, facing away from them. ***See illustration 10.84***.

10.84

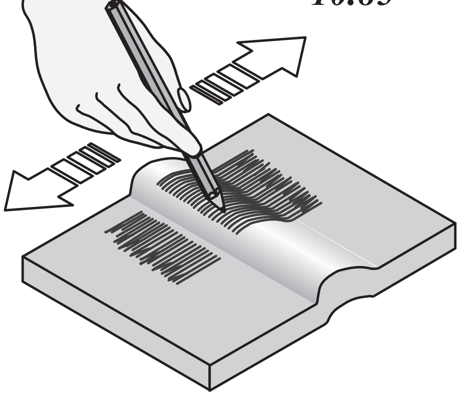


Just focusing upon the spine of crease, while important, ignores the engine room of the crease, the crease bead and the twin parallel shear lines.

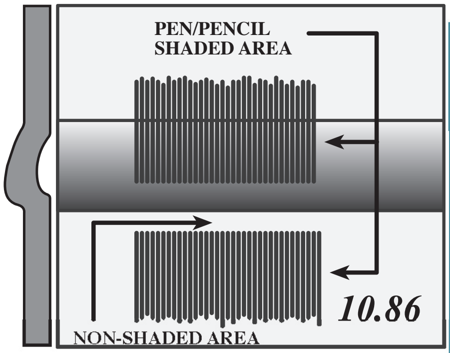
The Pencil Test

The ***Pencil Test*** is a simple, fast method of testing the centrality of the crease by using the bead profile as a ramp. To apply this test a pencil is rapidly rubbed backward and forward across the bead at right angles to the crease. ***See illustration 10.85***.

10.85



By coloring a solid area approximately 1 inch or 25 millimeters square with the bead running through the center of the shaded area, the bead will show a distinct white line on the side of the bead which has the greatest amount of delamination. ***See illustration 10.86***.

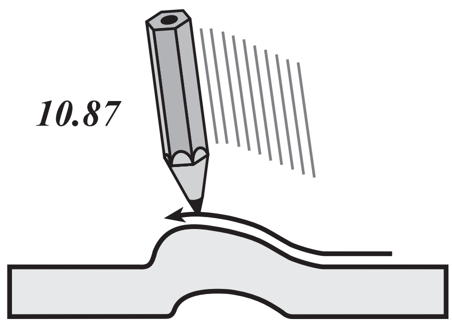


10.86

This analytical test method is again based upon the shape of the bead profile.

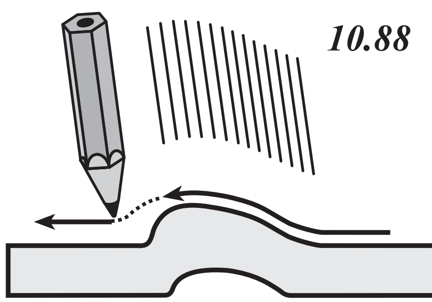
In one direction the pencil flows up the side of the poorly defined bead profile, which is a smooth ramp. ***See illustration 10.87***.

10.87



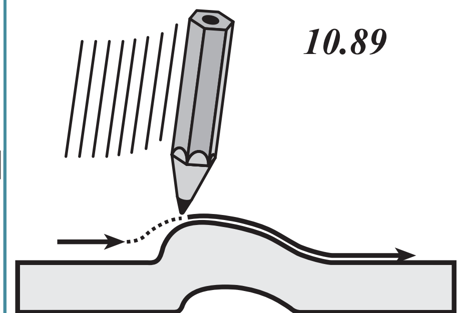
This rapid forward motion, across a smooth surface with no obstacles carries it over the ridge wall formed by the edge of the one-sided crease. ***See illustration 10.88***.

10.88



This leaves the area immediately under the ridge clear of any graphite from pencil lead. In the opposite direction the pencil strikes the bead ridge and bounces over the ridge, leaving the area at the junction of the bead free of graphite. ***See illustration 10.89.*** The rapid backwards and forwards motion of the pencil results in a line of graphic free paperboard at the junction of the one sided bead.

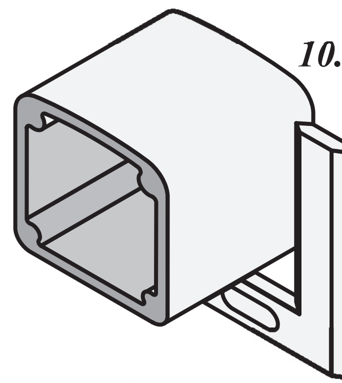
10.89



Clearly, an incorrect assumption made by many diecutting professionals, and the majority of carton users, is the formation of the crease is always perfectly central.

Unfortunately, the most common assessment is that if the spine of the crease does not fracture, then the crease is acceptable.

10.90



This attitude is responsible for poor gluing machine performance, for inconsistent die station to die station consistency, and for lower cartoning/packaging performance standards.

The paperboard crease is a replication of the action of the mechanical metal hinge, and as with the mechanical hinge the paperboard machining process must be balanced and consistent. The goal is to create an ***"Engineered Container," see illustration 10.90***, and these three simple but effective tests, are the first steps in determining the carton and container bead is in optimal alignment.

Chapter 10: The Keys to Optimal Crease Formation: Summary

The following pointers are some of the key principles you should have gained from completing this chapter. If you need to refresh your memory…

- ✓ To ensure crease formation and folding performance meets the design and the customer and the application requirements, it is important to constantly verify the alignment between the male steel rule die and the female creasing tool.
- ✓ When the male and female tools are misaligned, the result is numerous diecutting, crease formation and folding issues, which undermine quality, consistency and repeatability.
- ✓ The misalignment of the tools produces an asymmetric bead and unbalanced crease formation, which is often referred to as ***one-sided creasing***.
- ✓ The tool alignment problems were identified in three groups. These are:

➔: Inaccurate Tool Alignment
- ***→: Steel Rule Die Location***
- ***→: Counter Plate Location***
- ***→: Excess Pressure Lock-Up***

➔: Inaccurate Tool Fabrication
- ***→: Laser Verticality***
- ***→: Dieboard Shrinkage***
- ***→: Steel Rule Dish***

➔: Tool Register Variation
- ***→: Worn Pins-Register Holes***
- ***→: Adhesive Application***
- ***→: Matrix Movement***
- ***→: Counter Movement***
- ***→: Crease Competition***

- ✓ In terms of the consequences of these problems the impact on crease formation and folding performance, were identified as:

  - ✸ ***Bead Binding***
  - ✸ ***Spine Failure***
  - ✸ ***Skewed Folding***
  - ✸ ***Misaligned Folding***
  - ✸ ***Opening Force Variation***
  - ✸ ***Diecutting Pressure Spike***
  - ✸ ***Rapid Tool Wear***
  - ✸ ***Slow Finishing Processes***

- ✓ To provide a simple, easy and effective visual inspection system, three methods were specified. These were:

  - ✸ ***The Light Test***
  - ✸ ***The Fold Test***
  - ✸ ***The Pencil Test***

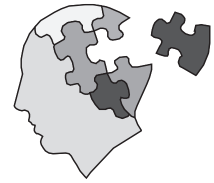
- ✓ The ***Light Test*** involves holding the carton, the container, or the diecut sheet at an angle to a strong light source, to detect the shadows, on one side of the one-sided bead, to determine if the crease bead is symmetric and evenly delaminated.
- ✓ The ***Fold Test*** involves holding the carton or the container, with the bead facing the observer, and by applying slight simultaneous pressure on each panel to attempt to fold the panels inward, and to detect if both panels fold at once, or one side ***"breaks"*** first.
- ✓ The ***Pencil Test*** involves using a pencil or a ball point pen, to rapidly shade in a section of the inside of the carton, bisected by the bead being checked. The strokes should be rapid, continuous, and light, without lifting the pencil and by going backwards and forwards until there is complete coverage of the surface.

Chapter 10: The Keys to Optimal Crease Formation: Questions?

The following questions are designed to stimulate critical review of the information you have assimilated and the resulting ability to understand how and why traditional creasing and folding work. This is not a test, but it is designed to reinforce the important principles of the creasing process, and to provide a foundation for further more sophisticated principles and more complex techniques...

- ✓ Why is it so important to test during make-ready and throughout the production run for tool-to-tool alignment?
- ✓ Why is checking the carton or container, by folding the panels with the spine of the crease facing you, the least effective method of assessing the performance attributes of the crease?
- ✓ What is a One-Sided crease, and how is this failure generated?
- ✓ What is the shape of the one-sided crease bead?
- ✓ Why is removing and re-inserted the chase and die, and the lower sliding bed a potential problem in tool alignment and in crease formation?
- ✓ How does variation in the ***"verticality"*** of the laser bead, the jig saw blade, and the router bit, undermine tool-to-tool registration and crease formation?
- ✓ Why is dieboard and steel rule die shrinkage a key factor to verify, to prevent tool-to-tool misalignment?
- ✓ What is steel rule ***"Dish" or "Concavity"*** and how does it impact tool-to-tool registration and the viability of crease formation?
- ✓ Why is the condition of the counter registration pins and counter pin holes so critical to tool alignment, and how does it impact crease formation?
- ✓ What is the most effective manner to apply spray contact adhesive to the fiberglass counter, and if it is not even or there is an excessive amount of glue, what are the consequences?
- ✓ What causes the matrix strip to move during diecutting, and what are the common preventative measures designed to eliminate this type of failure?
- ✓ What causes the fiberglass counter to move during diecutting, and what are the common preventative measures designed to eliminate this type of failure?
- ✓ What is ***"Crease Competition"*** and how does it impact tool-to-tool alignment and crease formation?
- ✓ How does the formation of a one-sided crease undermine crease formation and folding performance?
- ✓ Describe three ways in which a one-sided crease undermine crease formation and folding?
- ✓ How would you describe the ***"shape"*** of the one-sided bead?
- ✓ What is the ***Light Test***, and describe how it works, and how you would determine, which is the side of the bead where excess pressure is causing the folding problem?
- ✓ What is the ***Fold Test***, and describe how it works, and how you would determine, which is the side of the bead were excess pressure is causing the folding problem?
- ✓ What is the ***Pencil Test***, and describe how it works, and how you would determine, which is the side of the bead were excess pressure is causing the folding problem?

Brainstorming, Notes & Ideas

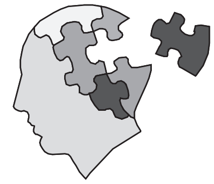


"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*

Contact Kevin - kevin@dieinfo.com

Brainstorming, Notes & Ideas

"Many ideas grow better when transplanted into another mind than in the one where they sprung up." *Oliver Wendell Holmes*



Chapter 11:
How to Crease & Fold Paperboard & Fluted Materials: Summary

I hope you found the manual informative, challenging, and stimulating. However, the first statement, which should be made in summarizing this technical work is from **Friedrich Nietzsche,** who said; ***"There are no facts, only interpretations."***

This is important as manufacturing is simply about the ***Movement of Information and Material***. And the converting of paperboard and fluted material to create an effective hinge mechanism, is a perfect example of this discipline.

The goal of the manual is to provide fresh insights into the practice of creasing, and to stimulate a reaction, which is converted into productive action. To reiterate the preceding quotation, this work represents a personal interpretation of more than 40 years of struggling with and surmounting the problems of creasing and folding paperboard and fluted materials.

While everything is based upon hands-on practical experience, I am constantly surprised at the diversity of materials, methods, and stimulating challenges I face, and I am convinced Warren Bennis was right when he stated. ***"There is no absolute knowledge. And those who claim it open their door to tragedy. All information is imperfect. We have to treat it with humility."***

My recommendation in using this manual, and in determining innovative action based upon the information it contains, combined with your own experience, is to consider the following issues:

- ☑ ***How to Use this Manual***
- ☑ ***Communicate, Cooperate, & Collaborate***
- ☑ ***Teamwork***
- ☑ ***Develop a Systematic Approach***
- ☑ ***Build a Tool Specification System***
- ☑ ***Develop a Standard Measurement System***
- ☑ ***Build an Information System***
- ☑ ***Research, Test and Evaluate***
- ☑ ***Close-the-Loop***

How to Use this Manual

"The secret to creativity is knowing how to hide your sources." *Albert Einstein*

Unfortunately, as by now you will have read the manual, it is rather late to tell you to develop a consensus of current creasing and folding issues, problems and opportunities for improvement, before you begin. If you can prioritize the top 5 creasing and folding challenges, understand the types of problems each one represents, this will make the use of this manual more meaningful. However, if the manual is to be used in training and knowledge development, I would recommend adopting this practice.

Therefore, the most effective manner to use this manual is to read and review it with positive skepticism. It is obviously an advantage to keep an open mind, and to consider testing every option before reaching a conclusion one way or another.

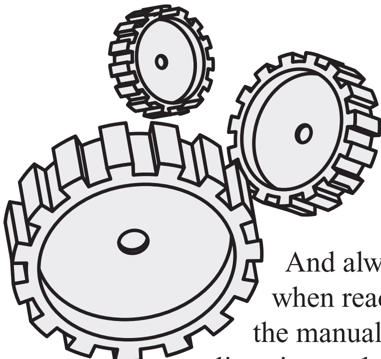
Read each section carefully, make notes, ideas and suggestions, using Post-It-Notes directly on the relevant pages. Review the summary at the end of each chapter and answer the questions. (You can remove your Post-It-Notes later so the next person reading the manual is neither influenced or constrained by your observations.)

The manual should also be used as an auditing tool, because when diecutting operations are evaluated carefully, the key specifications for tools are rarely consistent, and they are often fragmentary, and poorly organized. This is a great opportunity to establish a baseline for all key crease tool parameters, and to document current methods and practices.

Even if the current tool specification is organized, documented and regularly updated, it is important to follow-up, to find out if the tools are consistently made to the specified parameters.

Taking the time to review this manual represents a great opportunity to find out what is currently happening in your organization, to find out what each person knows, and to document the key parameters of established creasing techniques and procedures.

The most effective outcome from reading this manual is to combine the best ideas from the manual with the best ideas from the work team, and to develop a more effective method of creasing and folding.



And always when reading the manual or listening to the explanation for current in-house practices, consider the famous Yiddish proverb. ***"For example, is not proof."***

Communicate, Cooperate, & Collaborate

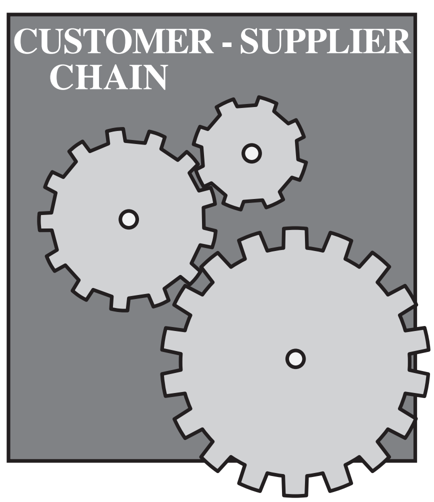
"The instruction we find in books is like fire. We fetch it from our neighbors, kindle it at home, communicate it to others, and it becomes the property of all."
Voltair

The most important task, after ensuring the safety of every team member, is to get everyone to know what everyone already knows. In setting goals, in making plans, and in executing a course of action, it is extraordinarily difficult to get everyone aligned with the desired outcome.

The disadvantage in overreacting to the remorseless march of the clock is in failing to allocate time for getting teams together to discuss issues and opportunities; to compare methods, techniques, and procedures; to share knowledge and experience; to define problems and argue over solutions; to find better ways to do things; to close-out and exchange information about difficult jobs; and most importantly, to develop purposeful relationships as they communicate, cooperate and collaborate.

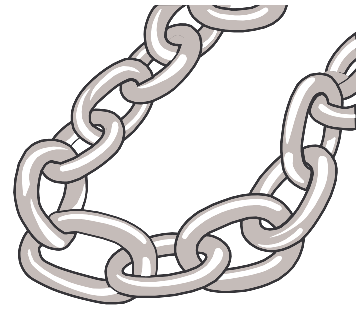
Most organizations are appalled when a technical auditor demonstrates the obvious, that knowledge and skill are enormous variables, and there is no mechanism to build a consensus.

It is vital to establish regular team meetings in which key players have the opportunity to develop a systematic approach to converting. This should include the CAD technician, a diemaking representative, a pre-press technician, a diecutting operator, a print technician, and a gluing operator. In addition, whenever possible include external suppliers, such as Paper Mill representatives, commercial diemakers, and die suppliers, as these people have valuable information to share.



It is vital to build cooperation within each production unit or cell, however, it is equally important to reinforce the customer-supplier chain, and to communicate between each discipline.

Each representative of each discipline would then have the responsibility to communicate and



discuss conclusions with his or her colleagues. Manufacturing converting is an incremental chain of activities, and every department is built around customer-supplier relationships.

At the front end of all companies is a critically important position, Customer Service. Why is this important for the company, but not important for each internal ***"business"*** discipline? How do individuals learn the consequences of their actions and decisions, if there is not organized feedback, and exchange of requirements?

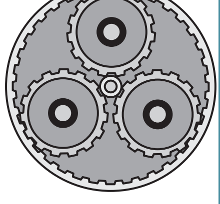
Before even considering any changes stimulated by this manual, it is essential to stabilize current methods and practices, and to establish a systematic approach to communication and feedback.

Take a hard look at the current organization. How do you currently communicate, cooperate and collaborate, to build competence, experience, and alignment?

Teamwork

"Teams are less likely (than individuals) to overlook key issues and problems or take the wrong actions." *Eugene Raudsepp*

There are two ways to organize people in an organization. One is an organization built around a recognition of the importance of teams, and who develops and encourages teamwork. The second is also organized around teams, albeit dysfunctional teams, and does little or nothing to develop a cooperative, collaborative environment.

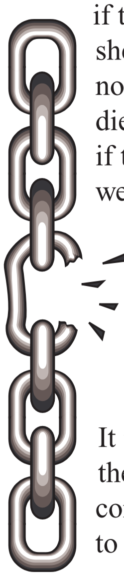


Teamwork is an easy attribute to claim, but it is a difficult discipline to manage.

The advantage of a well organized team, is it is organized to meld the best ideas of all of the participants, to take a consensus action to achieve a specific outcome. Creating an effective team, with each one a unique blend of knowledge, skill, and experience, will create a learning environment, and develop competence, confidence and parity.

This is particularly appropriate to the subject of creasing and folding paperboard, because the goal of the converting process, when the diecut product first emerges on-press, is the culmination of the efforts of many different people and teams from many different disciplines.

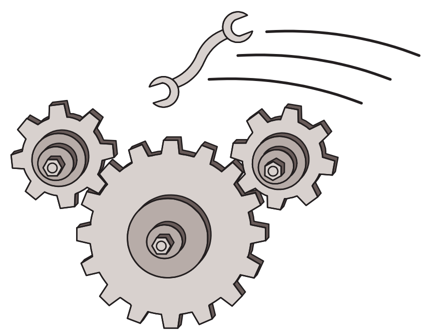
What would be the advantage of not communicating? Surely the CAD designer would like to know if the specifications he or she chose were effective or not effective? Surely the diemaker, needs to know if the die did not perform well on-press? And how often has post-process feedback from the gluing department complained of folding alignment problems?



It is amazing how even the most poorly organized company seems to be able to get people together, when things have gone wrong! Why not build a system of converting manufacturing around cooperative teams designed to make sure things go right?

Creasing and folding requires the involvement and the cooperation of individuals and teams from several disciplines. A Customer-Supplier Team should already be operating between the disciplines of converting, however, if this is not in place, this project would be the perfect starting point to create this discipline.

The team focussing upon this project should include Structural Design & CAD, Diemaking/Toolmaking, (Internal & External), Pre-Press, Diecutting, Gluing and Finishing, and Quality Management, if this discipline exists in the organization.

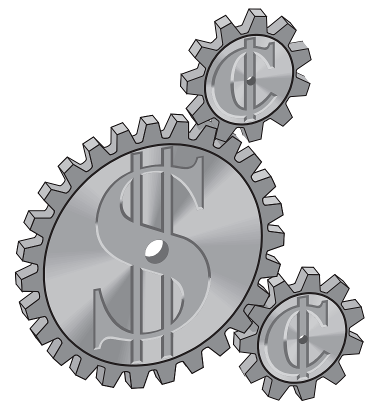


All of these people control and impact on-press performance of creasing and folding, therefore, this is your development team for this project.

Develop a Systematic Approach

"I must create a System or be enslaved by another man's. I will not reason and compare; My business is to create. " *William Blake*

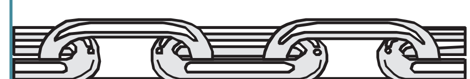
The advantage of a team approach is the ability to capture all of the best ideas, the most effective methods, and the creative ability of many talented individuals. However, this does pre-suppose there is an effective methodology in place to capture, to evaluate, and to continually improve procedures by communicating and sharing better methods and techniques.



The disadvantage the majority of converting manufacturers suffer, is the habit of allowing each individual to do things in a way, which reflects their individual experience, knowledge, and skill. While this is commendable in terms of respecting an individual, it produces results and performance, which are difficult to manage, and are impossible to control.

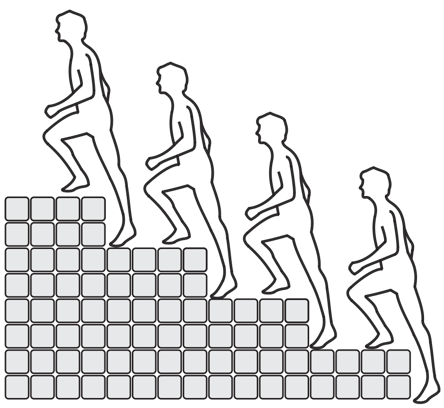
Every production cycle in converting is both a means to manufacture and an opportunity to research, and to experiment. An organization failing to capitalize on each production cycle progresses painfully slowly, and continually loses productive opportunity.

The solution is to build and to sustain a ***"System of Manufacturing."***



Webster defines the meaning of ***"system"*** as; *"A regularly interacting or interdependent group of actions forming a unified whole ... a group* *of techniques or an organization forming a network especially for serving a common purpose ... an organized set of doctrines, ideas or principles usually intended to explain the working of a systematic whole ... an organized or an established procedure designed to create a harmonious arrangement."*

To create a systematic approach it is necessary to find out what is currently happening and why it is happening. The next step requires unifying all current methods, to create a consistently applied series of steps, actions or procedures, which

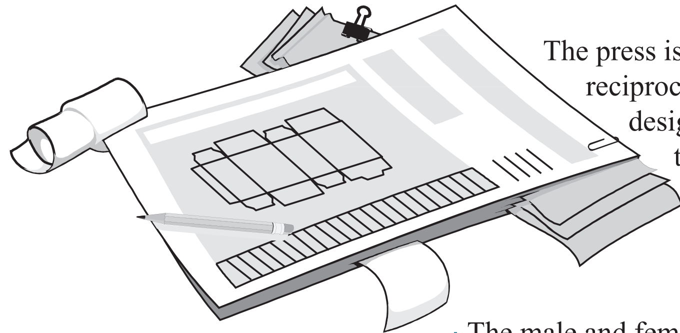


represent a consensus of the best ideas of the entire team, to execute a key activity.

Establishing a current benchmark for an important activity is a critical test of the effectiveness and the cohesiveness of the production team. While this is an important goal, it is not particularly easy! Persuading a group of professional crafts men and women to compromise by sharing, standardizing, and stabilizing key practices, is a difficult challenge. In practice this initiative is one of the most important team building opportunities.

But this is the only downside.

The ability to form a procedural



consensus, and to execute, review and revise as a team, will significantly improve productive output and performance improvement.

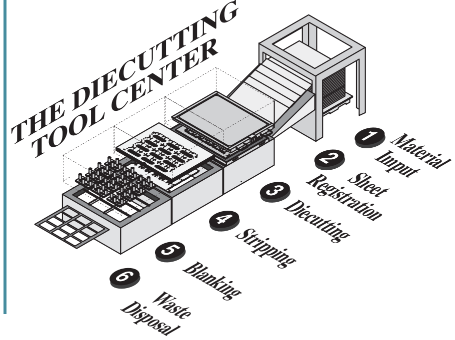
Build a Tool Specification System

"You cannot mandate productivity, you must provide the tools to let people become their best." *Steve Jobs*

Diecutting is the interaction of a matched male and female tool set with a sheet or a web of a substrate, with the intention of converting a finished product or a component of higher value from the material.

While a platen diecutter represents an impressive collection of technology, the machine is simply a tool holder!

The role of the reciprocating mechanism is to register the male and female tools together, to synchronize the male and female tool set in each press section, and to advance and register the material to be diecut to each sequential tool set.

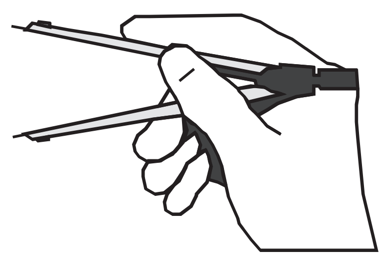


The press is simply that, a reciprocating mechanism designed to bring tools together, with a specific degree of force, to stamp out a diecut part.

The male and female tool set controls the quality, the productivity, and the repeatability of the finished product. In reality the accumulated knowledge, experience, and competence of the entire organization, is focused in the tools and the job they do.

To summarize, the steel rule die, and the integrated tools are more important than almost any other factor in the entire converting operation.

Therefore, it is vital every organization controls and manages



the specification of the diecutting tools, irrespective if the tools are made in house or manufactured by an external tool vendor.

There are six stages in the tool manufacturing process. These are

1: Analysis
2: Specification
3: Design
4: Machining
5: Fabrication
6: Finishing

There are no unimportant phases

of diecutting tool manufacturing, however, the first three steps, Analysis, Specification, and Design, control the entire product conversion process. In practice, if the specification of tooling is out of control, or out of tolerance, then the diecutting converting process is out of control and out of tolerance.

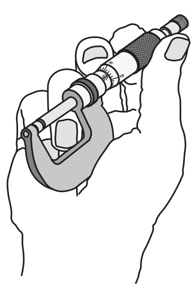
The entire Folding Carton and Fluted Container organization is built around and will succeed or fail based on the effectiveness of the tool specification discipline. The specification of diecutting tools controls productivity, quality, speed, cost and consistency.

Unfortunately, this is the Achilles Heel of most converting companies.

The tool analysis, specification and design disciplines of tool manufacturing are poorly organized, they are inconsistently applied and they are rarely documented!

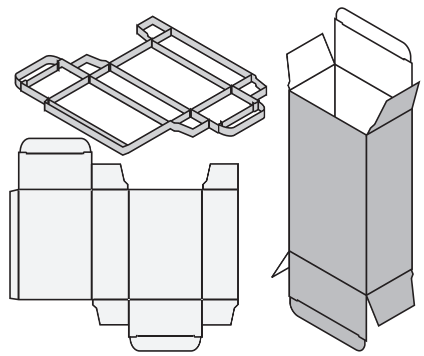
Develop a Standard Measurement System

"The only relevant test of the validity of a hypothesis is comparison of prediction with experience." *Milton Friedman*



One of the more complex challenges in paperboard and fluted material creasing, is to develop consistent measurement and evaluation criteria. Assessing crease formation and folding performance is currently a subjective process. As our customer driven goal is quality, consistency and repeatability, the verification methods have to be correct, consistent, and repeatable.

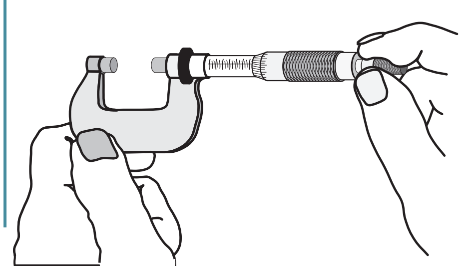
There are three immediate challenges. The first, is to evaluate the creasing and folding of each individual carton. The second, is to compare the performance of each carton from each die station in the



layout to determine consistency and repeatability. The third critical measurement, is to compare the performance of each carton from each die station to the same cartons from each die station, as the production run progresses. This is measuring how the progressive wear of the tooling and the subsequent compensation impacts carton folding repeatability.

The first customer in the supply chain is the gluing and finishing department. Therefore, it is useful to form a team, between the two departments, to determine a product inspection and performance assessment system.

A further series of measurements and assessment criteria has to be applied to the paperboard or fluted material being converted. How is the acceptability, the consistency, and the repeatability of these materials



verified. Is the paperboard sequenced as per standard Mill Specification.

The basic reality of manufacturing is contained in the statement: ***"If it is not measured, it is not controlled!"***

Developing a standard measurement system for assessing creasing and folding performance is not complex, but it is critically important. We should begin by defining current evaluation and approval methods.

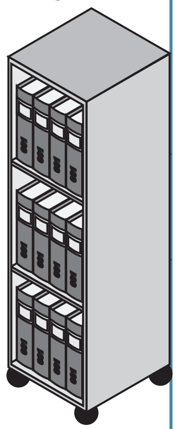
Who makes the decision in terms of what is good, what is bad, and what is acceptable? Who is the technical arbiter and expert, and who do we ask to confirm our assessment?

Build an Information System

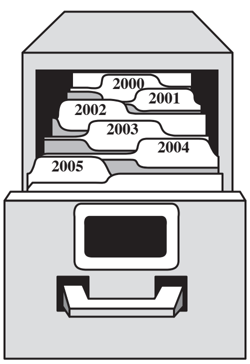
"I attribute the little I know to my not having been ashamed to ask for information, and to my rule of conversing with all descriptions of men on those topics that form their own peculiar professions and pursuits." *John Locke*

Manufacturing is simply the Movement of Information and Material. Each individual craft persons knowledge, skill, and experience, is in reality the ability to extract information from their internal data-base, and apply it to a technical challenge they are facing.

Our expertise is our ability to convert a product from a range of different and often diverse materials. This requires detailed knowledge of diecut product and its application; the toolmaking and diecutting process; and the key performance attributes of the material we convert.



Every facet of every manufacturing activity can be captured as information or technical data. This could include the pressure required to diecut a specific material; the channel widths, crease pointage and heights, necessary to crease and fold the material; the optimal nicking widths and pattern to stabilize a specific material; the most effective cutting knife and bevel angle to minimize flaking; and the abrasiveness of the paperboard/fluted material, and its impact on tool wear.

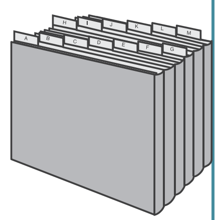


Every activity can be and should be captured as key data, which is continuously upgraded as new research and testing augments our knowledge and experience.

The first step, is to find what information is currently used to determined the diecutting tool parameter selection & specification? Who has this information, and how is the information archived, organized, evaluated, approved, augmented and distributed? Is the information up-to-date and is it consistently applied and reviewed?

The disadvantage many organizations face, is they underestimate the importance of information and technical data. For example, who has the creasing data base? Who has the key parameters for each job and each paperboard? How is this information used to consolidate knowledge, experience and competence? How and why does key information change, and who makes these decisions.

Start by defining in each facet of converting; cutting, creasing, perforating, scoring, embossing, and debossing; what information is necessary, who has responsibility for managing this resource, where it is kept and how it is used?



It is useful to integrate information collection as part of each job close-out. What worked well, what worked badly, and what do we need to change for the next order?

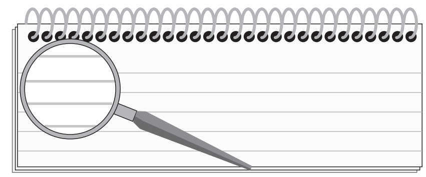
Research, Test & Evaluate

"If we knew what it was we were doing, it would not be called research, would it?" *Albert Einstein*

It should be obvious by now that every production cycle is an opportunity to research, to test, and to evaluate current methods and practices. In addition, every production cycle generates new information, new knowledge, and new opportunity to consolidate our control of the converting process.

In terms of creasing and folding this may entail testing and evaluating every key crease parameter against every paperboard in use, and new substrates about to be introduced.

Start by setting up some basic measurements. Create a Paperboard Binder, with samples of each type of paperboard included, and the current converting specifications for each material. Create a Carton/Container Sample Binder, with samples of each carton or container, and the current creasing specifications for each example.



With this information available, it is useful to conduct simple tests, to determine the range of tool settings and how they impact folding performance. Naturally the focus should be on solving current creasing and folding problems and issues. However, push the boundaries of each key crease tool setting to discover opportunities, limits and constraints.

It is useful to keep samples of these experiments to share with the rest of the team and to be used in training. For example, at the end of a production run take some waste sheets, and gradually edge the plate out of position to create one sided creasing. The resulting cartons will provide an invaluable training tool.

Every production cycle reveals new information, new solutions, and a greater understanding of the converting process. By failing to take advantage of this Research & Testing opportunity, we are ill prepared for the inevitable on-press converting crisis.

Close-the-Loop

"What we anticipate seldom occurs, what we least expected generally happens." *Benjamin Disraeli*

The most important task in any manufacturing operation is; ***"To get everyone to know, what everyone knows."*** This may sound trite but as our primary objective in productive, high speed converting, is ***Performance Parity and Procedural Uniformity,*** therefore, this is an essential discipline.

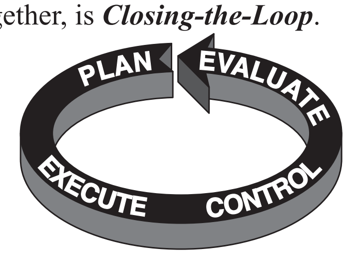
However, if there is no mechanism in place to collect and consolidate existing and new knowledge, it is difficult to build an effective team.

A good example of this, is the basic planning loop every effective manufacturing operation integrates into daily work. ***Plan-Execute-Control-Evaluate***. It is effective, primarily because it is based upon a closed loop of key organization activity.

In this summary chapter we discussed the following key issues:

- ***How to Use this Manual***
- ***Communicate, Cooperate, & Collaborate***
- ***Teamwork***
- ***Develop a Systematic Approach***
- ***Build a Tool Specification System***
- ***Develop a Standard***
- ***Measurement System***
- ***Build an Information System***
- ***Research, Test & Evaluate***

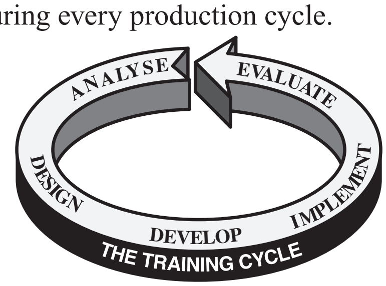
Each one is important but the discipline, which brings it all together, is ***Closing-the-Loop***.



This defines a number of important organization principles. First, manufacturing is a continuous loop of customer-suppliers, in which there should be an ongoing flow of information. What worked well, what worked badly, what do we need to change for the next cycle?

The second, is the importance of conducting a job close-out, or in the case of a significant failure, a process postmortem.

The Universal Mission Statement of all manufacturing companies is ***Safety-Speed-Quality-Cost***. This is always described as a loop of activity, because each of the four disciplines is improved by an analytical focus during every production cycle.



Manufacturing is a Learning and Training Cycle. Experience is simply the accumulation of knowledge gained from overcoming challenges and technical difficulty. The more effectively we share and ensure this information flows seamlessly from key person to key person in the loop, the faster the entire process improves.

A perfect example of this closed loop of activity, is the Training Cycle. Knowledge and skill improvement are generated by improving standard operating procedures, based upon an ongoing ***Analysis, Design, Development, Implementation and Evaluation*** of each activity. Naturally, the majority of the individuals and the teams involved in this loop of activity, are unable to be present when the product first emerges on the diecutting press. And given their work-load it is unlikely they are able to carve out the necessary time, or to match the schedule of the diecutting operation.

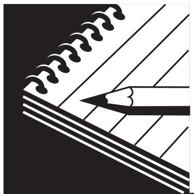
Therefore, it is vital a simple, fast and effective close-out is implemented at the end of each make-ready and at the end of the production cycle. This will provide these remote participants with the information they need to adjust and improve their system of manufacturing.

In practice, it is useful to provide each key department with a complete set of cartons or containers from every production run, so they are able to conduct their own close-out.

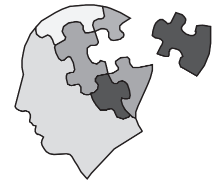
This is how we learn. We try something and it works, and we try something and it fails! But the bottom line is we have gained new knowledge and information about the product, the material, and the process.

Start by implementing a simple close-out discipline. List the top problem with each make-ready, or production run, and get the information to everyone involved in the customer-supplier chain.

By sharing problems, frustration, failure and success, we learn and grow as a team.



Brainstorming, Notes & Ideas



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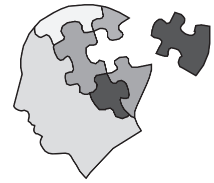
Brainstorming, Notes & Ideas



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  Contact Kevin - kevin@dieinfo.com

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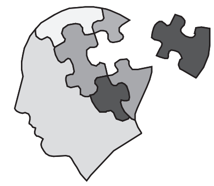

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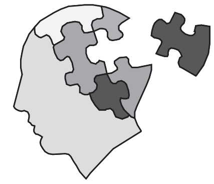

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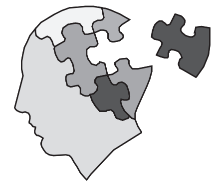

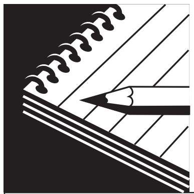

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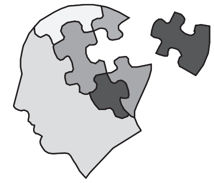

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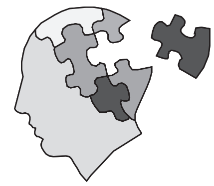

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