Rounding and Backing...Function Determines Structure

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For the past several years, binders and librarians have been debating the subject of whether or not a text block should be rounded and backed. As a designer and manufacturer of hydraulic rounding and backing machines used by binders around the world, I feel compelled to write on the subject.

In 1953, when I embarked on the design of the first semiautomatic, self-adjusting rounding and backing machine, I had barely a year's experience in the bookbinding industry and very little knowledge of the subject of rounding and backing. Prior to designing a machine that would round and back a variety of sizes of text blocks with only minor adjustments, I studied the literature on the subject in order to understand the reasons for these operations. I found that some styles of binding utilized only the rounding operation while others utilized both the rounding and backing operations. The definitions and reasons for both rounding and backing that appeared in the literature made engineering sense to me and I found no controversy on the subject.

Now, 35 years later, I find myself pondering the question of why rounding and backing is an issue. Is it a legitimate concern on the part of librarians? Is the issue merely the result of a packaging concept? I believe the answer to these questions is yes

In the past decade, there have been dramatic changes in the library binding industry We have seen a gradual disappearance of the traditional, knowledgeable craftsman. We have also seen economic changes take place in libraries, where binding budgets are under constant pressure. Binders are responding with different products to meet different end uses.

Like environmental, wildlife, and other groups who are trying to preserve what was once wholesome and good and which mankind has spoiled, so are the library preservationists and conservationists gaining stature in their energetic efforts to preserve the nation's documentary heritage. Librarians are now looking critically at all options. I must say that in some instances I would agree with the statement that rounding and backing may be detrimental to the text block.

I would agree that it is detrimental if an unskilled person using a hammer on the job-backer indiscriminately beats the back of the text blocks without any systematic regularity and without any care as to the consequences.

I would agree that it is detrimental if the semiautomatic machines are run by poorly trained operators who take short cuts that cause excessively large joint size and too much pressure by the backing roller on the text block.

I do not agree with the outright claim that rounding and backing is detrimental to the text block and should not be done. On the contrary, when appropriately and properly done, I view rounding and backing as a structural advantage.

The question of whether to round and back is not strictly limited to the specific function of the operations. The subject must be looked upon from a more objective perspective. The decision must be consistent with utility Factors such as thickness of text block, thickness of signatures, quality of paper (i.e., brittle or not), quality of thread if the volume is being recased, and anticipated use, all could effect the decision as to whether a textbook should or should not be rounded and backed.

Next to leaf attachment, rounding and backing is the most important operation for attaining overall durability, useability, and appearance of a library text block. While I shall later attempt to demonstrate the benefits of rounding and backing from a technical point of view, it is important at this point to review the traditional definitions found in most texts on the subject

Rounding

The inevitable back swell produced by the leaf attachment method constitutes a major portion of the convex-shaped spine. The purpose of "rounding" is to bring the swell into a controlled form in which the leaves do not extend beyond the edge of the cover. If the text block is bound without rounding, the swollen back, being wider than the front might become concave or it might crinkle up. Rounding, therefore, ensures that the text block will assume an even convex shape.

Backing

The process of shaping a "shoulder", or the more commonly known "joint", on each side of the binding edge prior to the casing-in is known as "backing". In this process the "rounded" spine is evenly distributed as the signatures or leaves are worked from the center outward to progressively interlock with each other, much like, as will be shown later, the tapered bricks of an arch. The 'joint" produced accommodates the cover boards which act as columns, preventing the text block from moving forward in the cover and providing a hinge-line from which the cover will pivot. Backing not only provides joints, it also scores the leaves at their binding edges. The outermost leaves are bent to an angle of approximately 45 degrees. The leaves at the center of the text block remain flat and those in between are progressively bent over in increasing angles. In this manner, unlike flat backed text blocks, the strain on the leaf attachment is relieved allowing the spine to retain its shape while enhancing openability. The easier a text block can open, the longer it will last.

The Effects of Rounding and Backing on the Text Block Structure

Text blocks have been rounded and backed by binders for hundreds of years. Whenever the subject is discussed, the arguments are usually based on the traditional reasons discussed earlier. Although understood by some, they may not be convincing for others. By promoting rounding and backing as being unnecessary operations, traditional values of bookbinding are being eroded to the point where we are finding it necessary to rediscover basic elements of proper structure. To achieve this, a correlation between the text block structure and that of other structural forms such those found in architecture and nature may make understanding of the subject easier. However, before this can be done, a brief review of some of the structural fundamentals is appropriate.

How Can Weight be Supported Over an Open Space?

If, for example, a gate or an opening is wanted somewhere in a wall and the wail is a low one, then the problem is simple. Leave out a place of the wall and hang a gate across the opening on hinges. However, if the wall is a high wall, and the opening is required on the lower part only, then how are the bricks above the opening kept from falling down? The problem is solved in three main ways: The Lintel, the corbelled arch, and the true arch.

Let us work out these problems just as engineers did several thousand years ago. The problem is gravity. Gravity is pulling the bricks downward. The downward force is known as the load. The load must be carried down to the ground around an opening. The greater the load to be carried the stronger the building i4itcrials will have to be. However, there are three different kinds of strength: compressive strength, tensile strength, and shearing strength.

Compressive Strength

If we place a text block in the hand press and let the top rnoveable platen press down on it, we'll find that the action of the screw "compresses" the text block and we can say that the text block has great compressive strength.

Tensile Strength

Now, if we suspend a text block from the ceiling with a rope, then the weight of the text block is pulling the rope making it taut or "tense". The rope is said to have a certain tensile strength.

Shearing Strength

Furthermore, suppose that while the text block is swinging we take a pair of blunt, heavy scissors and try to snip the rope. We find that unless we saw the scissors back and forth we can't cut the rope. We can say the rope has shearing strength.

Lintel

The lintel in Figure 1 is sagging, showing insufficient compressive strength. This structure is basically unsound if the load will be heavy or the expected Life will be long.

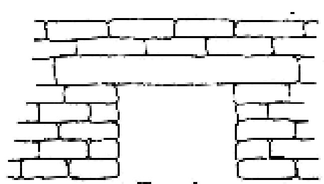

Figure 1

The simple old lintel was used in ancient times before a better understanding of architectural structure was common. Bridges were once just logs laid across a stream. We do not find many examples of bridges constructed with the lintel principle at the present time, for obvious reasons.

Corbelled Arch

The corbelled arch became the solution by which stones were made to carry a load using only compressive strength and shearing strength. Corbelling is the principle of building out the masonry step-wise from each side until the stones meet in the middle.

In the corbelled arch shown in Figure 2, when we look at each brick that sticks out, we see that the end which sticks out cannot tip downward because that would mean its other end would have to tip upward, and the weight of the bricks above keeps that from happening.

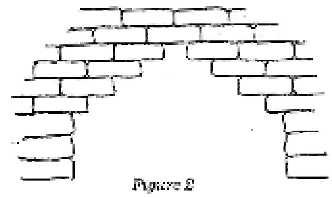

Figure 2

Each brick, like a little seesaw, is always weighted down on the side away from the opening. Corbelled arches, built by the builders of the tombs of Egypt and Mesopotamia over 5000 years ago, are still standing.

True Arch

In the true arch or as it is most commonly known as the Roman arch, the stones or bricks are dressed so that they are thicker at one end than at the other. If the stones are put one on the other with all the thick ends together and there are enough stones all the same shape, the pile will go up, curve over, and come down again in a perfect semicircle. By placing this configuration in a gap in a wall, the stones will form an arch over the opening (Figure 3).

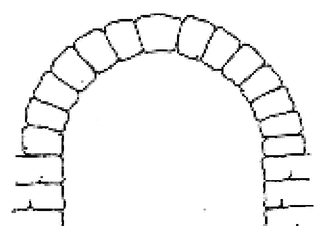

Figure 3

The rest of the bricks can be laid around and over the arch. One can readily see that the stones cannot slide down and fall because they are like wedges. The top stone of the arch, which is called the keystone, tries to slide down but cannot do so without forcing apart the stones on each side of it, known as the voussoirs. Its downward push is changed to a sidewise thrust against the stones next to it and these carry the thrust to the next stones, and so on down around the opening and reacted by the abutments, known as springings.

From the above, one can see the correlation between a rounded and backed text block and that of an arch (Figure 4). The center signatures can be likened to the “keystone” with the rest of the signatures or sections acting as voussoirs and the boards acting as the “springings”. The downward loads are shifted into thrust ones. These lateral loads run around the arch ring and are reacted by the boards, the abutments. The text block is allowed to retain its shape and increase its durability.

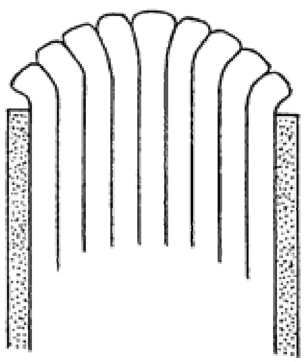

Figure 4

Shape and Strength and Their Relationship

Some elements of structure develop both tension and compression at the same time. Such an element is a beam. Every beam must deflect under the load which is applied to it and it will therefore be distorted into a curved or bent shape. To illustrate this, place a thin steel ruler on two books set apart. Place a weight on this ruler, like a small book, and you will notice the ruler will move down under the action of the weight and the beam will become curved. (Figure 5).

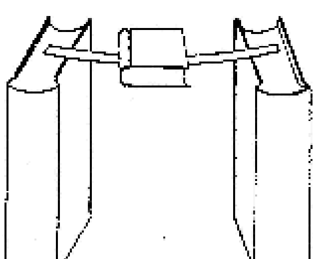

Figure 5

This can be better illustrated if you take apiece of foam rubber or Styrofoam, draw a set of vertical lines on one of its narrow sides; and draw a horizontal line halfway between the top and bottom of the Styrofoam. Bend the ends up with your hands (Figure 6). Notice that the distance between the vertical lines shortens at the top and lengthens at the bottom of the Styrofoam beam. Material on the upper concave face of the bent beam will be shortened or strained in compression.

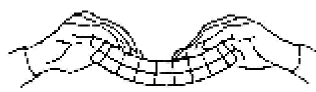

Figure 6

Material on its lower convex face will be lengthened or strained in tension. Note that the distance between the vertical lines remains unchanged along the middle of the beam and so does the length of the line. This means that along this horizontal line the beam develops neither tension nor compression. This is why the horizontal midway line is called the neutral axis. The ruler, under the book’s pressure, behaved like the bent Styrofoam beam too, but the lengthening and shortening at its bottom and top edges was so tiny you could not see them.

A simple experiment that illustrates the relationship between shape and strength is to hold a thin sheet of 8-1/2” x 11” paper by one of its short sides. You will notice that the sheet droops and is unable to carry even its own weight (Figure 7). However, if you bend it slightly

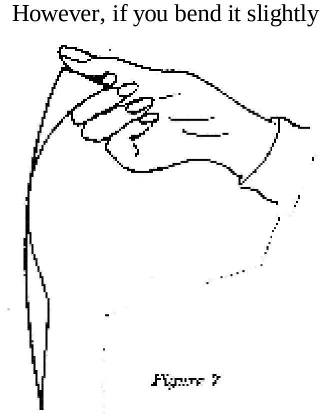

Figure 7

upward and give it a curvature, it cantilevers out and may carry some small weight in addition to its own dead load (Figure 8). This simple experiment shows that the same amount of material changes its strength and stiffness depending on how it is shaped.

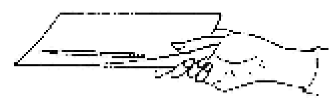

Figure 8

In curving the paper in this experiment we have moved some material away from the neutral axis of the cantilever, putting it above and below this axis and, hence, increasing its strength and stiffness. This is why a rounded and backed text block is stronger and more durable than a flat backed text block.

Another way of emphasizing the strength that comes from curvature is to try to span a distance of about 8 inches between two upright books with the same sheet of this paper. If you lay the paper over the books, it is so flexible that it bends down and slides off the tops of the books (Figure 9).

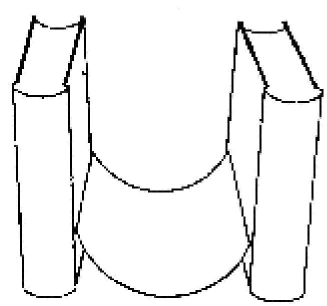

Figure 9

Its thickness is insufficient to work as a lintel. It lacks the needed stiffness to cover the span. But if we curve the paper into a cylindrical or barrel shape, and set it between the books, bracing its ends against the book covers, it will become a self-standing arch, whose outward thrusts are balanced by two books, which act as buttresses (Figure 10).

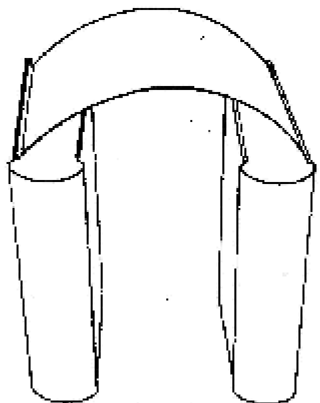

Figure 10

Rounding and Backing By Machine

Since most commercial library binders round and back by machine rather than by hand, it is important to review some of the principles of operation.

With a properly maintained and operated machine, the rounding and backing operations become more forgiving than when done by hand. However, every machine has its limitations and it is important, therefore, to review some of the principles of operation of the semiautomatic machines and their performance capabilities.

Rounding is produced by means of two rollers, appropriately called “rounding rollers”, which clamp the text block with a uniform pressure, and are allowed to rotate an equal amount through a preset arc. The amount of rotation will dictate how far below the backing jaw-blades the text block will be fed and, consequently the size of the joint. This feature is advantageous since increased rotation of the rounding rollers will reproduce the required round as well as a larger joint necessary for thicker text blocks. Remember that the naturally produced swell contributes a major portion of the round, convex-shaped spine. Under this principle of operation and with a properly adjusted machine, there is no possible way for the round to become asymmetrical (Figure 11).

Backing is accomplished by means of a roller, known as the “backing roller” that is brought into contact with the back of the text block and is allowed to gently roll along the convex-shaped back. (Figure II).

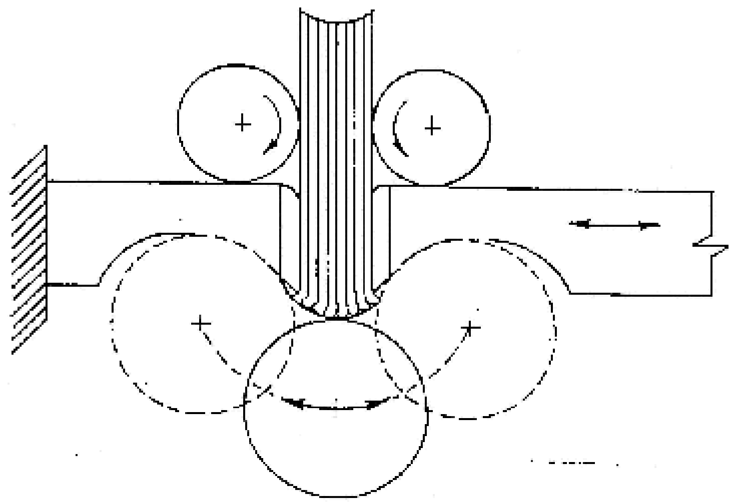

Figure 11

The large non-uniform product mix found in a library bindery poses many challenges to both operator and machine. Text blocks, with varying thickness and different types of paper, have different requirements for rounding and backing. Furthermore, unlike edition binders, where text blocks seldom exceed 2-1/2” in thickness, the library binder’s machines can accommodate text blocks 3-1/2” thick. Under those conditions the machine calls for a skilled craftsman with knowledge of various kinds of papers so as to predict their behavior in the machine as well as all other aspects of forwarding in order to maximize the capabilities of the machine and produce a quality product.

If, for example, we take two text blocks of equal thickness, one with pulpy paper and the other with coated stock, each will behave differently when rounded. The first, due to the relatively high friction between the leaves, will have a slightly convex-shaped back, while the second with smooth paper and less friction will be well rounded with a more convex shaped back. The latest models of semiautomatic, self-adjusting machines provide means for adjusting the curvature of the path which the backing roller will follow This unique feature allows the operator to match the curvature of the backing roller path to that produced by the rounding rollers. Here is where an operator, knowledgeable in the behavior of various types of paper, can maximize the performance of the machine.

What About Quarter Bindings, Flat Backs, and Other Binding Styles?

Although the analysis of various structural forms was limited to architectural ones, one can easily find forms in nature that would follow similar principles. Have you ever seen a square egg, tomato, apple, or a square watermelon? Or, have you ever seen a flat backed turtle? The natural curvilinear shapes of all these and a host of others are representative of structures • capable of withstanding compressive loads with optimum weight carrying capabilities. The principles governing these shapes and forms also apply to rounding and backing.

Why then have quarter bound, flat backed text blocks, and other binding styles? As stated earlier, librarians are taking a more critical look at the structure of the text block in relation to its end use and are considering all options, including the option of not binding at all, and thus maximizing the yield from their limited budgets. Once the end USC has been established, binders eagerly respond to their customers' needs with creative packaging solutions, and quarter bound and flat backed books are such examples.

While at Johns Hopkins University John Dean conducted studies on levels of use for periodicals after binding. Out of 400 titles monitored, over 87% were found not to have been used since binding. This study resulted in the adoption of the "Quarter-Buckrarn Periodical Binding". In this style of binding, the case is made up 7 of two bare boards joined with a pre-lettered strip of cloth glued directly to the spine and to the single folio endpapers. The flat backed text block and the boards are trimmed flush at the head, tail, and fore edge. This style of binding is claimed to be relatively inexpensive, although some binders assert that it is less expensive to construct the conventional case than that of a quarter binding. This type of binding is appropriate for materials with a very low use factor.

Flat backs are not new T.J. Cobden-Sanderson, who founded in England the Doves Press in 1900, was fond of flat backed text blocks. Unlike today's true flat backs, his was almost a flat back which had to be very well constructed in I order for it to retain its shape in use and I not become concave.

Contemporary flat backs are in most respects similar to the so-called "Economy", or "Budget" bindings. They use the conventional fully cased cover and materials, the exception being that they are not rounded and backed. This style of binding is somewhat more expensive than quarter bindings. In any event, it too is designed to meet a specific end use.

Flat backs also open well, but to their detriment, the fore edge of a flat back will quickly collapse into a convex shape that is both unsightly and damaging to the binding. Gravity, unless checked by the principle of the arch provided by rounding and backing will yield the same in a book as the lintel yields in a bridge...an eventual collapse of structure.

As seen earlier, the sections in a rounded and backed text block are not suspended between boards, but are supported by the "abutments" of the boards. In this manner the strain on the leaf attachment is relieved allowing the spine to retain its shape. Consequently, where openability and durability are concerned, a properly rounded and backed text block is structurally superior to a flat backed text block. □

Author Jack Bendror, president of Mekatronics, Inc./Bendror International, Ltd. and an Associate Member of the Library Binding institute, holds Bachelors and Master's degrees in Mechanical Engineering, lie has devoted a career of over 35 years to designing and manufacturing machinery for the library binding industry. His efforts at automating what were formerly hand operations to improve the quality of library bound books and the productivity of library binders have resulted in many automation breakthroughs. Among them, the self-adjusting Rounder & Backer Hydropress Building-In Machine, MD-16 (computerized book measuring unit), RB-7 and GEM (computerized cover lettering systems), and most recently, ABLE. (Advanced Bindery Library Exchange), a hardware/software product that provides both the bindery and the library with means of communicating binding/rebinding information more quickly and accurately. He and his wife, Gloria, have a daughter: Deborah, and a son, Steven.

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