Timber Framers Guild

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Healthy Businesses

Frank Baker
Riverbend Timberframes, Blissfield, Mich.

Is good health something we strive for, or do we just hope for it?

Our physical, fiscal, emotional, and spiritual health are often neglected in our busy lives. We often focus on one and neglect another until danger signs appear; then we react. We hope our reaction is not too late to avoid serious consequences such as death or bankruptcy. We are challenged to maintain a balance in our lives, recognizing enough critical signs to head off problems early. This is why we exercise and diet to maintain our physical health, spend time with friends and family to maintain emotional health.

Our businesses are a demanding and (we hope) fulfilling part of our lives. They contribute both positively and negatively to our emotional, physical, and fiscal health. In the quest for balance, we must recognize that each time we seek more of something we must give something else up. If we want more leisure time, we must work less; if we work less, we will likely have less money. This may be perfectly okay, but stress increases significantly when we try to have it all. Sooner or later something will give, and it is always some form of health—business or personal.

A business can be healthy only if its owners, employees, suppliers, and customers also stay healthy. This may seem like a tall order for anyone to manage; and it is, But you didn’t go into business because you thought it would be easy, did you? If you did, get out now while you have your health. If you are in business for the challenge of it, you can rest assured you’ll be challenged beyond your dreams.

To succeed in striking the proper balance, we must analyze what is important to us, create a plan for achieving it, and monitor how we behave to ensure it is consistent with our plan. We need to do this as an overall life plan that includes both personal life goals and business goals. If they are not synchronized, we’re destined for problems.

If you think this presentation has all the answers, forget it. I have more questions than suggestions. Knowing the timber frame community for almost 25 years now, I know that there are some excellent minds in this group and I plan to tap them once again for good ideas.

I agreed to do this program because Joel McCarty is persuasive enough to convince me that I might have something of interest to offer everyone. I suspect he really thought that anyone who could survive an aneurysm in Costa Rica tended by Bennett and Leroy must have something interesting to say!

Honestly, I agreed because I always learn through the process of preparation, and I learn further by interacting with those who attend and share their thoughts, plans, difficulties, successes and failures. I do plan to share some tools and thoughts on how to monitor business health. This will be about planning and measuring tools and processes. I do not guarantee that they work or that we use them consistently in our own business. Like preparing for this presentation, it is not something I do all the time, but I find that periodically taking stock of how business is progressing towards our goals and how we measure up in the world in general are healthy things to do in themselves.

Frank Baker left General Motors a long time ago to found Riverbend Timberframes and then added panel-making and the formation of InsulSpan to the feathers in his cap.

FrankB@riverbendtf.com, 517-486-4355.
Furniture from the Forest

Bruce Beeken
Beeken Parsons, Shelburne, Vt.

This discussion and the accompanying slides will explore the evolution of furniture maker Beeken Parsons. Their goal in forming a partnership in 1983 was to create furniture that reflected shared interests in craftsmanship, design, and wood. From the start, Bruce Beeken and Jeff Parsons have seen design in the large view that integrates esthetics, process, and materials. The connection between material and end product has deepened substantially as our source of wood shifted from the lumberyard to the forest.

Initially the Beeken Parsons workshop operated on a word-of-mouth basis. The occasional museum exhibition served to expand our name recognition, but within limited circles. The early days established an esthetic foundation, with an emphasis on forms with graceful curves and mild organic shapes. The furniture was conceived with a keen understanding of furniture traditions and functional considerations.

We live and work in a place and a culture that has, in the past, placed a high value on small villages with simple, understated, but well-designed, structures that inform our aesthetic sensibilities. Rather than being bound by these influences, we look for a fit between this tradition and our time. Our furniture speaks of our respect for economy and elegance; it is born of an appreciation for what is essential and what endures. Beneath it all, we attempt to bring spirit and humanity to our designs.

A craftsman’s preferred techniques and the feeling of that craftsman’s finished work are usually plain to see. Beeken Parsons is not an exception. The interplay among techniques like bending, shaping, and mortise-and-tenon joinery distinguishes our work, and in many ways, informs our designs. As commissions increased in scale, Beeken Parsons recognized the need to bring our craftsman sensibilities to an increased scale of production. This often involved an interesting process of stretching furniture-manufacturing techniques to fit the esthetic requirements of a piece. The technical end alone cannot be responsible for efficient production. The partners thought there should be a two-way conversation between the intended look of a piece and the process by which it would be made. We believe that simplification of design, a boiling down to the essence of an idea, has the potential of creating well-resolved furniture designs that can be reasonably produced and, in the end, be successful as individual pieces or large groups.
In addition to technique, love of materials is common among craftsmen. Beeken Parsons’ association with the wood we use begins in the forest or at the log landing. Relationships with foresters, loggers, and sometimes landowners provide access to logs. It is the business’s intent to produce furniture that reflects the mix of species and grades of hardwoods that grow in our region. Custom sawing allows our lumber to be roughly dimensioned to the furniture. This process yields a lot of heartwood whose knots, irregular colors, and textures Beeken Parsons prefers. The beauty of nature is found, not in its regularity, but in its rich variety of shapes, textures and colors. This array of character lends richness and vitality to the simple forms found in our furniture. Character also means challenges beginning with the mill, carrying through to kiln drying, and affecting almost every other step of the process, including marketing and distribution.

The past several years have been a time of growth for Beeken Parsons. To the mix of custom residential furniture and larger institutional projects (college libraries and so on) has been added a line called Forest Furniture. The mantra in developing Forest Furniture was, “How simple can this be?” Bruce and Jeff have focused on developing a direct marketing approach to selling this work that attempts to replicate the experience a customer has in a visit to the workshop. The natural wood character of the furniture is used prominently in promotion—“Furniture with soul.” An environmental message is attached to the business’s commitment to sustainable forestry practice, which is underscored by our certification with the Forest Stewardship Council.


Bruce Beeken and Jeff Parsons formed a partnership in 1983, establishing a workshop in Shelburne, Vermont. They met as students in Boston University’s Program in Artisanry, where they earned degrees in furniture design and construction. Subsequently, Bruce was awarded a National Endowment of the Arts Craftsman’s Fellowship and Jeff worked in New York City, New Hampshire, and Vermont in production woodworking shops. Their partnership has resulted in an approach to furniture making that integrates their interest in design, process, and material.

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Ben Brungraber, Benson Woodworking, Walpole, N.H.

In a practical working sense, I see three steps to the engineer’s job:
1. Determine the design load and design load combinations.
2. Model and analyze the structure under those loads.
3. Design members and connections in response to the results of the analysis.

These three steps contain some pretty intensive structural engineering considerations. We will examine those.

We’ll also consider the differences in the task when work outside of the company has been done on the house. Has the frame been designed by someone else (less desirable) or are we laying out the frame to fit a conceptual design?

We’ll also talk about what it takes to be an engineer who analyzes timber frames. I see these requirements at least:
• The engineer must know the National Design Specs (NDS) for wood and other timber design codes.
• The engineer must have studied the reports produced by the Timber Framers Guild about frame engineering.
• The engineer must be familiar with the realities of creating a frame—the entire building process involved.
• The engineer must be ready for a significant learning curve.
• The engineer must of course have a civil or structural engineering stamp in at least one state.

The scenarios for entry-level engineers include (1) working for an engineering firm (or starting one’s own company) that has timber framers as clients, or (2) working as an engineer in a timber framing company.

Ben Brungraber is an engineer, among other things, with Benson Woodworking Co., Inc., in Walpole, N.H. His education and career have long focused on connecting heavy timbers to one another in pleasing and reliable ways.

Grigg Mullen, Virginia Military Institute, Lexington, Va.

I see myself as a junkyard engineer: a generalist, but with a special interest in timber framing. I’ve concerned myself with the engineering aspects of structure, rigging, wood materials, code compliance, trajectories, and foundations. I will talk about these aspects.

What does it take to be a timber frame engineer? Strangely enough, the most important knowledge for this specialty is all the stuff you take as a sophomore in college: basic structural and statics, dynamics, materials science. You need a basic understanding of the forces at work in a timber frame.
For new engineers, the most important knowledge that you must gain is to know how a timber frame is built. A thorough understanding of the process is crucial.

I think that we in the timber frame industry are growing our own engineers. Many companies have experienced the frustration of seeking a stamp of approval from an engineer who doesn’t understand timber framing. We’ll talk more about this as well.

Col. W. Grigg Mullen, Ph.D., P.E., is a professor of civil engineering at the Virginia Military Institute. He is currently on sabbatical in order to further develop the Timber Framers Guild apprenticeship program. grigg@vmi.edu, 540-464-7331.
Codes: the Practical and the Possible

ENGINEERING TRACK

SHARED SESSION

Working with Existing Building Codes

Ben Brungraber, Benson Woodworking, Walpole, N.H.

A hands-on look at building codes as they are today. Topics will include:
- the three primary building codes in the U.S.—how they differ and how they work together
- the powers local building officials have
- strategies and methods to deal with their reasonable concerns
- provisions that influence building codes.

For Ben Brungraber’s biographical information, see page 6.

The Call for New Standards

Dick Schmidt, University of Wyoming, Laramie

Present timber codes—and why they’re not enough

Heavy timber (post and beam) construction is used in a broad range of structures, including buildings, bridges, and towers. The timber members in these structures are usually connected with the aid of steel bolts and metal fastening hardware such as plates and hangers. Design procedures for this conventional approach to heavy timber construction have a sound technical basis in comprehensive past research. Likewise, a modern design standard, the National Design Specification for Wood Construction (NDS, published by the American Forest and Paper Association, AFPA), which assumes the use of metallic fasteners, aids the engineer in producing safe, serviceable structures. Structural designs that conform to the NDS are automatically code compliant, because the NDS is a consensus standard that is recognized by the various code-writing agencies.

In a traditional frame, by contrast, the timber members are attached with pegged mortise and tenon joints, dovetails, scarfs, and many variations of these carpenter-style joints. Unfortunately, modern building codes and design specifications evolved after timber framing gave way to conventional construction techniques. Accordingly, today’s codes contain no provisions for the particular details unique to traditional methods. Architects, engineers, and contractors are constrained in their use of timber-framing techniques because of the lack of both design provisions and knowledge regarding structural behavior. Likewise, building inspectors and code officials (especially in geographic regions where timber-framing was not historically practiced) may be reluctant to approve these construction methods.

The technical problems associated with the design of a timber frame lie not in the behavior of the members themselves, but with the joints. Current practice, guided in part by the NDS, is adequate to predict the structural performance of the members. Likewise, certain joint design considerations, such as those involving load transfer through direct member-on-member bearing, are treated satisfactorily in the NDS. The difficulty arises when carpenter-style joints are used to transfer tension loads. In this case, the shear, bending, and dowel bearing strengths of the wooden peg are
critical to the integrity of the joint. Also, since the NDS’ full-strength requirements for peg-hole end
distances (in the tenon) and edge distances (in the mortised member) are difficult to satisfy, joint
failures due to cross-grain tension at the mortise or splitting in the end of the tenon are design
concerns. Designers are confronted with the problem of how to detail such a joint (or an alternative)
to resist tension forces due to wind and seismic loads, with little guidance from the NDS.

**Historical precedent as a guide**

Design procedures for timber frame structures in the U.S. have evolved from historical precedent.
The timber frame revival began with restoration and reconstruction of existing structures.
Craftsmen studied these structures and the writings of their builders to learn how they were made,
and they designed new buildings following the lead of their ancestral models.

The use of historical precedent for connection design is not always adequate. Specific construction
details can easily be used out of context with respect to the entire structure in which they are found.
That is, a particular connection detail that has performed well for hundreds of years might be
viewed as good practice without full consideration of the characteristics of the remainder of the
structure in which that detail is found. Since many new timber frames are built in forms (and
sometimes for uses) that differ markedly from their historical predecessors, it is unwise to assume
that historical practice is always applicable.

Traditional timber framing has a longer history of success than does conventional heavy timber
construction. Yet current design specifications and building codes do not include explicit provisions
for timber frame joinery. Use of hybrid systems and hidden metallic fasteners provide alternatives to
the design of all-wood joinery. However, these alternatives are not acceptable to traditionalists and
preservationists. Hence, rational design guidelines for wood joinery, in the form of industry-wide
standards, are needed.

Many engineers (even good ones) are unfamiliar with the basics of a timber frame and the details
that make it work. Even with the available training, comprehensive guidelines for joint design are
not available. As a result, some designers cannot see farther than the nearest steel bolt when it comes
to joining two timbers. Nevertheless, capable engineers are doing the job now. But without
commonly accepted design standards, designers must act conservatively. The professional engineer
must regard his duty to the public welfare as paramount. Historical success stories are not sufficient
guidelines for the designer. The saying, “We've always done it that way” is not good enough.

**Real standards on the horizon**

The Timber Frame Business Council and the Timber Framers Guild are currently sponsoring a project
at the University of Wyoming that will ultimately result in a structural design standard for timber
frames. This standard will serve as the fundamental guideline for designers (including architects and
engineers) to assure good engineering in their structures.

The adoption of standards in the timber framing industry is a passionate issue for Guild members,
perhaps because it is surrounded by confusion regarding their intent and scope. To clarify this issue,
we explore several questions:
• What are design standards and who will set them?
• Who will be required to meet them? Who will enforce them?
• Will they limit creativity and stifle innovation? Can't we just get by without them?
• What is the process for development of the standards? What will they look like?
What are design standards? Who will set these standards?

From the perspective of structural engineering, a **design standard** is a set of rules that defines minimum acceptable criteria to assure that a structure will safely serve its intended function. As practice in a profession matures, the lessons learned are compiled in a unified form. In essence, a standard is a representation of the accumulated knowledge of the profession. When we use a design standard, we demonstrate that we have used, in distilled form, the large body of expertise available to us. Alternative names for a standard include code and specification. Usually, a design standard is written by a committee of professionals (normally volunteers from industry and academia) who have expertise and interest in a particular issue governed by the specification.

By way of contrast, let’s switch the word order and consider a standard design. A **standard design** is a design that is developed out of experience, without consideration of the needs or interests of one specific client. Standard designs are established primarily for economy. With experience, we tend to develop routines that are efficient and predictable. A standard design is simply an expression of that routine. Your favorite method for joining a floor joist to a summer beam can be regarded as a standard design. Standard designs are developed, not by a committee of experts, but by the builder himself.

Who will be required to meet them? Who will enforce them?

When a design standard is established, we are all obligated to abide by it. This is true even when the standard does not meet all of our expectations. The obligation might be a legal one, through inclusion of the design standard in the local building code or in a contract with the client. However, we also have an ethical obligation to follow the design standard, since it is the accepted representation of a body of knowledge.

If we don’t like a standard, we can have it changed. If we know that the provisions of a standard are overly burdensome or conservative, then we must work to improve the standard. Design standards are never static. For example, the most applicable design standard for timber framers, the NDS, was originally introduced in 1944 and is now in its 13th edition. To change a design standard, we document what we have learned by objective experimental methods or theory, cast the results in a form that can be interpreted by practitioners, and then submit the changes to the appropriate standard-writing body. The standard-writing body then reviews the recommended changes and, if the case is sufficiently compelling, issues a revision to the standard.

Enforcement of design standards is handled in two ways. First, local building officials (inspectors) interpret the building code and assure that a particular structure satisfies the code. If the inspector doesn’t like what he sees, he can intervene in the building project until the problem is resolved. The second enforcement method is through the court system. In this context, suffice it to say that, if an applicable design standard exists, you had best follow it.

Will they limit creativity and stifle innovation? Can’t we just get by without them?

Design standards do not specify how a particular structure must be built. They are not so specific as to require what joint type must be used in each situation. **Design standards don’t specify standard designs.** Instead, the design standard defines the allowable load for a particular type of joint, based on the associated material and geometric characteristics. The designer’s task is to adjust materials, geometry, loads, etc. so that the actual loads experienced by the building don’t exceed the allowable load.

The absence of an industry-sponsored design standard for all-wood joinery stands as a barrier to general acceptance of timber framing. A design standard is essential for engineers and designers to
learn the methods of timber frame design, to reduce conflicts with building officials, and ultimately to help the market for timber frames grow beyond its current niche status.

**What is the process for development of the standards? What will they look like?**

The Business Council and the Guild have chosen a two-step approach to the ultimate goal of a timber frame design standard. The first step is to develop a **recommended practice document** for the industry. This document will be written following an interpretation of available research reports and technical papers, a distillation of the critical information, and finally development of a set of recommendations believed to constitute good practice.

The recommended practice manual will reduce the effort required by design professionals to become familiar with the available research. It will also expand the opportunities for application of the recommended practice to those who might not be so familiar with the structural system under consideration. However, the recommended practice document is not enough. It is not a substitute for a design standard, in that the judgement of the engineer or the building official still governs acceptance of this approach. Hence, the recommended practice manual will provide an important starting point for a consensus-based standards group to develop a **timber frame design standard**, which would ultimately be accepted by building code officials.

Development of a standard by joint cooperation of the timber frame industry and a professional society, through a process approved by the American National Standards Institute (ANSI), is the approach that will ultimately lead to de facto acceptance by designers and code officials. This approach is based on a consensus process, in which every provision of the standard is approved by the committee as a whole. To win approval, the provisions must be airtight. The development process would normally be seeded by an industry-sponsored version of the standard, in this case, the recommended practice manual. The consensus process is directed within the professional society, not strictly within the industry. These groups normally rely on the efforts of volunteers to craft the precise language and rules in the various standards. A recommended practice manual, submitted under sponsorship of the Business Council and the Guild, would help to prime the pump.

This is the approach that was followed in development of the new Load and Resistance Factor Design (LRFD) specification for wood design. The AFPA hired a consulting firm to develop the draft document. Following conclusion of that work, the American Society of Civil Engineers (ASCE) joined in the effort with AFPA to work the document through the consensus process into an ANSI-approved standard. Now, the LRFD specification is included by reference in the International Building Code (IBC) 2000. Since the process is pre-approved by ANSI, the final result would be a nationally recognized standard that is then published, sold, and maintained by those who develop it. The rigor of the process and the volunteer milieu mean that the standard can take many years to develop.

As it is currently envisioned, the recommended practice manual is being developed in the form of a draft standard (the set of rules) with an attendant commentary (a discussion of the rules). The study will have two main focal points:

1. The role of carpenter-style joinery with wood pegs in timber frame design
2. Load sharing between the timber frame and its lateral force resisting system

The scope of the manual will be limited to only those issues not already covered in the NDS. Design provisions that are already governed by the NDS, such as axial, bending, and shear force capacity of heavy timber members, will not be repeated.
The recommended practice manual will include two main parts:

**Draft specification**
The set of provisions (rules) that must be followed in order for the resulting structure to be regarded as conforming to the specification.

The specification will be performance-based: it will specify the minimum levels of strength, stiffness, or other characteristics of the completed structure. By contrast, prescriptive specifications define the materials and methods used in construction; then the resulting level of performance is only presumed to be attained. Performance-based specifications are preferred because they permit greater flexibility and creativity on the part of the designer, while still resulting in safe and serviceable structures. The specification will be offered as a draft, since it is unrealistic to expect that it will be acceptable in initial form to external reviewers (such as the staff at AFPA) who would be responsible for endorsing it as an industry standard. Also, since development of the standard is expected to identify gaps in the knowledge base and available performance data for timber frame design, the standard will be incomplete: a draft.

**Commentary**
A discussion of the specification provisions to clarify their intent.

This discussion will include appropriate citations of the literature upon which the provisions are based. In addition, the commentary will include recommendations for designers by which they can achieve the objectives of the specification. For instance, methods of structural analysis that account for the flexibility of wood-pegged joints and interactions with other structural systems can be discussed. Generally, it is inappropriate to require a particular method of analysis in a specification. This task is normally left to the judgment of the designer. However, guidance in the commentary on analysis alternatives is desirable. In this way, the commentary will serve as a teaching document to guide designers in application of the specification.

**Dick Schmidt** is a professional engineer and Professor of Civil Engineering at the University of Wyoming, where he teaches a broad range of courses in structural engineering. He is a member of the Board of Directors of the Guild and has conducted research in the engineering aspects of timber framing for several years.

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Understanding and Using Square Rule Layout

Rudy Christian
Christian & Son, Inc., Burbank, Ohio

The essence of timber frame carpentry is layout: so much so that much mysticism and lore have grown up around it. The ancient methods of scribe rule layout, sacred geometry, and the systems of carpenters’ marks used to identify each joint can take years if not decades to master. It’s easy to believe that early carpenters would have welcomed a simpler method, but it is surprising that it took until the beginning of the 19th century to happen. Square rule layout first appeared in the New World around 1800. By 1850, it had spread across America and for the most part replaced scribe rule layout.

So, what is square rule layout, and why is it so much easier than the older ways?

Probably the single most important difference is that a carpenter using square rule lays out timbers one at a time, rather than working with whole assemblies. By understanding how square rule works, a framer can start laying out and cutting up timbers before s/he even has all the timber in the yard, a fact that comes in handy when dealing with some suppliers! Since s/he is working to the “perfect timber” within the real timber, the fact that the timbers aren’t square or sawn accurately isn’t a problem either, and the framer can go about the work knowing the frame will fit up without any test fitting ahead of the raising. In short, square rule saves time and labor, and reduces the number of steps in timber framing.

Once the basic concept is understood, there are several ways in which the layouts can be drawn onto the timbers. The tools required include a framing square, chalk box, marking gauge, and pencil. A razor knife or scratch awl are useful for those timbers that are already gray. Oh yeah, a pair of sawhorses comes in pretty handy too! But it’s easier to understand if you watch it being done.

During this half-day workshop, we will discuss materials and talk about tools and layout in a hands-on setting. Audience participation and interaction are encouraged. So bring your pencils, notebooks, and questions, and let’s have some fun!

Rudy R. Christian is the owner of Christian & Son, Inc., a timber framing company in Burbank, Ohio, that designs and builds custom timber frames based on historic patterns and consults on preserving historic timber frame structures. Rudy’s background in engineering and general contracting set the stage for his appreciation of the structural integrity of heavy timber construction. Rudy is dedicated to preserving the knowledge of timber frame joinery systems and the craft of building with heavy timber. He discovered timber framing at a workshop taught by Ed Levin in Gambier, Ohio, some 20 years ago, and has not looked back since. He is also the current Guild President.

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Chip Carving
PRE-CONFERENCE WORKSHOP

Richard Cormier
Wise Owl Joinery Company, Port Williams, Nova Scotia

The day begins with the introduction of the tools (a cutting knife and a stab knife), sharpening techniques, and how to hold the knives properly. Then we progress to laying out the borders, three-sided chips, curved chips, and straight line chips. This is the foundation for chip carving.

The second part of the day emphasizes the layout and carving of letters and dates, the spacing of the letters being the most critical part of this procedure. We will discuss project preparation, species of wood, moisture content, and staining options.

The whole idea is to have fun and walk away with the desire to learn more about this art form. Timber framers will find this most useful for all kinds of detailing throughout their careers.

Tools required:
• 1 Moor cutting knife (large or small)
• 1 Moor fine ceramic stone (white)
• 0.5 mm mechanical pencil
• accurate compass
• white polymer eraser

I will provide the rest.

Suggested Reading
Wayne Barton, Chip Carving Patterns.

Wayne Barton, Chip Carving Techniques & Patterns.

Wayne Barton, New & Traditional Styles of Chip Carving.

Dennis and Todd Moor, An Introduction to Chip Carving Theory and Technique.

Dennis and Todd Moor, Free Form Patterns for Chip Carving.

Richard Cormier took several courses with Todd and Dennis Moor, Canadian champs since 1993.

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Historical Forms

ENGINEERING TRACK

SHARED SESSION

Covered Bridges

David Fischetti, DCF Engineering, Cary, N.C.

By far the most popular traditional truss configurations for covered bridges in the 19th century were the Burr Arch and the Town Lattice. Although Theodore Burr’s (1771-1822) patent of 1817 claimed nothing but the arch combined with the multiple kingpost truss, it became the most popular covered bridge structural system in the United States. In 1820, Ithiel Town (1784–1884) obtained the patent for the plank lattice truss design. Town, a Connecticut Yankee, began to build covered bridges in North and South Carolina and Georgia. The Clarendon Bridge (1819) in Fayetteville, N.C., was one of the first of many successful projects by Town and his agents. Builders paid Town for the rights to use his patented system of bridge building. In 1835, Town secured a patent for the lattice truss with double webs and secondary chords.

Although Theodore Burr suffered financial failure leading to his death in 1822, Burr Arch covered bridges continued to be built, resulting in a total of 300 remaining in the United States as late as 1971, with 175 located in Pennsylvania, more than in any other state. Still, Burr is associated with the first half of 19th-century covered bridge building and Town with the second.

The Burr Arch truss is a two hinged arch combined with a multiple kingpost. The arch affords great stiffness to the system. The construction of the abutments is critical to the Burr truss because the stability and stiffness of the arch depends on non-yielding supports. In areas where rivers are wide and flat, meandering across coastal plains, the construction of non-yielding supports is difficult. This is where the Town lattice was used to great advantage. The Town lattice requires a wide, flat bearing where the reacting forces can be spread across many lattice-chord intersections. By spreading the weight of the covered bridge across a wide area, stresses in soft underlying soils can be reduced.

In the Burr truss, the arch is integrated into the multiple kingpost truss. Joinery connecting truss to arch, truss chords to each other, individual leaves of the arch together, transverse bracing, and horizontal bracing can become quite complex. The Burr truss requires more skill in timber joinery as well as much larger pieces of timber to accommodate the shoulders of the posts.
It is claimed that the Town Lattice is distinctive in its relatively small sizes of lumber and minimal amount of joinery. The construction of the Town lattice is deceptive. Critical issues such as the disposition of splices in the chords, accuracy in the boring of holes for the trunnels, the moisture content, and the quality of the sticks mean the difference in the construction of a good or bad bridge.

Although many multiple kingpost trusses and Town Lattice trusses have been retrofitted with two hinged nail laminated arches, there are several pitfalls of such an application. First, the retrofitted arches must bear against non-yielding supports to contain the horizontal thrust. Lateral stability of the arch is critical in achieving the full capacity of the two-hinged arch. Also, to properly function, the arch must clear the bottom chord. Sufficient bolting and nailing must be applied to the arch for it to keep its shape. The practical problem of how to integrate retrofitted arches into the inside of a covered bridge has often been poorly solved. Many times, the retrofitted arches have been connected to the bottom chord forming a tied arch that is much less stiff than a two-hinged arch. This, combined with insufficient lateral support of the arch and insufficient nailing between individual laminations, has resulted in limited improvements in the capacity of some bridges.

The secret of the Burr truss was that the arch and truss had to be “properly yoked” together. In many reinforced multiple kingpost bridges, the arch is minimally connected to the truss and the floor beams are suspended with hanger rods from the arch. This, combined with insufficient lateral bracing and the tendency to tie the arch to the bottom chord, reduces the effectiveness of adding a retrofitted arch.

The practical length limit for both Town Lattice and Burr Arch bridges is 200 ft.

David C. Fischetti is a Registered Professional Engineer in 17 states. He has 33 years of structural design experience. Mr. Fischetti is internationally known in the field of historic preservation and conservation engineering. Mr. Fischetti has evaluated and designed repairs to covered bridges in New York, New Hampshire, Maryland, Vermont, Georgia, and North Carolina.

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Hammer-Beams
Ed Levin, Paradigm Builders, Hanover, N.H.

Every timber framer, it seems, aspires to build a hammer-beam roof, but relatively few are fully aware of the structural challenges that hammer-beams present. Since significant numbers of new hammer-beam roofs flow annually out of North American timber frame shops, education on the subject seems in order.

The hammer-beam roof was a late medieval innovation that served both aesthetic and structural purposes. One the one hand, it produced an arched effect reminiscent of stone vaulting; on the other, it enabled framers to cover long spans without using either gargantuan timber or intermediate support. Most of the long span structures we’re familiar with today are either arches or trusses, so it’s understandable that hammer-beam frames are sometimes referred to as hammer-beam trusses, but this designation is a questionable one.

Timber frames use the ability of wooden beams to resist axial loading (tension-compression along the grain), shear (loading across the grain), and bending. Trusses, strictly speaking, are pure tension-compression structures, built up out of individual, axially loaded members joined with pinned connections to avoid developing any bending or shear stress. This ideal is difficult to achieve, since for practical reasons joints often must have some moment capacity, thus generating secondary bending and shear stresses. However, these are minor and can usually be discounted.

The advantage of a truss in spanning distance is obvious when you compare how beams react to axial versus bending loads. Lay a 2 x 4 flatwise over a couple of blocks spanning eight ft., stand on it at midspan and it will sag two or three inches. If you can manage to stand the same stud up and balance on its end grain, the stick will get shorter, but only by a couple of ten thousandths of an inch, In the same vein, consider a simple 24-ft. span. Use a single timber to bridge it and you can support a ton or two. Truss the beam by adding a couple of struts and a kingpost and your carrying capacity goes up by an order of magnitude.

Hammer-beam history can be divided into three periods. The first era of hammer-beam building spans the late Middle Ages from the end of the 14th to the middle of the 16th century. Two building types predominate. At the minor end of the spectrum, there are numerous small—16- to 24-ft. span—chapel roofs, where the timber work mimics stone vaulting to a greater or lesser degree. (We find it hard to imagine timber framing as the more economical
building choice, but it may have been.) At the upper end, one finds baronial halls and cathedral roofs, spanning 30 to almost 70 ft.

At the onset of the Renaissance, hammer-beams disappeared from the builder’s catalog for 300 years, making a comeback during the efflorescence of revival styles that bracketed the turn of the twentieth century. This new wave of hammer-beams, built during the generation preceding and following the index year of 1900, echoes the range of their medieval ancestors, save in the matter of size. Built as institutional buildings—churches, auditoriums, private schools, and college refectories—they tend toward the large end of the spectrum.

From the pre-modern hammer-beam period, we skip down to the present day, when once again hammer-beams have come into fashion, starting in the mid-1970s and continuing today. This time domestic architecture predominates, principally in the form of the great room, a reflection of its baronial forebears.

Two principal structural and aesthetic differences distinguish medieval from modern hammer-beams. Stone walls were an intrinsic and essential part of the structural system of older hammer-beam frames, but, in the modern idiom, single tall wall-posts replace the ancient combination of heavy masonry wall, corbel, and cripple wall post. And today’s hammer-beams are, by and large, an abstraction of the original form, a sort of truss diagram incarnate. Gone are the graceful sweeping curves and elegant geometric patterning; composite curved brackets and arches are replaced by single straight timbers perhaps with shallow curves bandsawn on their inner surfaces.

Under our legal system, a defendant is said to be innocent until proven guilty. Conversely, a hammer-beam roof does not enjoy any presumption of structural adequacy. Aspiring builders of hammer-beam roofs would do well to understand their fundamental structural mechanisms, and to consider professional review of all but the most modest designs. To this end, we sample the dangers and delights of hammer-beam roofs.

In 1969, Boston native Ed Levin graduated from Dartmouth College and got his start in timber framing dismantling an early 19th-century barn in Norwich, Vt. He raised his first new frame in 1971 and for the next decade and a half operated a small timber frame business based in Canaan, New Hampshire, before embarking on his present career as a frame designer.

Ed is a contributing editor of Timber Framing, has written extensively on joinery and engineering, participates in many Guild projects, and does pioneering work on curved framing and compound joinery. He and his family make their home in Hanover, New Hampshire. Ed’s work can be found throughout North America and beyond. He is proud to be a founder and loyal member of the Timber Framers Guild. ed Levin@valley.net, 603-643-2002.
Is Big Best or Beautiful?

Anders Frøstrup
Timber AS, Tonsberg, Norway

With hope of the exchanging of views.

A big ...

“Everything is big in Texas,” is frequently, and proudly, used in America on everything typically American: cars, thoughts, turkeys, swimming pools, money, and timber frames.

building, home or

“Big thinking” results in big buildings—and homes. Compared with Scandinavian design, this is obvious: big refrigerators, big living rooms with cathedral ceilings, big dimensions on structural elements.

timber frame

The American timber frame is fatter, chunkier, and visually more dominating than its European counterpart. This has to do with timber supply and history.

affects both the people living in them

It’s easy to get lost in a big home—mentally as well as physically. The “great room” with high cathedral ceiling is a favourite in adverts for timber framing companies and in timber framing magazines. In a church, the high ceiling and big space have a big impact on people: most of us feel small and humble. The same goes for the frame. In designing homes, we are looking for something else. (Yes?)

and the people building them.

Timber framing companies often use “big” in trade advertisements. For craftspeople “big” can be a real challenge, and can give everyone a good feeling on raising day. But “big” also means heavier lifting (bad backs); more time consuming handling, a “filled up” shop, and the need for more heavy-duty equipment.

Size is connected with physical proportions, economical structures,

Big loads need big cranes and trucks. Big farms have big barns and big companies have huge office buildings. Big can be good for business too.

ways of living,

Big congregations need big churches, and the supporters demand a seat each when the local basketball team plays. Big families with a lot of children and grandparents need a bigger home compared with the small one that has suited us for over 50 years.

sex,
Big is macho. (No?) There are some great small bus shelters in the Burlington area—made by men? and ways of thinking.

When nice Americans visit the fjords on the west coast of Norway, their favourite expression is “breathtaking.” Looking at a nice (and big) timber frame, the expression often is “impressive.” People’s homes should be neither breathtaking nor impressive, if it’s not all about trying to keep up with the Joneses. (Yes?)

Thinking small,

The transformation from big to small is hard and difficult (often with a feeling of loss). This goes for people and buildings, and for the thinking. The other way around—from small to bigger—is easier (gaining). Education of craftspeople (that’s big) starts with small basic skills and pieces of knowledge.

designing small,

Smaller (not so big) homes with human proportions, less formal rooms, more multi-function, and built-in functions are great to live in. It’s a difficult process for the designer to shrink the plans on the drawing board; it’s easier to make them a little bigger.

and building frames with small timbers

The designing, cutting, transport, and raising of frames with small timbers (posts typically 6 x 6, 5 x 5) has many up sides: easier handling, more possibilities for production in series, some not so complicated joints, pre-assembly of wall or roof elements in the shop, safer raising by hand. Small-timber frames often need special small-timber joinery (keys, scarfed joints with wedges), longer and fewer braces, self-carrying roof trusses.

is great!

In Norway and the rest of Europe, timber framing with small timbers is a part of our tradition and history. In the land of “the big trees” it may be great also—for people and for the environment—to build more timber frames with small timbers.

Man has to fit.

Anders Frøstrup is a master carpenter and has written several textbooks on carpentry, drawing, and building. He runs the only timber framing business in Norway.

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Stave Churches

Anders Frøstrup
Timber AS, Tonsberg, Norway

My talk will be in two parts. The first will focus on the timber frame construction of the stave churches. The second part will be a visit to some of the churches still standing today.

Christianity was brought to Norway 1,000 years ago, and it gave rise to many cultural changes. The development of the wooden stave church was one of them. None of the 28 stave churches still standing belongs to the first generation of Norwegian wooden churches. They were built in the 11th century, and were closely related to the stave churches with walls of upright posts and planks. The posts, however, were embedded in the ground, which gave them sufficient stability to function as the constructive framework of the building; but it also caused their bases to rot.

The first generation of wooden churches survived only about a hundred years. In the 12th century, the need for more solid construction became obvious. Introducing sills as a dry base for posts and wall planks solved the problem. The method proved so effective that churches built in the 12th century are still standing today.

It is this method of construction that has given the stave churches their name. A stave wall consists of vertical planks with their bases in a groove in the sill-beam and their tops in a groove in the wall plate. At each corner is an upright post (stave) connected to the sill below and the wall plate above. Thus, a stave wall has a solid frame consisting of sill, wall plate, and two corner posts (staves). The different types of stave churches have this stave wall as a shared feature.

The stave churches are constructions of high quality. In virtually all of them the doorframes are decorated from top to bottom with carvings. This tradition of rich ornamentation appears to go back to the animal carvings of the Viking age. The stave church doorways are, therefore, among the most distinctive works of art to be found in Norway.

The interiors of the stave churches are dark. The only original sources of light were small round openings high up under the roof. The wood carvers often made embellishment in the interior. In some of the churches, the posts are equipped with capitals, giving associations with the contemporary Romanesque stone churches. The obvious wish was to decorate the stave churches in the same way as the best-known stone churches of the day. The basic construction of the stave churches—intimately linked to the properties of wood—has, however, been preserved intact.

For Anders’ biographical information, see page 20.
The Swiss Carpenter Apprenticeship

Simon Gnehm
Biel, Switzerland

In Switzerland, our students go through a selection process at age 12. Their academic performance places students in three different levels. The goal is to have similar intellects in the same classroom for the following four years. General education and prep work for a future career dominate the schedule during that phase. Parents, teachers, and counselors help with the task of finding a career.

So here I am, age 16, and I choose to become a carpenter. I have a contract with a company and receive an invitation to visit the school facilities. A day a week is spent at school with all first year carpenters from my district. Our class counts 24 young men. We take care of general education stuff, like correspondence, mother language, math, and also drafting and trade-specific issues. The other four days I’m working in the shop or onsite under a foreman’s supervision, learning how to be an efficient worker.

General woodworking knowledge and three different yearly courses are taught at the school’s facilities. Their goal is to fine-tune skills and to prepare the apprentice for the ongoing process of becoming a well-rounded carpenter.

The first course starts soon after the beginning of the education. It lasts about two to three weeks and covers the usage and care of personal tools, safety rules, wood recognition, paperwork, and basic wood joints. The courses in the second and third year cover stationary power tools, handheld power tools, organizing the workplace, three dimensional thinking, compound joinery, and stair construction. All is applied by building models and drafting plans.

The combination of working at the shop, attending courses, and going to school helps the apprentice to reach the set goals step by step.

Goals after the first year:
• Know the setup of your shop.
• Understand the position of carpentry in the construction business.
• Recognize and eliminate hazardous situations.
• Use and maintain tools properly.
• Be a helpful and courteous worker.

Goals after the second year:
• Execute simple tasks onsite and in shop.
• Use power tools properly.
• Use and explain work and staging processes.
• Explain the different layers of roofs, walls, and ceilings.
Goals after the third year:
- Interpret plans correctly and apply the proper materials.
- Explain the construction processes in combination with other trades.
- Make a bill of materials and report the work process independently on small projects.
- Know how to handle customers.

The costs of the apprenticeship are covered by three government entities: town (where apprentice lives), canton (state), and federal.

The income of an apprentice is very small. He/she starts with about five Swiss francs (Sfr) an hour in the first year, eight Sfr the second, and 11 Sfr the third. The carpenter is one of the best paid apprentices. After the apprenticeship, the pay reaches about 25 Sfr an hour, which is a nationally guaranteed minimum for carpenters.

At 40 hours a week, this will get you 4,000 Sfr a month before taxes.

To get a picture of the amount, here are a few costs to compare:
- In Biel, the average three-bedroom apartment costs about 1,100 Sfr a month.
- A Big Mac costs six Sfr.
- A gallon of gas costs 5.05 Sfr!!
- $1 US buys about 1.5 Swiss francs.

There are more than 30 sections in Switzerland with their own infrastructure to educate carpenters. In the year 2000 there were 2,506 carpenters being educated, 14 of them female.

The career options after the apprenticeship are excellent. There are possibilities to make your way up on the pay scale by taking evening and weekend courses, or you can go back to school full time for up to 4 years. The resulting degrees are recognized throughout the country. Each degree will also get you to a nationally guaranteed minimum income level which corresponds to the difficulty of the degree. The pay will also be adjusted according to performance and length of your employment, but that is handled by employer and employee on a case-by-case basis.

Simon Gnehm was born in 1971 in Zürich, Switzerland.
Married to Bonnie from Houston, Texas, in 1996.
Worked in Boulder, Colo., for Timmerhus from 1996-98.
Since Fall 2001, student at the Swiss school of engineering for the wood industry, Biel, Switzerland.

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On this bridge, wood successfully cohabits with concrete and steel.
Radio Frequency Vacuum Drying of Large Timber: an Overview

Joseph N. Howard
Sundried Wood Technologies, Elkview, West Virginia

In the manufacture of large timber structures, using dry, dimensionally stable timber makes it easier to produce a high-quality product. Dry timber helps traditional and modern timber joints remain tight and structurally sound. There are two sources for dry structural timber: recycled timber and timber dried in a kiln. Recycled timber is an excellent use of our natural resources, but the supply of good quality recycled timber is becoming scarce and more expensive.

There are three basic methods of drying timber: 1) conventional convection kilns, 2) dehumidification kilns, and 3) vacuum kilns. The focus of this presentation is on the third, vacuum kiln drying, particularly radio frequency vacuum kiln drying of large timber.

In vacuum drying, timber is placed in a tight drying chamber, and the vacuum system pulls a vacuum on the timber. Wood is theoretically dried with moisture evaporation at low boiling temperatures, usually about 40°C (100°F). Vacuum drying is based on the fact that the boiling point of water is substantially lowered when the atmospheric pressure over the wood is lowered. In essence the vacuum kiln provides “high temperature” drying at low temperatures. Many studies on vacuum drying have found that vacuum drying significantly shortens the drying time, especially for thick lumber, and the drying quality is usually good. The difficult parameter in vacuum drying timber is how to apply heat to the timber, since convection heating will not occur in a vacuum.

In radio-frequency vacuum drying, the wood is placed between metal plates or electrodes and essentially becomes the dielectric of a large capacitor. Rather than heat transfer via convection or any other conventional method, transfer takes place via dielectric heating. When a radio frequency electric current is applied via a high voltage oscillator circuit, the molecules change their directions cyclically, resulting in a rapid vibration of molecules, and heat is generated. Both research and practical experience agree that vacuum drying of lumber is fast. Large timber (sans tyloses—without membranes that occlude the longitudinal cell structure) can typically be dried to a uniform moisture content of 7 to 8 percent in one week, whereas with conventional kiln drying, for the same size timber and to the same level of moisture content, drying can take two to three months.
This presentation will answer the following questions:

- Why dry?
- How does wood dry?
- How does a kiln work?
- What are the mechanisms involved in kiln-drying timber?
- Do dimensions have an effect on drying rates?
- Can all timber species be dried in a radio frequency vacuum kiln?
- Does radio frequency vacuum drying induce more stresses in the timber than drying by other methods?
- What is the quality of radio frequency vacuum kiln dried timber?
- Is radio frequency vacuum kiln dried timber expensive?
- How do the mechanical properties of radio frequency vacuum kiln dried timber compare to green timber?
- Do insects explode if they are inside the kiln when the vacuum is pulled?

We'll look at results of laboratory tests on the mechanical properties of radio frequency vacuum dried timber and green timber. They compare and contrast the elastic modulus, the modulus of toughness, and the modulus of rupture. You will come away with a better understanding of how wood dries, fundamentals of radio frequency vacuum kilns, and the physical and mechanical properties of dry vs. green wood.

**Joseph N. Howard** is vice-president of Sundried Wood Technologies. Joe received his undergraduate degree in electrical engineering from the University of Kentucky and his graduate degrees in civil engineering (structural engineering) from Virginia Tech. Joe has 20 years of combined experience in consulting, manufacturing, and academia.

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Plumb Line and Bubble Scribing DEMONSTRATION

Josh Jackson
Dwelling Design Build, Montpelier, Vt.

Long before people were able to mill timber to the accuracy required by square rule and mill rule systems of layout, frames of great complexity were being precisely scribe fit using material that would drive many modern framers to distraction. Both the French and the English developed such scribe systems. The French maintained a continuous 700-year tradition that allowed them to work accurately with the crooked, hewn timber at hand, with little reliance on calculations and numbers. Modern framers can now use these techniques, sometimes with the addition of bubble scribes, in their own work with round and crooked timber. This workshop seeks to give participants a sense of the techniques and underlying principles of scribe layout through a hands-on demonstration of plumb line and bubble scribe techniques.

There are three significant differences between scribe layout and square rule layout. First, the layout floor largely replaces the use of dimensioned plans. Second, layout is referenced from actual surfaces rather than theoretical planes within the timber. Third, joinery is laid out by drawing how the actual timbers at each particular joint intersect, using a plumb line and dividers or bubble scribes to transfer that information from one timber to another rather than to some theoretical perfect timber.

The layout floor is the foundation of the scribe system and is where the building’s dimensions and details are set. Full-scale drawings of the various planes such as floors, walls, bents, and roof sections are developed and lined out on the floor. All the timbers in a given section through the building are then aligned above the floor drawing and shimmed level both across and along the piece. If a timber has already been scribed in another plane, it will also have a “bring me back” mark somewhere along its length to insure proper location in each lay-up. It is also possible to scribe accent pieces into a square-ruled bent, the assembled bent then taking the place of the lay-up floor.

To align timbers to the layout floor and also to locate joinery, reference planes are needed. Through the unwinding process, any shape timber can be marked with lines representing these perfect planes. A level spot near the center is chosen and marked for future use. Then squares are shimmed at either end where joinery falls such that these squares form a plane with another square or winding stick located at the level mark. Lines are then laid out from the squares (which could be thought of as similar to the reference faces used in square rule), resulting in true planes regardless of the shape of the actual timber—bowed, crowned, twisted, hewn, recycled, or round.
Joinery layout is accomplished in a direct manner when scribing. With timbers properly aligned above one another, joint details are scribed or picked, transferring information from one piece to another using either plumb line, eyes, and dividers or a set of bubble scribes. With square timber and plumb line, while sighting in the plane of one timber, one picks the distance from string to timber and transfers this distance (with dividers or eye) the same distance from the string onto the other timber. When picking points, the distance from the reference lines is also used to correctly locate these picked points on the other timber. On round stock, the same approach can be used to pick points for mitered joinery. To use bubble scribes, one measures the distance between the reference lines on the timbers to be scribed. Then one sets the scribes to the distance and, with pens in a plumb line, adjusts the bubbles to bull’s eye. The scribes will then simultaneously draw on both pieces how they would intersect if their reference lines were in the same plane.

Scribing is a powerful tool that makes working with unusual geometries and irregular timber relatively easy and replaces calculations with more spatial techniques. Joinery need not be housed nor timbers reduced unless desired. Though there is significant care and material handling involved in setup, and a mis-cut brace can mean a trip to the vineyard (penance due when a lay-up must be repeated, a downside of each brace being unique), this technique offers possibilities not easily matched with other methods.

Josh Jackson received his BSME from Yale University in 1989. After two summers as a Heartwood apprentice, he went to work at Big Timberworks in Bozeman, Montana, where gnarly recycled timber, funky natural curves, and bubble scribes were all the rage. He managed to slip 31 forked timbers into his parents’ frame, and scribed the 12 valleys in that roof system. Josh is currently starting Dwelling Design Build with his partner, Ben Yeomans, crafting fine timber frames and custom furnishings.

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By definition, morphology is a branch of biology that deals with the form and structure of plants and animals.

This presentation will deal with the form and structure of logs; in other words, log quality issues, which are important to the log-home builders. The lecture will cover the following key chapters:

- Basics of tree growth and annual ring formation. How and when do trees grow? What are tree rings made of? What is photosynthesis? What happens in a tree during the dormant season?

- Major tissue types and their role in a tree stem. Outer dead bark, inner living bark, cambium, sapwood, and heartwood.

- Microscopic structure of wood. What are the major cell types in softwoods and hardwoods? How do these cell types contribute to the horizontal and vertical transport of sap and nutrients in a living tree? What about moisture movement in a dead tree during drying? How about the uptake of different protective coatings and preservatives?

- Wood density, strength, stiffness, and thermal insulating value.

- Wood-moisture relationships, hence shrinkage and swelling. Why does flat-grain shrink twice as much as edge grain? What is the normal cupping pattern in boards, towards the bark or towards the pith?

- Old-growth and second-growth differences. What about this “juvenile wood” we keep on hearing about? Is it useless or simply not as good as mature wood?

- Spiral grain. Where does it come from? Do all trees have spiral grain? What about left-hand and right-hand spiral? Which one is more acceptable to the log-home builder?

- Taper. What causes it and how can it be minimized?

- Quality attributes of different species. Western red cedar, Douglas fir, spruce, lodgepole pine, white pine, Ponderosa pine, aspen, balsam (true firs), hemlock, and so on.

- Compression wood.

Les Jozsa
Forintek Canada, Vancouver, B.C.
Natural durability and photo degradation of exposed elements.

Decorative use of wood.

Specially built models of softwood and hardwood structure (from 100 to 10,000 times magnification), a collection of cross sections, and actual pieces of lumber will be used to put across the above key ingredients. We will touch upon differences between visually graded structural lumber grades, mechanically stress rated (MSR) lumber showing “weak” and “strong” examples, and joinery grades for the secondary manufacturing sector (doors, windows, furniture, etc.).

Key overheads throughout the workshop will link the above ingredients, and copies will be provided for the registrants for note taking.

Les Jozsa recently retired from Forintek Canada Corp. as a Resource Properties Specialist. His current clients include Forintek, BCIT, Ministry of Forests, Forest Management Institute, UBC, Weyerhaeuser, Western Red Cedar Lumber Association, and WoodLINKS. His contract work with these agencies includes technology transfer, training and education. His expertise includes planning, coordinating, and conducting research on wood quality studies involving particularly the use of X-ray densitometry. His resource evaluation studies have dealt with both the present and the future to maximize returns from present forests and to determine the impact of silvicultural treatments on wood production and wood quality in future forests.

Les has published over 150 scientific papers, technical reports, and articles, while being very active in training and education through lecturing and giving workshops. He received his Bachelor of Science in Forestry degree at the University of British Columbia. His work experience includes forestry, pulp and paper R&D, X-ray densitometry, and dendrochronology specialization. He is also an expert witness in forensic dendrochronology in the Supreme Court of Canada. In his spare time, Les has developed a high level of skill in wood carving as well.

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Construction Law and Contract Management: Know your Risks

Michelle F. Kantor, J.D.
MFK Consulting, Inc., Chicago, Ill.

Contract management is key to assuring profitability. Contract terms and conditions are crucial to manage risks for both the contractor and supplier. This session will help you to identify risks associated with the contracting process, from bid submission to close-out. We will discuss contract management and risk identification techniques. We’ll also identify key contract terms and conditions to understand and negotiate before the work is done.

Topics include:
• types of construction contracts and cost methods
• the designer’s role
• risk identification
• bidding issues
• plans, specifications, and scope of work issues
• key terms and conditions
• scheduling, milestones, and delay responsibilities
• payment issues
• standard form contracts—advantages and pitfalls
• performance issues and practical ways to address them
• damages—types of damages the parties may seek
• remedies for breach of contract
• claims
• construction contract checklist for the owner-purchaser

Michelle Kantor has been working in the construction law field for over 14 years. She has extensive experience in construction law, private and public procurement, litigation, and consulting. As an attorney, Michelle has negotiated a large number of construction contracts and has provided consulting in construction law and claims. She has represented numerous owners, developers, contractors, subcontractors, suppliers, design professionals, and other commercial businesses. Michelle has previously worked as general counsel to a construction internet company, worked as in-house counsel for a large HVAC company, and was a principal of a construction law and litigation practice for several years. She has delivered presentations and provided training on a variety of construction law and business management topics at seminars, conventions, in-house workshops, and trade association meetings. michelle.kantor@att.net, 773-227-9510.
Annihilated Heritage

Witold Karwowski
Arteco and Design Restoration Corp., Astoria, N.Y.

Poland has a rich, ancient heritage of wooden architecture. The oldest wooden structures discovered on Polish territory date from 4,000 B.C.: the remains of a log burial structure in central Poland. The structure, 500 x 32, 15 ft. high, is considered the largest man-made structure ever built previous to the Egyptian pyramids. (See the story in the Polish edition of National Geographic, October 2002.) Another major archeological discovery was made in 1930. This find, a wooden village on an island in a lake near Biskupin, is dated at 500 B.C. The island village contained fortifications, streets, and houses made of wood using sophisticated construction methods like corner posts with horizontal legs mounted by feather or key joints.

The Slavic tribes that settled in Poland in the sixth and seventh centuries A.D. also used wood to build houses, but with the simpler saddle-notch techniques. Use of wood as the basic construction material lasted until the 14th century, when brick and timber structures were introduced to northern Poland by German knights. At that time many Germans and other Western Europeans (including Jewish settlers) migrated to Poland, bringing new ways of building with wood.

Since the 14th century, three main ways of construction existed: stone and brick, timber frame using different fill materials (brick, clay), and log structures made entirely of wood. The form and method of Gothic wooden architecture lasted until the end of the 16th century.

Excerpts from the touring exhibit. The exhibit shows some of the only remaining knowledge about the wooden synagogues of Poland (completely destroyed during World War II) and gives an outline of the planned international reconstruction project.
Transformations in Polish architecture under the influence of Italy, Germany, Russia, and even distant Armenia are clearly visible today. Under the sway of these new cultural traditions, structural forms kept changing, adapting new styles and technologies. Especially interesting in this culturally rich architectural setting are the synagogues, typically built of wood but also with stone or brick.

The Jews, who found safe haven in Poland in the 14th century under the king’s protection, constructed very specific structures for their religious observances. The first known wooden synagogues were built in the 17th century. Thanks to the Polish government’s decision in 1920 to document important historical monuments, we now have a vast collection of archives on these wooden synagogues. This is fortunate, because they were completely destroyed during World War II. The variety of style, size, and artistic expression found in the interiors make the synagogues unique subjects for Polish, Jewish, and German architectural researchers.

The fact that there are no surviving examples of this important element in Poland’s architectural heritage has led the Polish Association of Conservators of Historic Monuments to the idea of reclaiming it. They created a touring exhibit to tell the story and they plan to reconstruct the oldest documented example of the wooden synagogue—the Zabludow Synagogue, circa 1635.

The Zabludow Project—International Workshops in Historic Carpentry—is being organized by the Polish Association of Conservators of Historic Monuments and its partners. The reconstruction project, scheduled to start next year, will promote the use of international workshops in traditional crafts. The workshops will take place in Białystok, Poland, and should be held annually for the next 5 to 6 years. The goals of the Zabludow Project are to:

- reconstruct a historic building destroyed in WWII
- establish an educational and scientific center
- create job opportunities and professional training in traditional carpentry
- document the specifics of the construction process.

The project is being organized as a non-profit initiative with support from governmental sources as well as a fund raising effort in Poland and other countries.

Witold Karwowski, a historic preservation architect from Poland, is at present in New York running Arteco and Design Restoration Corporation, the remodeling and sometimes historic preservation company. svante@rcn.com, 917-855-0972.

A pre-WWII photo of the Zabludow synagogue.

All images taken from the book Bramy Nieba (Gates of Heaven) by Maria and Kazimierz Piechotkowie.
Penguins in Bondage: Height Safety for Timber Framers

Steve Lawrence, Gordon Macdonald, and Jaime Ward
Carpenter Oak & Woodland, Scotland

Falling from height poses the single greatest risk to a carpenter at work. Whether you’re a professional timber framer or building your own home, whether you’re working in a highly-regulated country, or out of sight in the “back-and-beyond,” if you work aloft, then sooner or later the odds are that you’ll take a tumble. Regardless of your home country’s rules of play, it makes sense to come to grips with height safety.

Modern fall-arrest gear is highly evolved and reasonably affordable. With the addition of new lightweight safety nets, any timber framing company, large or small, can now protect itself during a raising. The techniques for using this new generation of equipment have been proven in the field and can keep you fast, efficient, and safe. We’ve been using this stuff to build our frames for several years now, and after buying, bouncing in, and breaking all sorts of expensive kit, we’re ready to tell you what we’ve learned.

This workshop will be a hands-on sort of thing. We’re going to skip the Rules and Regulations in order to focus on good equipment and sound practice. No fancy jargon, no jazzy leaflets, just common sense. We’ll show you how to assemble a safe fall-arrest rig, and we’ll show you what happens when you need it! Falling is the easy part. Have you thought about what happens next?
Steve Lawrence
I first met Steve five or six years ago when I was traveling around Britain (trying to con freescibing lessons from my fellow Guild members here in the U.K.). We worked together on a wee cruck-frame where Steve had been drafted in as the local rigging expert, and not long afterwards Steve offered me a job on the roof of Stirling Castle’s Great Hall. Needless to say, we’ve been working together ever since, and Steve currently runs our crew here in Scotland. He originally apprenticed as an engineer-machinist, so he has an innate technical understanding of access equipment, but it was his work as a tree surgeon—fiddling about with chainsaws while dangling from a string—that first led him down the road of rigging. Fortunately for us, Steve finally answered his true calling as a timber framer when he joined COWCo 11 years ago. We both took our roped-access training together (Industrial Roped Access Training Association—IRATA), and Steve routinely uses his expertise to set up access systems for our crews on site. Steve is the most capable rigger I know, and when it comes to putting up timber frames, there’s nobody else on the planet that I’d rather have by my side!—Gord

cowco@netcomuk.co.uk, 011-44-1225-743-089.

Gordon Macdonald is a West Coast boy who apprenticed as a carpenter and then ran his own timber framing company for five or six years in British Columbia. A keen climber, he shares his passion for framing with what he calls “vertical camping.” Gord moved to the U.K. in 1996, and then opened our Scottish yard in ’99. He’s still with us as one of COWCo’s directors and the manager of our framing yard here in Scotland. Gord’s combination of skills—carpenter, framer, climber, manager—have helped us to develop a range of safe and innovative systems for working at height.—Steve
gordmac@uk2.net, 011-44-1575-560-393.

Jaime Ward is one of our lead carpenters, and joins us as the third penguin of our troupe. Another experienced climber, Jam has traveled and climbed his way around the world for many years. With a degree in timber engineering, experience in forestry, and plenty of mileage on the tools, he has been a welcome addition to our crew for four years now. When our company chose to dangle three of us through the IRATA training a few years ago, Jam was an obvious choice.—Gord and Steve
cowco@netcomuk.co.uk.
Pity the Poor Rafter Pair

Ed Levin, Paradigm Builders, Hanover, N.H.

Dick Schmidt, University of Wyoming, Laramie

Pity the poor rafter pair. So many methods exist for holding a pair of common rafters in a building, each with its own set of advantages and disadvantages. Correspondingly, an equal number of methods is available for structural analysis of the rafters to determine the forces to use in design of the pieces. These analysis methods also have their own set of advantages and disadvantages. Unfortunately, there isn’t a one-to-one correspondence between “optimal” rafter configuration and “optimal” analysis method. A brief study of five different rafter configurations is discussed. The discussion will include the performance aspects, as well as the structural analysis methods, applicable to each configuration.

Let’s start with common rafters supported at their ends by a wall plate and a ridge beam. This configuration yields generous headroom below the roof. The wall plates and the ridge provide vertical support to the rafters, and no outward thrust is generated. This is the simplest configuration to analyze. If loads are determined correctly, the rafters can be analyzed based on their span length (horizontal distance between the plate and the ridge) rather than their actual length. However, because the rafters carry their loads through bending members, the roof span will be limited by the depth of the rafters. In addition, the ridge must be designed to carry 50 percent of the total load on the roof, which might lead to a prohibitively heavy member at that location.

An alternative is to eliminate the ridge and allow the rafters to bear against each other. This change induces compressive force in the rafters, which translates to outward thrust on the plates. To resist the thrust, the plates would need to be heavier (wider) and more securely tied together across the end walls. Analysis of this configuration must retain the actual geometry of the rafters. Finally since the rafters carry compression in addition to bending, their size will increase.

Thrust on the walls from the “no ridge” option can be taken out directly with a tie at the level of the plate. But that doesn’t relieve the combined compression and bending in the rafters. This converts the rafter pair to a simple truss configuration with superimposed chord bending. Unfortunately, that wonderful headroom is lost to the tie.
Shifting the tie up a few feet above the plate recovers some of the highly prized headroom. However, the design will now be controlled by bending of the rafter tail below the tie. The joinery required to engage the tie in the rafter carves away critical material from the rafter, compounding the bending problem. Finally, the tension connection between the tie and the rafter will require some ferrous connection hardware; pegs won’t do it.

That raised tie wasn’t such a good idea after all. Let’s look at supporting the rafter with some principal purlins. Looks like an ideal solution, each purlin carries perhaps only one-third of the total roof load, so size will be more manageable than for a single ridge beam. The additional mid-length support of the rafter substantially reduces its bending moment, permitting shallower sections. The dark side of this configuration is in the structural analysis. We’ve gone beyond the limits of simple, equilibrium-based structural analysis. Now, each rafter is supported by a wall plate, a purlin, and its companion rafter. That means the system is statically indeterminate. Classical methods of analysis are suited to the task, but many analysts would turn to computerized means to accurately study performance.

To predict resultant forces, stresses and deflections in a whole bent or whole frame under load, PC based Finite Element Analysis (FEA) or frame analysis programs provide a powerful tool.

To produce a deflected shape like the one shown at right, beam geometry is imported into the FEA software from a 3D CAD drawing. Individual members are assigned section and material properties, end (joint) conditions, and restraints (foundation). The virtual frame is then loaded, in this case with the dead load of the frame, roof skin and roofing, plus live load (snow).

In addition to deflections, the analysis generates axial and shear forces and stresses, moments, and bending stresses for each member (from which one can infer joint loads). Information is available in tabulated and graphical form and can be presented either beam by beam or via whole or partial frame diagrams.

FEA offers the timber frame designer a very powerful tool, but accuracy of results is entirely dependent on correct representation of the frame and load conditions. Furthermore, frame models are only an approximation of the real world, where timber strength and stiffness may vary from NDS specs and connections do not always behave like their idealized virtual equivalents. These caveats notwithstanding, frame analysis pushes the envelope for the timber framer, and it offers enlightening and often startling insights into timber frame behavior.

For Dick Schmidt’s bio, see page 10. For Ed Levin’s bio, see page 18.
Why Buildings Don’t Fall Down

FEATURED SPEAKER

Matthys Levy
Weidlinger Associates, Consulting Engineers

The images broadcast on September 11, 2001, will forever be imprinted on the memory of all who saw them. Until the moment when we witnessed the collapse of the iconic World Trade Center, we always thought of buildings in terms of strength and stability. It was inconceivable to us that the twin towers would ever collapse in our lifetime. This was especially true of two seemingly strong and massive buildings as the twin towers. What I saw reminded me of the final scene in the movie The Planet of the Apes, when the protagonist sees the fallen Statue of Liberty signifying the end of life on the earth as he knew it. In the same way, the fall of the World Trade Center Towers signaled a change in our view of the future, whether through increased skepticism or outright cynicism.

While the basic facts of the collapse may be clear, the details can teach us a great deal about what contributed to the failure. It is the same lesson that is repeated throughout our book, Why Buildings Fall Down; that is, redundancy or the lack of it is the ultimate cause of all failure.

In this talk, the mechanism of the failure that led to the collapse of the World Trade Center towers will be examined in detail. While timber may be the theme of this conference, it is a material that possesses common qualities with other materials. Where timber structures demonstrate redundancy, they can result in as dramatic structures as those in any other material. To complete this exploration, the work of the Swiss engineer Julius Natterer will be shown.

Matthys P. Levy is a founding Principal of Weidlinger Associates, Consulting Engineers. Born in Switzerland and a graduate of the City College of New York, Mr. Levy received his M.S. and C.E. degrees from Columbia University. He has taught at Columbia University and Pratt Institute and lectured at universities throughout the world.

Mr. Levy is the recipient of many awards including the American Society of Civil Engineers’ Innovation in Civil Engineering Award and the International Association of Shell and Spatial Structures’ Tsuboi Award. He has published numerous papers in the field of structures, computer analysis, aesthetics, and building systems design, has illustrated two books, and is the co-author of Why Buildings Fall Down, Structural Design in Architecture, Why the Earth Quakes, Earthquake Games, and Engineering the City.

Mr. Levy is a member of the National Academy of Engineering and numerous professional societies. He is a registered Professional Engineer in the U.S. and in Europe; he is also a director of the Salvadori Center that serves youngsters by teaching mathematics and science through motivating hands-on learning about the built environment.

Projects for which he was the principal designer include the Rose Center for Earth and Space at the American Museum of Natural History, the Javits Convention Center and the Marriott Marquis Hotel in New York, the Georgia Dome in Atlanta, La Plata Stadium in Argentina, One Financial Center tower in Boston, Banque Bruxelles Lambert in Belgium, the World Bank Headquarters in Washington, DC, and a cable-stayed pedestrian bridge at Rockefeller University. He is the inventor of the Tenstar Dome structure, a unique tensegrity cable dome used to cover large spaces with minimal obstruction,

levy@wai.com, 802-238-8675.
Vernacular Wooden Roof Trusses: Form and Repair

Jan Lewandoski
Restoration and Traditional Building, Greensboro Bend, Vermont

In the roof systems of churches and public buildings, particularly in the eastern half of North America, are tens of thousands of timber trusses dating from the late 17th century to the early 20th century. Because of their location in dark, bat-infested regions that are hard to access, they are rarely seen. Yet they usually represent the most ambitious and sophisticated framing in any given town. The typical trusses vary from 36 to 75 feet in span. Most were carpenter built and designed but commonly based upon an illustration available in the builders’ guides of the time. Their prevalence in both remote village and large city can be attributed to the availability of long and large timber in the New World and the tendency towards technical innovation that followed the Enlightenment and the Industrial Revolution. The forms of most of these trusses are variations on the Kingpost, Queenpost, and Scissors. Small amounts of iron tension joinery were incorporated into them during all periods.

I have been examining, repairing, and rebuilding timber trusses in the Northeast for 25 years. While their performance has generally been exemplary, the trusses fall victim to rot from roof leakage, breakage from unusual snow or wind loadings, increases in their loadings such as suspended balconies, slate roofing, or chimneys, fire, lightning, the removal of vestibule walls under the trusses that support the steeple, and abusive cutting away of critical members by other tradesmen or uninformed carpenters. Their repair in place is difficult because they both support the roof and usually cover an expensive, finished space such as the nave of a church. Also, the very nature of a truss, and its function, discourages the splicing in of short repair pieces.

In this session we will discuss the typical problems of timber roof trusses as we find them, strategies for repair, different rigging solutions, and a number of case studies.

Jan Lewandoski is the principal of Restoration and Traditional Building, a company in northern Vermont that restores wooden bridges, truss roofs, steeples, barns, and other large wooden objects all over the U.S. He has been a Guild member since the second conference and is a director of TTRAG. In addition to onsite work, he spends a lot of time looking at old frames and old books about them, both here and abroad, and sometimes writing.

janlrt@sover.net, 802-533-2561.
Building a Ballista for the BBC

Gordon Macdonald
Carpenter Oak & Woodland, Scotland

As many of you will know from the recent article in Timber Framing, we were foolish enough to take on the task of building this amazing machine earlier in the year. What initially began as a reasonable proposition to build a Roman catapult for a BBC Television documentary quickly became a technically challenging and logistically far-fetched race against the clock. Will we ever learn?

Over a two-week period on site in England, more than 30 fine people worked night and day to construct this machine, and I’ve brought together a collection of the best images to illustrate our trials and tribulations along the way. With a bit of luck, I’ll be able to impart some sense of the tremendous fun we all had too!

Gordon Macdonald is a director of Carpenter Oak & Woodland and manages their framing yard in Scotland. Working as a multi-disciplined team that included historians, engineers, scientists, carpenters, riggers, blacksmiths, and axe-throwers, his crew of more than 30 people built and then fired this awesome machine in less than two weeks on site in England. Teamwork makes it all happen!

gordmac@uk2.net, 011-44-1575-560-393.
The concept of the “Wizards” originated after a few attempts at presenting complex materials in a conference environment (80 people with different backgrounds). I am not a trained educator, but I did realize that there was too much information being dispensed and no real chance at an interactive discussion, one to one, aside from at the dinner table or pub. We all see differently, use different processes, and learn differently. I had an idea.

With an earnest willingness to humiliate myself in public, I proposed to the conference organizers that a jolly group could be gathered to provide a solution to this perceived dilemma. Though the original concept focused on math, the field broadened quickly to include almost any useful skill. To further entice professional participants to join the group of Wizards, I suggested that there be a fee for the service offered. Education being the purpose of this gathering, it seemed logical enough to request a donation to the Guild’s Mark Brandt Memorial Scholarship Fund. It is hoped that the contributions of our panelists (time and experience) and of those seeking the answer to almost any question (a donation to the fund) will make this forum rewarding to all involved. Should this prove worthwhile, we hope to repeat the process at future gatherings.

This forum will take place in the Exhibition Hall. A schedule of panelists and topics will be posted; you can make appointments.

The questions asked and the solutions derived may actually be worthy of publication.

Regarding donations, please remember:
• You have access to a professional whose time is valuable in the real world.
• You can expect a quality response to your question or problem. This response may be another question or method to arrive at the ultimate answer.
• The response may take time to develop; there is no good instant anything.
• The use of an air horn, gong, or other device is a signal that your time is up.

Regarding panelists, please remember:
• They do not consider themselves wizards. Period.
• They are participating in this forum to raise money for a good cause, so be polite.
• Please try to respect the schedule of panelists. They are here to learn, too.

At the time of publication, the members of this small and humble group are, but shall not be limited to:

Al Anderson, Blue Ridge Timberwrights: rigging, raising.

Tim Bickford, Bird’s Eye View Woodworking: unusual woodworking, creative solutions.

Randy Churchill, Joint Effort Timber Framing: math issues, engineering concerns, sled dogs.

Thomas Cundiff, The Edge Woodworks: Construction Master IV, developed drawings, scribing.

Glen Dodge: calculator tricks, plumb line scribe, more.
Ed Levin, Paradigm Builders: anything goes.

Joel McCarty, Timber Framers Guild: calculator tricks, baseball.

John S. Miller, Dreaming Creek Timber Frame Homes: roof math, more.

John Mumaw, Lost Bent Woodworking and Design: roof math, AutoCAD, design.

Annemarie Roseberger, Legacy Timber Frames: anything but trig or CAD.

Andrea Warchaizer, Springpoint Design: design, CAD modeling of complex roofs.

Donna Williams, Bear Dance Joinery: joinery solutions but no math, please.

Jack Witherington, Methods and Materials Building Company: snap line square rule on hewn materials, apprenticeship.

Curtis Milton, Monolithic Building Services: originator, facilitator, host.

To date we are lacking representatives from the international membership, but we can hope.

Please remember: I have pitched this as a fun format, established to both increase awareness of problem-solving techniques and raise some money for the scholarship fund. This is not intended to distract or detract from any of the other important goings-on of the conference.

Thanks to all for your cooperation and enthusiasm. milton@ncia.net, 603-387-6770.
Sharpening hand tools is for me a fascinating task. I really began to understand the principles after seeing a silicon wafer under a scanning electron microscope (SEM). Under the microscope the wafer, which appears flat to the eye, looks like a maze of mountains, cracks, and cliffs. The SEM made me think about what the surface of the steel in an edge tool really looks like. It also made me realize how difficult it really is to get a “perfect” edge. A perfect edge by microscopic standards is impossible; all we can hope for is moderate consistency on that level.

Keeping the super miniature scale in mind has several advantages for a tool sharpener. First, it means that, if you can see any imperfection in the edge, it must be giant under the microscope; therefore, any visible imperfections are unacceptable. Second, the flatness of our stones comes into play. If you can see or feel any undulations in the surface of the stone, it’s nowhere near flat. The crystalline structure of sharpening stones is giant. The crevasses and cliff tops are what cut against the steel. As you sharpen, those leading particles are broken away from the mass and form a slurry. The particles then roll and slide under the tool like marbles. They have very little abrading power because they are no longer fixed to anything.

The only way to realize the full potential of any stone is to continually wash away those “marbles” so that the steel can have full contact with the fixed structure. Allowing the slurry to build up will clog the pores of the stone, reducing its cutting action, and will cause the tool to slip and slide, rounding the surface instead of flattening it.

As I sharpen a tool, I am continuously lapping the stone with other stones and the tool itself. I am always thinking more about the surface of the stone than the surface of the tool because the stone changes much faster than the tool.

When I have reached a consistency with one stone, I then move to a finer one to remove the scratches from the last. After the first stone, the tool should be looking as nearly perfect in shape as possible; it is very inefficient to try to reshape a tool with the next finer stone. When I’m sharpening a plane iron, I often go back to the beginning to reshape. (As with buildings, a proper foundation is essential.)

My lacquering teacher, Mr. Mineo Niikura, always says to change the water often and if possible to use a continuous supply of clean water when sharpening. He doesn’t want to put rough particles on top of his finish stone. The pretty surface comes from a +/- 8,000 grit natural stone. When lacquering, the problem is magnified. One small particle can ruin a lacquer surface at the end.

The tendency with chisels is to gradually make the tool angle shallower because the iron is so much softer than the steel. A skewed motion is good technique and I use it a lot, but I try to work the tool perpendicular to the stone and in a straight push—not one after the other, but in sets. No matter how much I try to control it, my right hand is dominant, so I skew with the tool handle to the left. My tendencies are exaggerated in my plane irons so I’m always adjusting them in the same direction. Working in sets in different directions also lets you see if you really are working flat.
Harrelson Stanley lived in Japan for 12 years and apprenticed for nine years under two master craftsmen. Prior to his Japanese sojourn, he graduated from the furniture making program at the North Bennett Street School. Today, he operates a school dedicated to hosting Japanese craftspeople in Pepperell, Mass. hms@janesetools.com, 978-433-6927.
Historic Barns: Preserving a Threatened Heritage

Thomas D. Visser
University of Vermont, Burlington, Vermont

Whether still surrounded by hay fields or scattered through developed residential areas, historic barns and farm buildings linger as vulnerable survivors of the past. Each has a story to tell about the cultural traditions and technological innovations that helped shape the history and appearance of rural places. Many older barns also provide wonderful opportunities to observe historic timber framing techniques. Today, however, historic barns are among the most threatened heritage resources. This presentation will trace the history of barns in New England and explore national barn preservation strategies and initiatives.

Prof. Thomas D. Visser directs the Historic Preservation Program at the University of Vermont. He is the author of the award-winning Field Guide to New England Barns and Farm Buildings, published by the University Press of New England.

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