TIMBER FRAMING

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The Highland Fling

Rick Brown

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GUILD NOTES & COMMENT

A New Executive Directorate

EXECUTIVE directors are well-known figures in the world of non-profit organizations. I have had direct (form-letter) communications with several. It is a harmless relationship and no one gets hurt. They seem to stay busy with the affairs of the office and yet have time to develop manifesto-length communications that make me wish I had their job. Except for all the politics.

I am no expert on the history of our organization, but I am unable to throw perfectly good reading material into the recycling bin, so I am able to refer to the back issues of the journal for enlightenment. To whom did I lend TF 19? I may never know. I am sure it had something to do with the compound joinery article in that issue.

In TF 17 (September 1990), a small paragraph at the end of a report by Ed Levin ("Guild Directors Meet") quietly announced: "Realizing that the continuing expansion of Guild activities has begun to outstrip the administrative duties of a volunteer board and part-time paid staff, the directors agreed to take the first active step towards the hiring of a full-time executive director. A three-person search committee will lay out the lines of the job and report back to the board."

The job description at that time included conference director, administrator of all educational programs of the Guild and the dissemination of information to the public, monitor of the Guild finances, including publication expenses, and editorial contributor to the Guild's quarterly. Of course this person would get a part-time assistant. I must admit, I do not remember reading this paragraph before. My small company was busy, but I should have seen it. That is a pretty tough job description for any individual.

On page three of TF 20 (June 1991), Jim Young introduced himself. I am unaware of the actual process that brought us all together, but he was hired by the board of directors (Arvin, Benson, Brungraber, Christian, Gardner, Levin, Magee, Murray, Landau) for a term of one year. His noted concern for the Guild at the beginning of his service was whether timber framing could have an impact on the houses of the next century, or would remain a quaint local phenomenon. This was only nine years ago. This was the first issue of the journal with any mention of e-mail.

The Guild's seventh annual meeting in June 1991 produced a largely new board, as elections were then held at the conference venue. Lucky Mr. Young, five brand new bosses who had little or nothing to do with developing his position. (Gardner, Landau, Magee, and Murray were joined by Wilkins, Adams, Orpin, Witter, and McCarty as the new board met for the first time.) We then planted trees. We did not have auctions. *Scantlings* was unveiled and we heard of Guelph and The Bridge.

The announcement that the board had terminated Mr. Young was discussed at the business meeting in Guelph in June 1992. The admission of error and responsibility was acknowledged personally by Mr. Gardner: "The Guild was perhaps asking too much of one person and perhaps erred in the choice of that person." Mr. Baker wondered at that meeting how we could exist without continuity in leadership. The volunteers of the Guild brought the coffers a serious contribution with their labors. The Albion Hotel will never be the same. Nor will most of us who were there.

The directors added in Guelph were Beemer, Lukian, and Jacob. We encouraged and funded a trip to Russia to help build an apprentice shop. Our paradigms were notably shifting as evidenced by the continuing dialogue of purpose. By September 1996, the Guild was concerned about which 501c status (3, educational, or 6, trade) should be pursued and why. Plans for successfully landing projects and funding were published and applied. The suggestion of an executive director was raised again with the implication that continuity in funding growth would benefit all.

The 1997 directors meeting at Oak Haven, Burbank, Ohio, saw the rekindling of the recurrent goal: additional leadership for the Guild. While I was not present at this discussion, the obvious result was the creation of the project management position that was filled by Will Beemer. This half-time job was advertised within the Guild, and the decision process was defined by the board. The office in Bellingham was an official address, and we continued to grow. Successful projects and workshops served to raise funds in addition to membership and conference fees, and the future was filled with potential.

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The stage was now set for the directors meeting in Gloucester, Mass., this past May. Friday night meetings included an announcement by long-serving Executive Secretary Sharon Grier that her term with the Guild would end in January 1999. The next day, visitor Brian Wormington placed a formal appeal to the board that they once again advertise for and hire an executive director. To encourage this, Brian was prepared to develop a newly evaluated job description, and soon got that in motion. Board members Andrea Warchaizer and Tom Southworth were appointed to recruit members for the official search committee. Tom called on Ross Grier, John Reed (a founding director and second Guild president) and me to assist.

The position was advertised. Five respondents presented detailed résumés and answers to some very specific questions. The responses were discussed at length and another round of questions was relayed back to all the candidates.This final rebuttal phase was performed on a short turnaround time as a form of testing task-specific responsibility. The results were enlightening and, we thought, indicative. Following the board's conference call on September 13, after much hand-wringing over the summer months, the search committee made a recommendation to the Board. This so influenced the Board that a decision to hold a new directors meeting resulted in a mid-October gathering in Marlboro, Mass.

I had been involved with the project long enough that I asked to observe the meeting. Using the honest and confidential referral by the search committee, the conversation, led and focused by Andrea Warchaizer, was a systematic approach to the problem at hand. The document from the search committee listed plainly the strengths and weaknesses of the candidates. During the course of the day I observed the cyclic nature of decision by committee. The eventual standoff led to an interesting discussion of the possibility of hiring two individuals, since no single individual seemed to fill completely the job description. By early evening a consensus was reached and the candidates were informed of the decision by Tom Southworth. The board had decided to hire *two* executive directors, Will Beemer and Joel McCarty, both to have equal status and responsibility to the board.

Since that moment, I have been partly included in the loop of an ongoing discussion to work out the realities. On November 10, I joined a meeting in Alstead at Andrea's house for a dinner conversation that covered most of the topics of concern and began to hammer out precise duties, practicalities and budget. The overwhelming consensus was positive in that particular group. Significant progress continues.

The details of our future are naturally unknown. The possibilities are limitless. The board thinks that we need more and diversified leadership and is prepared to employ two very capable leaders in Will and Joel. Both have the experience and benefit of coming from within the organization and long service on the board, and both understand the subtlety and nuances of the Guild. Early on, they will have to face a board with three newly elected officials who have varying amounts of political experience. By definition, an executive director is to enact the mission of the Guild and the wishes of its board. The tasks specified appear to be more than one individual could accomplish. That was the case years ago, and we are a much different and busier group today. If we cannot afford to employ this level of leadership, then we have another decision to make. I think we need a project to test our new strengths. Suggestions anyone?

THIS brings us to the question of budget. Our past experience with an executive director wound up with the board, afraid of a financial hemorrhage, ousting leadership they questioned and doubted. Was this the correct decision? We did not fold, we did not suffer tremendously as a whole, but those remaining administrators obviously pulled it together, at some expense. A substantial and humble board moved forward with the tasks at hand. Sharon's invaluable services, and a responsible administration, kept the ship afloat.

September 1994 found a large number of Guild volunteers, along with the majority of the board, assembling a large barn for the state of Ohio in a largely untested model of contractor and volunteer, and a marketing opportunity for Guild wares. The Skamania conference produced the first formal discussion of accepting journal advertising, which readily appeared. At our 1995 rendezvous in Maine, a model was developing to pay instructors and cooks with workshop fees. It worked well.

At Williamsburg 1995, retiring treasurer Christine Benson observed, "It's extremely difficult to keep this community going. The only way is to create a ripple effect, to take another step." The event of that moment, though appearing to be a step backward, was the formation of the Timber Frame Business Council, which freed the Guild of its trade organization status. This allowed the Guild to become a purely educational organization, reclassified by the IRS, with many new possibilities for future funding and growth. New revenue streams were analyzed as the Guild made the move toward 501c3 status. The unforgettable 1996 rendezvous at Pinkham Notch, New Hampshire, again with paid cooks and instructors, was a soggy success story, a model of volunteers teamed with a professional staff and involving huge donations by the community delighted to receive a renovated building. There was cash flow in the equation and plenty of good energy. Volunteers did not pay to learn or eat but did work for little other compensation. The Guild coffers received the financial fruit of our labors.

From a small businessman's perspective, a budget is vitally important. The future cannot be managed without a plan. The Guild currently employs Sharon Grier as an executive secretary, working in a real office. To assist with volume-production paperwork, an assistant is employed. I am unaware of any complaints about this arrangement. We have a conference coordinator who gets paid to arrange our excellent conference venues. We have a workshop coordinator to ensure that the workshops we sponsor and advertise are of good value. The total compensation for these positions is substantial.

The board has proposed we hire two executive directors and omit an executive secretary. The budget numbers indicate that this is a rather daring move. It is, however, for a trial period, and as such should be given the opportunity to succeed or fail.

The 501c3 groups that canvass me, like hungry dogs you should not feed, have success raising necessary funds for large bureaucratic machines. If the Guild asked me to double the membership fee I pay to support better member services and additional professional staffing, how could I say no? I would not willingly let anything proposed by the Guild, and supported by its membership, fail. I intend to contribute all I can.

—CURTIS MILTON

Curtis Milton operates Monolithic Building Services (milton@moose.ncia.net) in Jackson, New Hampshire. He served on the search committee to find an executive director for the Guild.

Cecil Hewett has died aged 71 in Chelmsford, Essex. In his native land, Hewett's correct redating of important English buildings, typically by hundreds of years, "fundamentally changed the whole mode of thinking in a whole field of study," as A. Gibson and D. Andrews remarked in The Independent *(London) of September 30. In this country, Hewett's superbly illustrated books, chiefly* English Historic Carpentry *(1980), inspired leaders of the timber frame revival, offering engineering insight and patterns for joinery based on his observations of surviving buildings from the late Middle Ages, arguably history's finest period for structural woodwork. He is survived by his wife Pat Burge and two sons.*

A Bonnie Trip to the Land of Chips

Janice Wormington

Castle Urquhart, near Drumnadrochit, Scotland.

IN late October and early November, some 35 North American timber framers joined with another 15 of their European counterparts at Urquhart Castle in Scotland to build two giant trébuchets designed to fling 300-lb. missiles at a castle wall. The events were filmed by a WGBH/Nova crew as part of its "Secrets of Lost Empires" series, scheduled for airing in the spring of 2000.

Although the timber framers worked under harsh and medieval conditions, in stiff, mud-soaked clothes, in sleet, rain and boot-sucking mud for long, ten-hour days, they were stalwart enough to see the project through. And they were rewarded, with both trébuchets hurling straight and true.

For our part, we were the tourists, taking a vicarious role that we regret not for a moment. We observed, we recorded, we commiserated and we lunched. Most of all, we marveled at the unmatched beauty of rugged, snow-capped mountains and lush glens, of lakes, rivers and bogs and great tracts of bleak moors dotted with sheep. I think many of us with a connection to Scotland (my grandmother was a Campbell who married a Montgomery) jumped at the chance to experience the country firsthand and reconnect with our heritage. That was easy to do. Highland hospitality is unrivaled, and the historic castles and battle sites are telling, dramatic reminders of the bloody history.

Our first lesson on Highland hospitality came on the three-hour bus trip from Glasgow to the Abbey at Fort Augustus, where we would live for the coming weeks. The trek north passed by gently rolling hills of heather, by Loch Lomond and over Rannoch Moor, a high peaty wasteland. The day was raw, gray and rainy, appropriate for a mandatory stop at Glen Coe (overleaf), also known as the Glen of Weeping. Running between steep peaks slashed by cascading waterfalls, the glen is the site of a massacre of the MacDonald clan who were hosting the Campbell clan, an event portrayed in the opening scene of the movie *Braveheart*. At dawn on February 13, 1692, the Campbells turned on their hosts, apparently on orders from the English government, and killed some 40 MacDonald men, women and children, and the lasting disgrace is the betrayal of trust between guest and host.

We were more fortunate. Our hosts at the Fort Augustus Abbey (facing page), which sits at the southernmost tip of Loch Ness, were unfailingly cheerful and accommodating, and the only near-massacres were self-imposed at our favorite pub, the Lock Inn. The Abbey, which includes a working monastery of ten resident monks, was a Benedictine boy's school until 1993 and later reborn as a bed and breakfast with self-guided tours. The gray buildings form a kind of campus and stand on the site of an early 1700s fort, one of several linking strategic points here and at Fort William and Fort George, built by the English in an attempt to control the rebellious Highlanders. Our rooms were Spartan, with twin beds, a desk and a sink, and with communal bathrooms on each hallway. We shared two bathrooms for about 20 people.

The showers leaked, the windows wept, the ceilings dripped and we learned to step over puddles on the cold tile floor. As the weeks passed, when the toilet flushed, our sink got noisier. This was not camping, but close to it (the space heater in our room made things tolerable). Still, I would recommend the Abbey as

good value for the money, and the Abbey staff was always eager to please, even to accommodate our last-minute requests. We all were invited, even women and children, on a guided tour of the Abbey by Father Aelred—a very rare event, we were told. Besides, we could attend mass several times a day and meet Father Gregory, who said he saw Nessie, the notorious Loch Ness monster, in 1972. I attended Sunday mass, along with others in our group, and tried to be kinder to Brian. . . all day.

Another reason to recommend the Abbey is the food the chefs served, which was a far cry from the usual cholesterol-laden, artery-clogging Scottish fare. The words *Scottish* and *cuisine* are not often used together in one sentence, and there is a widely held theory in the United Kingdom that the longer you cook a roast or other perfectly good cut of meat, the more tender it becomes. (My mother-in-law holds the record for pressure-cooking liver for an hour.) In Scotland, everything that can be is deep fried, not only the ubiquitous potato but even pizza. At the local lunch places we tried, our choices were fish and chips, scampi and chips, macaroni and chips, lasagna and chips, chips and chips, sausage rolls, bacon rolls, steak pies, egg on toast, toasties and fries in gravy. A local favorite that can stay local was a Mars candy bar, batter dipped and deep fried. I am not making this up, though I admit I never tried it.

Ellen Gibson

The Abbey at Fort Augustus, about 20 miles south along Loch Ness.

The Scottish diet is so appalling that Scotland has some of the bleakest health statistics in the Western world. A recent study commissioned by the Scottish Office (which runs Scotland for the British government) concluded that Scots have the world's highest mortality rate from coronary heart disease. Nearly 20 percent of men and 13 percent of women in Scotland never eat vegetables.

The most famous Scottish dish is haggis, traditionally served on Robert Burns' birthday and St. Andrew's Day, and accompanied by a kilted highlander with bagpipes. The Abbey chefs served us chicken legs stuffed with haggis in a tarragon sauce. Delicious. Serve haggis with *bashed neeps* (mashed turnips) and *chappit tatties* (mashed potatoes). To cook haggis, start with a sheep's stomach bag, a wee bit off-putting if you've never tried it, and stuff it with spiced sheep's liver, heart and lungs, oatmeal and onion. Follow it up with a typical Scottish dessert like currant Duff, forfar bridies, ardentinny drop bannocks (try saying that after a few wee drams of single malt) or clootied dumpling.

A culinary account of Scotland would be incomplete without mention of the single malts, scotch whiskeys, ales and beers, known as *uisge beatha*, Gaelic for "water of life." We couldn't possibly have sampled them all, though we did our best, retiring after dinner to the charming Lock Inn Pub, where barkeep Elizabeth and owner James beamed at the windfall of some 50 thirsty workers imbibing for two weeks. At the Pub, a brief five-minute walk through the trees, we continued the tradition of evening entertainment called a *céilidh* (pronounced kayly), Gaelic for "visit." Dan Fadden of Philadelphia, guitar in hand, led the group in traditional folk songs over many evenings. He was such a hit that he was advertised on the Pub's blackboard as a featured performer. The Gaelic toast is *Slainte* (slahn-tchuh), for "cheers" or "health." Alternatively, we gathered in the Abbey's gallery for impromptu jam sessions, with twins Henry and John Russell on guitar, Paul Slemmings on bouzouki, Marcus Brandt on banjo and 11-year-old Susannah Kricker on violin.

The Pub sits next to the 60-mile-long Caledonia Canal, which bisects the small village of Fort Augustus and connects Loch Ness to the other three lakes of the Great Glen, which cuts diagonally across the Highlands. When boats enter the canal, a swing bridge in the center of the village halts traffic to let the boats pass, the lock fills and lads walk along ramps, pulling the boats through the lock.

The largest body of fresh water in the UK, Loch Ness is 23 miles long, scenic and deep (up to 900 ft.), with rugged mountains rising steeply from the wooded shoreline. If you proceed north along the western side of the loch, you arrive at Castle Urquhart, its plundered and crumbling walls standing on a promontory overlooking the water. Probably the most inaccessible in all of Scotland, as well as one of the largest, the castle dates to the 12th century and its commanding position in the Great Glen gave it tremendous strategic importance. Built as a fortress and as a home, Urquhart Castle was taken by Edward I of England (of War Wolf fame), and later held by Robert the Bruce, when it became a royal castle. It was destroyed in 1692 by government troops to keep it out of Jacobite hands. War Wolf was a new English siege engine to be used in the 1304 siege of Stirling Castle, but the castle surrendered before it could be tested. Edward I, not wishing to be deprived of the use of his new toy, insisted the inhabitants stay in the castle so that he could blast the walls away.

There was very limited parking at the castle, and no food or refreshments, though the castle stands several miles from the village of Drumnadrochit. Scottish guidebooks suggest that tourists park in the village and walk the few miles to the site. Can you imagine any American tourist attraction offering such advice? A proposal to build a new visitor center and car park into the side of the hill is controversial, for it seems the local merchants fear the loss of business the center would present. Nessie does bring the tourists to Drumnadrochit, with a choice of not one but two exhibitions offering eyewitness accounts and research projects to prove or disprove the beast's existence. The gift shops were larger than the show areas, with many choices in refrigerator magnets. Still, as we stood at the castle site, observing construction progress and waiting for the weather to change—the wait was never very long—the strong winds on the lake made even the most cynical of us look twice at every ripple on the dark waters, for a sign.

The only predictable thing about the weather over Loch Ness was its unpredictability. Days were grey and rainy, punctuated by sunny periods and rainbows. Laura Brown reported seven rainstorms in one day. Even the locals complained about the worst

weather in 30 years, as they said it had rained every day in the summer and continued right through our visit. The grassy area at the start of the project got progressively muckier, and straw and mats helped only a little. Rubber boots, layers and waterproof clothing could protect the workers, but they worried about their tools. Still, it could have been worse. Farther south, the central Highlands were under water.

The only land access to the castle was a narrow steep path from the parking lot, and even the lunch wagon got hung up at the turn once. No wonder the timber came in by barge from Inverness.

GETTING back and forth to the site proved a challenge. An expensive luxury, a rental car offered us freedom to visit the site, then tour the surrounding areas; otherwise, we were at the mercy of riding the crew bus, which left the Abbey mornings around 7:15 and returned around 6 in the evening. Or we could ride the public bus, which ran about every two hours between Fort Augustus and Inverness. At about $8 round trip, that was no bargain either. Our rental car was tiny. With Brian's size 13 shoes, there was barely enough room for his feet to rest separately on the brake and clutch, and the back seat had little knee room. That was my assigned seat for every trip—my frequent gasps when faced with oncoming traffic in the wrong lane proved too much for a driver trying to shift with his left hand and concentrate on driving on the left side of the road.

Gas costs about $5 a gallon, and the narrow roads give one pause, especially since the Scots drive fast. The road along Loch Ness from Fort Augustus to the site was curvy and narrow. Similar roads in the Berkshire hills of Massachusetts are posted at 35 mph, but the posted speed in Scotland was 60 mph and drivers are expected to drive at least that fast or be frighteningly tailgated. Coaches (buses) or trucks meeting on the narrow roads were particularly thrilling. On the group's trip to Stirling Castle, our coach lost a mirror to an oncoming truck that was hugging the center line. Nevertheless, the Scots are ever so polite, with a penchant for adding explanations on road signs, such as "Frustration Causes Accidents," "Please Allow Overtaking," "Please Use Laybys to Let Queues Clear," and, best, "Traffic Calming Scheme Ahead."

Glen Coe, site of the 1692 massacre of the MacDonalds by the Campbells.

In touring, we marveled at the Scottish highlands and pastoral lowlands, with more sheep than people outside of the cities and villages. Sheep were everywhere, and there seemed to be a different variety for every valley we visited. On our way to Glen Affric, certainly one of the most beautiful glens in Scotland, we spied a group of sheep in the road trying to return to their field by jumping through the wire fence. One by one, recounted Susan Norlander, who toured with us, they would back up to get a running start, then jump and land flat on their backs or get some body part caught on the fence, with a look of horror on their little faces. Then, once unstuck, they affected a look of "So what's your problem?" In Glen Affric, a one-lane road wound through a forest preserve of birch, pine, oak, alder, ash, hazel, rowan, aspen, wych elm and willow. The road had frequent pull-offs where we could get out and wander through the woods or walk by the river and enjoy the carpet of heather, the waterfalls and views of snow-capped mountains. Less than one percent of the original forest remains in Scotland, and in the preserve trees were fenced off to prevent further damage by deer and other animals.

There is a reason for the denuded hills everywhere—the Clearances. From 1780 to 1860, thousands of Scots were evicted from their homes in the Highlands and the Islands to make way for sheep. Land was cleared for the sheep and their grazing prevented any new trees from growing. The evicted farmers either moved to the cities or emigrated to North America, New Zealand or elsewhere. In the mid-1800s, the Irish potato famine reached the Highlands and even more people emigrated, such that by the end of the 1800s, the rural Highlands and the Islands were almost deserted.

The Clearances followed another hated act imposed by the English and lowland Scots determined to quash the rebellious Highlanders. Following the defeat of Bonnie Prince Charlie

Glen Affric, west of Castle Urquhart.

Photos Janice Wormington

on April 16, 1746, at Culloden, the last battle of the Wars of Independence, the Act of Proscription of 1747 banned the wearing of tartan and Highland dress and the playing of bagpipes, and broke up the clan system. These two acts marked the demise of a centuries-old way of life and social system in the Highlands. Still today there is an ongoing campaign for Scottish independence. A T-shirt spotted in Glasgow bore the slogan, "NO UK IS OK."

One of the best aspects of the project for all of us, I think, was meeting and working with an international group of timber framers. A large contingent came from Carpenter, Oak & Woodland Co., Ltd., of Chippenham, Wiltshire, among the largest timber framing companies in England with 64 on the roster. British timber framing companies are extremely competitive and don't cooperate or even get together at conferences. Carpenter Oak director Bill Keir said he had never even met his counterpart at another large English timber framing company.

Now, you might think that as we were Americans in the UK, communication should have been no problem. But as Oscar Wilde said long ago, "We really have everything in common with America nowadays, except, of course, language." The dialect, vocabulary, and the melodic, mystifying brogue often made a foreign language of what we heard. To blend in better, we observed some valuable practices. First, substitute "Loovely," accent on the first syllable, whenever you would say "Okay" or "Fine." Hand change to the cashier: "Loovely." Comment on the menu: "Loovely." Get directions to the ladies' room: "Loovely." Second, in idle chat about the weather (and we had plenty of weather during our brief stay), smile and say, "The weather is haw-rid, isn't it?" The proper response: "Yes, loovely." When it's really pouring, it's "booketing." At lunch, you may have a wee boofy (buffet) lunch.

Scotland is old and respects its history. The burial cairn at Corrimony, near Glen Urquhart, dates from 2000 B.C., as do the Clava Cairns near Inverness. At these sites, as elsewhere, Scots resist the urge to turn wonderfully preserved sites of antiquity into a US-style Cairn World, surrounded by hotels and fast-food joints. Instead, these attractions are located on narrow back roads, surrounded by beech trees and fields of sheep.

AFTER the one trébuchet had fired successfully and the second was nearing completion, we bade the COWboys a good journey back to Chippenham, and we set off to Glasgow for our flight home on British Air, a very pleasant experience (we're embarrassed to admit). The timber framers, by contrast, worked till late in the afternoon, returning to the Abbey in time only for a quick shower, dinner and packing. They then boarded a coach for the all-night journey to London's Gatwick Airport, only to find the USAir flight was delayed. Nine hours late, it finally took off. Everyone missed connecting flights in the US and, to add insult to injury, the airline also lost travelers' bags. After the unpleasant incident at the start of the trip, when USAir had closed the flight door on one of the group and threatened to leave without her and to arrest one of the others who was protesting inside the plane, this particular airline did not distinguish itself in customer service. The COWboys, we learned upon our arrival, also had a miserable trip home. Their van broke down leaving Inverness, and they returned on the back of five separate flatbed trucks that would slowly and uncomfortably relay them home. Bill Keir reports he "walked through the door 19 hours after leaving Urquhart, just in time to help Sarah get the girls up, and go to work. Never mind it was worth it."

It was all worth it, and I can't wait to go back.

—Janice Wormington

Janice Wormington (janicew@newvista.com) runs the Guild website.

Less Cackling, More Eggs!

Rick Brown

Cormac Seekings and Grigg Mullen III, lathe powerplant.

LOOKING at the photos, the Fling Thing is already sepia legend. It looks as if it were sunny all the time, axes whirring into logs, joints getting cut, ropes being pulled, Guildfolks' smiling faces and our usual suspects in amongst yours. Look closer though, and you wonder why that sound mike is in the picture and why all the timbers look so grungy. And why is Wil Wilkins' fiery forge surrounded by steaming, upturned boots on sticks and just what is that small black planet in the sky over Castle Urquhart?

This was a TV gig and Nova set up the project for maximum drama, perhaps fittingly, but unfortunately surrounded it with the political complexity of high-medieval warfare. Pick an impossible site, order the timber at the last possible moment, attempt to set up competing teams and don't give the framers even a vague design until day one on site. Only after two weeks of everyone's hard work in the cold and deepening mud and the torrential showers did the TV people begin to grasp that all the artificial drama was meaningless next to the real excitement of joining together to get the job done with so much enthusiasm, ingenuity and great, good humor fuelled by nights in the disingenuously named Lock Inn. Our only real regret is that the last-minuteness of the TV people's arrangements meant that many framers from this side of the pond did not get up to Loch Ness.

Back at Carpenter Oak in Wiltshire, it was already Day Four of the Fling when we loaded up the minibus at the yard for the 600-mile drive northward the next day. Fortunately we thought to bring our four-wheel timber trolley. Our first contribution on Friday was to give everyone a day off to come see our new Great Hall roof at Stirling Castle and say hello to old and new friends, all mysteriously clad in red fuzzy vests. We didn't quite have the gumption in fresh acquaintance to fall to the floor in the pub before Ed Levin with chants of "We are not worthy!" But Ed was looking rather tired after some long nights slumping over his computer back at the Abbey, trying to make sense of siege mechanics in the modern world.

The seven of us arrived ready to work on Saturday morning. Coming down the winding track to Urquhart, we found an epic scene—scurrying figures, army tents, mud, military jets speeding overhead down the Great Glen, and the medieval castle with the monstrous lake behind and the shooting range complete with the target faux castle wall before. In the lee of the slope to stage left were the framers next to the lake, and as we got down there it seemed to us that there was way too much still to do. Somehow the timber had been unloaded from the barge Muriel and things were beginning to happen. The undercarriage of the fixed-counterweight machine was ready to go and the hewing of the big oak throwing arm was in progress with "our own Henry Russell" in action alongside Dave Dauerty, Jim Kricker et al. John Russell was in place as British morale officer, Cormac Seekings was getting the big wheel lathe spinning with Marcus Brandt, and our German journeymen friends Mikail and Nils were there too. Once we'd trolleyed our way down the hill with a half-ton of tools, we joined the casually organized fray spinning boring machines and laying to with axes. "Has anyone seen a drawing?"

There was plenty for us Brits to see and learn here. One, bring insulated Wellie boots. All our waxed boots gave way after one to three days in the trenches. Two, it's most useful having a blacksmith on site: to make great stuff, dry your boots and provide visual and sound effects plus horns. Three, lessons for the medieval siege: keep your experts at a distance, especially the explosives one—boiling bones and mixing incendiaries are not conducive to good health; and build thick walls—trébuchets are deadly accurate!

Dave Gaker

Rick Brown and the Leadheads, casting 1,000-lb. counterweight wafers.

There was a bit of a contrast in framing styles. We decided American square rule is fine when things are completely worked out ahead of time, as they clearly were for Col. Wayne Neel's fixed-weight treb, but when things are being designed on the go, scribing is the best way—you know the mating pieces will fit. Seeing a set of drawings with all four sides of every timber drawn completely boggled us, so we semi-scribed our bits for making the basket. "Surely you don't want us to make four of everything?" we asked.

Another oddity was seeing so many housings. In our work and in traditional carpentry, we tend to use housings very sparingly and then only in load-bearing situations. We also drawbore everything. We still can't understand the American fetish for Japanese chisels and saws (though we love inklines in our shop). One of the best things about doing a large amount of framing by hand is the sound of many hand tools augering, hewing, carving, sawing, chiseling and lathe-hogging. Marcus Brandt's lathe was hugely effective, turning even the 12x12s for the capstans. The lathe hog is a great tool, the first time we had seen one. I'm sure some of us will be copying the setup sometime.

Wil Wilkins

Above, Marcus Brandt hogging a capstan spool. Below, journeyman Nils Rossner of Germany hollowing out a carriage wheel center.

PERHAPS most effective of all were the Leadheads doing the impossible: converting 14,000 lbs of junk lead into 1,000-lb. half-octagons and derricking the ingots onto the lead sled (our ever useful trolley) for a team of sledders to push through the mire up hill to the treb. All done in four days. The ingots were then cunningly bolted to the throwing arm of the fixed-weight machine.

Our bunch had planned to stay for just a long weekend, all we thought we could manage, but 'course, once there most of us couldn't leave without seeing that "thang flang." (Our fake American accents were at least as bad as Americans pronouncing every good measurement as "spawht awn old chap".) But seeing the thing fling was fantastic. That Sunday evening, Col. Grigg Mullen shouted "Fire in the hole!" to the chanting of "Give Peace a Chance" from the wag framer peaceniks on the hill. Then the fixed-weight treb chucked big stones a long way with such smooth ease, each shot followed by a delirious charge by the crowd, apparently demented extras from *Rob Roy*. To come within a whisker of the target on only the second shot was very satisfying.

We partied late, drank too much Scotch, got up early and overstayed our final day to see one more stone go. Our hangovers were something to behold. We said our good-byes, and 20 miles down the road in Inverness our van broke down, so we had an epic journey home ferried back on five trucks over 18 hours to match our fellow flingers' transatlantic expeditions.

It was great fun getting a dose of Guild spirit over here, very refreshing, something we can learn a lot from. There were plenty of eggs and a good deal of cackling. Let's do more stuff together. —PAUL PRICE

Richard Archard, Bill Keir, Roger Law, Steve Lawrence, Gordon Macdonald, and Dave Saville formed the rest of the COWCo team.

Rick Brown

Rick Brown

Beavering away on axles and wheels for the carriage of the fixed-counterweight machine, from left, Colin Stotts, Donna Williams, Dan Fadden, Derwin Hanney. Beyond, Dave Gaker explains a point to Laura Brown and work begins on the oak log for the other machine's arm.

Hephaestus Vulcan

Rick Brown

At left, Wil Wilkins, in protective headdress, forges a needed piece of gear. "For the first time, I felt like the village blacksmith." Above, Eric Westergard and Jim Kricker hew the second of eight sides on the perfect fir log that became the throwing arm of the fixed-counterweight machine.

Wil Wilkins

Carving ammunition, apparently not yet a lost art.

Rick Brown

And the finished ball, weighing around 250 lbs., in the slingshot.

Jim Kricker, left, and Wayne Neel inspect the beautifully cast lead weights for the fixed-counterweight machine.

Ellen Gibson

A Serious Challenge

THE adventure began when WGBH-Boston contacted me last June regarding a new documentary in their science and technology television series Nova, to be devoted to medieval siege technology. Two types of throwing machine were envisaged. One, with a fixed counterweight (known in Europe as a mangonel), had been designed by an engineer using a computer at the Virginia Military Institute (VMI). The other, a larger machine featuring a hinged counterweight (the trébuchet) was designed with compass and square, according to an essentially Euclidean geometry and recorded in the portfolio of Villard de Honnecourt (Paris, Bibliothèque nationale ms fr. 19093, ca. 1215/25). Today this form of geometry is known as *le trait*, which translates roughly as the art of tracing according to formulas of applied geometry.

Construction of these two machines was intended to answer several historical and technological questions: (1) Was it possible to construct the larger of the two while using only medieval materials and techniques? (2) Were these machines actually capable of projecting stone balls weighing 300 lbs. over more than 160 yards? (3) Were they capable of breaching a 7-ft.-thick granite wall? (4) What was the potential firing accuracy? (5) Why did the hinged-counterweight machine (trébuchet) systematically replace the fixed-counterweight model by the 14th century?

Thus, I found myself on 15 October at Caerphilly Castle near Cardiff (Wales) alongside, among others, Michael Prestwich, an English historian, and Roland Bechmann, a historian, architect and the acknowledged French expert on Villard de Honnecourt. In the beginning, my role was limited to being a technical consultant. Yet it soon became clear that, whereas the Virginia team responsible for the fixed-counterweight machine knew exactly how to proceed, the candidates responsible for the hinged-counterweight machine were manifestly inexperienced. At the last moment, the executive producer Michel Barnes, well aware that I had built some 30 machines over the past 15 years, decided to entrust me with its construction. I was obviously seduced by such an immense undertaking, as well as by the means put at my disposition, although I admit to having had some anxiety since I did not yet know the timber framers involved and I am used to working in French with my own trained crew.

I was entrusted to build a machine based on the 13-century drawing of Villard, an architect-engineer, who alone, to my knowledge, has explained the necessary principles of weights and proportions that would allow one to construct immense machines capable of delivering graceful and stunning performances, all the while using period materials, tools and techniques. In earlier times, when the general population could neither read nor write, the essential geometric formulas were encapsulated and passed along by means of animal figures. My own training made it possible for me to understand the animal drawings in the Villard portfolio, which proved equally necessary for building his trébuchet. According to the historian Prestwich, Villard's trebuchet would have been quite similar to another contemporary model built on orders of the English king, Edward I. Known as War Wolf, its reputed dimensions were so large that its very existence has long been doubted. We shall see!

Construction of the two machines took place at Castle Urquhart on the banks of Loch Ness, which for lack of any road better than a mule path necessitated a rather folkloric delivery of materials by boat. Obviously, no hoist could be brought in. Among those present were historians, engineers, some 40 carpenters and the film crew. My first contact with the timber framers occurred one evening in a pub at Fort Augustus, where they were carrying on merrily. I knew immediately we would get along just fine, and by the end of the evening I was even convinced my English had improved. While a similar type of guild known in French as *compagnonnage* exists in certain European countries (France, Belgium, Germany, Switzerland and Luxembourg), here I was a lone Frenchman, forced to communicate not only in English, but also in inches, feet and yards. The aspirin intake rose precipitously for the first few days!

CONSTRUCTION itself began on 19 October, ending on 5 November, including four days for assembling the machine. Every bit was executed using traditional tools and a hand-actioned lathe. The throwing arm was hewn from a 50-ft. oak with an average diameter of 2 ft. Delivered uncut, it was worked on six faces solely with the axe. But it only took four hours to set the mast in place 24 ft. off the ground, using a system of pulleys and a shear leg. These same lifting techniques exist in Europe, but, unfortunately, they are rarely used nowadays. I was gladdened to see once again this marvelous spectacle.

Earlier on during construction, my desire to do a particularly interesting job as well as possible outweighed my sense of the project's difficulty. Then, during filming of its construction, we learned that it would be the largest trébuchet built in several centuries, which put me somewhat on edge, since I myself had never built anything so large. Difficulties of lesser and greater importance surfaced, most notably with regard to the main axle, whose diameter had been made too large in relation to the diameter of the mast, something that would seriously compromise the latter's strength. Undoubtedly, this stemmed from a problem in communication. We had to reinforce the unit with planks on both sides of the mast and encircle the whole with iron bands, all of which set us back. On this point, I might add that the construction of the other, fixed-counterweight machine was very demanding of manpower, and I am thus grateful to the faithful few who made certain the hinged-counterweight machine was also brought to completion. They kept me from becoming discouraged, which still warms my heart, and I am sure our paths will cross again.

My anxiety grew when the machine was complete. In her assembled state, she rose as high as a four-story building. We loaded the counterweight bin with a few tons of wet sand. We strained to load the 300-pound stone ball into the braided hemp sling, and the crew stood back awaiting the signal for its release. A heavy silence descended on the work site, normally so animated. Everyone was waiting, and I was feeling the pressure. I stepped back to calm myself by taking time to contemplate "the beast." She was truly magnificent—powerful, balanced, of noble breed. Then I sensed a real harmony and a mounting confidence. I silently thanked my operative ancestor, Villard de Honnecourt, and his little secrets of geometry. Still fearful for the mast's solidity, we had purposefully underloaded the counterweight for the first trial, but, brave beast, she functioned correctly although the shot was really too short. Since all had worked well, we loaded the bin to an approximate total of six tons of wet sand.

Having a certain experience with these machines, I had noticed from the beginning of construction that the machine was incorrectly oriented vis à vis the target, but despite my repeated demands (undoubtedly my English is at fault. . .), the orientation was not changed. Yet, this did not prevent a suite of beautiful shots, remarkably well grouped, although to the right of the target. The next day the timber framers convinced me to angle the ammunition trough in order to shoot further to the left. Quite honestly, I didn't give much credit to this idea and was concerned about saftey, but straightaway we found it was a perfect solution. I would not have expected such a high degree of technical performance and

Above, the counterweight basket before mounting to the rest of the trébuchet at right.

power of destruction, but I leave this to other witnesses to describe.

THIS project provides an answer to a controversial question: why did the trébuchet, with its hinged counterweight, systematically replace the fixed-counterweight siege machine by the 14th century? While the smaller machine of VMI required less wood, its manpower needs were greater, and it took six tons of lead to weight the mast. Even today this is costly, so what must we think of its relative cost in the Middle Ages? Not to mention the exorbitant cost for transport and frequent theft of parts, how could one afford such expense when, for example, at the siege of Aiguillon (Southwest France, 1346) 12 machines were dressed against the ramparts? On the other hand, the concept of a mobile counterweight allows one not only to build a more reliable, more robust, and more easily adjusted machine, but also to load the counterweight with readily available, free materials (earth, rocks, and so on) found on site. One might sum up this historical problem with a one-liner: "How can you flatten your neighbor on the cheap?"

I hope to have conveyed my feelings, concerns and joys. This superb machine fulfilled its promise, and the timber framers paid her a great compliment in naming her "The Graceful." I also appreciated the elegant touch of raising the French flag on the machine as well as on the castle keep. It was an extraordinary adventure, a once-in-a-lifetime chance, and I am fully cognizant of my good fortune, even if it came after 15 years of passionate but especially hard work. Despite my past experience, I was anxious because success was not guaranteed in this case. I was happy, thanks to this exceptional opportunity, to be able to confirm the efficacy of ancient know-how, indispensable for simple things of day-to-day life in the Middle Ages, but which so many people today try to negate. While I also work with computers and appreciate progress, I firmly believe with regard to this machine, which marries knowledge, beauty and power, that we should be careful not to ignore and thus lose the richness and wisdom of our heritage. I am very proud to have worked with exceptional people, true professionals, without whom nothing would have been possible. I believe our understanding was founded on common values.

Now I plan to finish current projects that have understandably fallen behind (without regrets!), including a drawbridge near Cognac in France, a three-year project in Switzerland and other long-term, passionate projects in the Charentes Maritimes (France), Belgium, and Canada. The year 2000 promises well!

—Reynaud Beffeyte

The author (armedieval@wanadoo.fr) lives in Castelmoron-sur-Lot (Lot-et-Garonne) in Southwest France.

Photos Ellen Gibson

At rest, the hinged-counterweight machine stands nearly 54 ft. high.

The Highland Fling

Figurado, the fixed-counterweight machine, complete, mounted on its track. Ellen Gibson

SO here we are in calf-deep mud beneath the ruined walls of Castle Urquhart in Northern Scotland, three dozen US and Canadian Guild members, soon to be joined by a dozen British framers, a couple of German journeymen and a French master builder of siege engines. A stiff breeze off Loch Ness lends heft to the usual rain, with a wee bit of sleet mixed in for variety. It's a degree or two above freezing, but not for much longer as the sun long ago took its daily bow and now sulks behind looming hills as it retreats towards the invisible horizon. Each day is conspicuously shorter than its predecessor, and we only have a dozen of them in which to land the 40 tons of sawtimber and the 50-ft., 11,000-lb. oak log currently filling the hold of the round bottom barge rolling in the lake 25 yards off shore, and then turn the lot into two immense trébuchets.

Only yesterday it was spring and Michael Barnes of WGBH-Boston had narrowed down options for the proposed Nova trébuchet film to summer in Wales or winter in Syria. But as spring gave way to summer and fall, the date kept slipping back while the venue moved further north, till the word was Inverness in late October. So here we are in the cold, dark and wet, warring against time, the elements and a shipload of English oak. Still, I suppose it could be worse. One more slip and we'd be doing this in the Shetlands in December.

The stated goal of our project is to test whether large siege engines were a real threat to fortifications in the late Middle Ages, but in truth a variety of forces in imperfect alignment drive this effort to build and fire two large working replicas of medieval trébuchets at a facsimile castle wall. First and foremost are (or ought to be) these historical questions: were such siege engines capable of breaching castle walls, and might they have accounted for the trend to much thicker battlements that coincided with the peak of trébuchet evolution? But the historical imperative must contend with the dramatic needs of the film company to produce a program that will sustain viewer interest (or rather with the producer's perception of such needs), with the meager budget available to carry it off, and, finally, with the real-world possibilities attending the particular mix of framers, film crew, tools, timber, time and site conditions.

Two different styles of machine are called for, partly as a historical conceit, but largely for dramatic reasons, one competing against the other (a reasoning similar to that which prompts farmers to raise two pigs together). Producer Barnes hopes to embody differential features as much as possible in the two contenders: one with a hinged counterweight, the other with a fixed; one with steel axles, the other with wood; one monolithic vs. one composite throwing arm, and so on. As it turns out, we manage the two type of counterweights, but the other features sort themselves out according to historical prototype and available resources. For both machines we will use wooden axles in wooden journals (most common in medieval illustrations), and one-piece throwing arms, each hewn from a single tree. The last is an authentic choice given the material at hand and, in any case, the woodworkers cannot bring themselves to dice up a perfectly adequate whole log to produce laminations for layer-cake stacking. This reluctance is not merely craftsman's

conservatism, but rather a kind of timeless carpentry logic at work, itself a piece of legitimate historical evidence.

To be sure, the largest trébuchets, and those built in places with limited timber resources, had composite arms, like the famous Innsbruck Bellifortis, prototype of our own Lexington (Va.) Bellifortis (see TF 44)—but only when the builders could not locate a single tree large enough to make the throwing arm. Besides, close examination of the prime evidence for composite throwing arms (the medieval Arabic *Elegant Book of Trébuchets*) seems to indicate that multiple arms were not simple laminations of two stacked rectangular parts, but more likely bundles of four round members lashed together to form a more or less round composite section.

A development of the late Middle Ages, the trébuchet is sometimes described as a catapult, but is more properly a kind of large motorized slingshot, powered by gravity. A heavy weight (earth, stone, lead) can be either fixed to the end of a wooden throwing arm, or placed in a wooden basket pivoting on the end of the arm. Thus the terms "fixed" and "hinged" counterweight. The throwing arm with fixed axle is carried atop timber frame trestles that support the axle journals, in which the arm swings.

When the trigger is pulled, the short, weighted end of the arm is pulled downwards while the opposing longer end spins up, pulling a rope sling attached at its tip. This sling, which carries the missile, accelerates rapidly as it is whipped around by the rotating arm, ideally releasing the ammunition at the point when the arm is vertical and the sling at 45 degrees to the horizon, sending the projectile out at speeds in excess of 100 mph. Historian Vernard Foley of Purdue clocked our fixed-counterweight machine with a radar gun at 127 mph (eat your heart out, Roger Clemens).

The principles of trébuchet design were embodied by the original makers in a set of proportional rules, making the design of a traditional trébuchet an exercise in pure geometry, all flowing from the size and shape of the throwing arm. First you acquire and measure your throwing arm log. This tells you all you need to know about the size and shape of your machine.

Typically, hinged-counterweight trebs used a ratio of 1:4 or 1:5 to locate the main axle dividing the log into the counterweight arm (distance from main axle to counterweight-basket axle) and the throwing arm proper (length from main axle to tip). With a fixed-counterweight machine, you don't have to make room for the basket in the at-rest position (arm vertical), so the counterweight arm can be longer (for better leverage), with ratios ranging between 1:1 and 1:2. In addition to the geometry governing the arm and its parts, there are established whole number ratios relating and regulating the size and position of axles, basket, trestles, base, sling, windlass, ammo and ammo trough. In his article "Design Considerations for a Large Trébuchet " (TF 44, June 1997, pp. 12-14), treb designer, mechanical engineer and military historian W. Wayne Neel of Virginia Military Institute catalogs more than two dozen such proportional relationships.

So, two machines to contend against one another, and two teams to compete in building them, or so the theory went. But as we saw again and again, the conventions of the script took a back seat to the immensity of the job and the caliber of the workforce, and the high drama in this story grew out of the cooperation of the participants, not from their contending against one another.

Budget and site topography determine the size of our siege engines—they are to be capable of throwing an 18-in.-dia. 250-lb. sandstone ball 200 yards. The preponderance of historical evidence favors hinged-counterweight machines in this size class. However, Colonel Neel has located a couple of drawings from the 13th-century Spanish *Cantigas de Santa Maria* to use as a basis for his fixed-counterweight design. Design is one area where the dramatic restrictions imposed on participants by the filmmakers do hold sway. Historians, archaeologists, engineers and builders are instructed by the film makers not to confer in advance of the event, and indeed the first day of construction dawns without a single measured drawing of either machine, a situation that is remedied as rapidly as possible.

Of course, some advance design work was essential so as to be able to order the timber (all English oak with the exception of a Douglas-fir log, found near the site, for the fixed-counterweight throwing arm), truck it 400 miles from Humberside to Inverness, load it on a barge, tow the barge 20 miles down the Caledonian Canal and Loch Ness to the beach below Castle Urquhart, then move the timber from the grounded barge, across the shingle and up over the steep bank onto the work site in the absence of crane or road. We did have an amphibious forklift.

In the case of the fixed-counterweight machine, the product of a single designer steeped in the history, geometry and physical principles that govern such engines, compiling the timber order was a straightforward process. Having posited the size and shape of the throwing arm, Wayne and I could communicate in the familiar proportional shorthand of trébuchet geometry, making both the timber takeoff and the preparation of working drawings a simple matter.

No so with its hinged-counterweight sister. Subject to the constraints of space, time and money, this was to be a replica of the trébuchet documented in the notebook of the early 13th-century French architect Villard de Honnecourt. Input for the design of this machine came from several parties, and since Villard's notebook includes a drawing only of the base of his machine, plenty of room was left for debate about the size and details of the superstructure.

ONE of the keys to the effectiveness of trébuchets was their ability to hit repeatedly in or near the same spot, and another the capacity to make fine adjustments to the point of aim so as to shear away an entire section of wall. A prime factor enabling this accuracy, at least in the case of hinged-counterweight engines, was their smoothness of action and resultant stability. As with a cannon, one might expect a strong recoil when a heavy ball is fired at high speed, but experience with the Lexington Bellifortis had taught us that a well-designed treb puts so much of its potential energy into the flight of the projectile that there is very little left over to rock or move the machine. Indeed, residual pendulum motion in Bella (as she is sometimes affectionately called) is mild and brief.

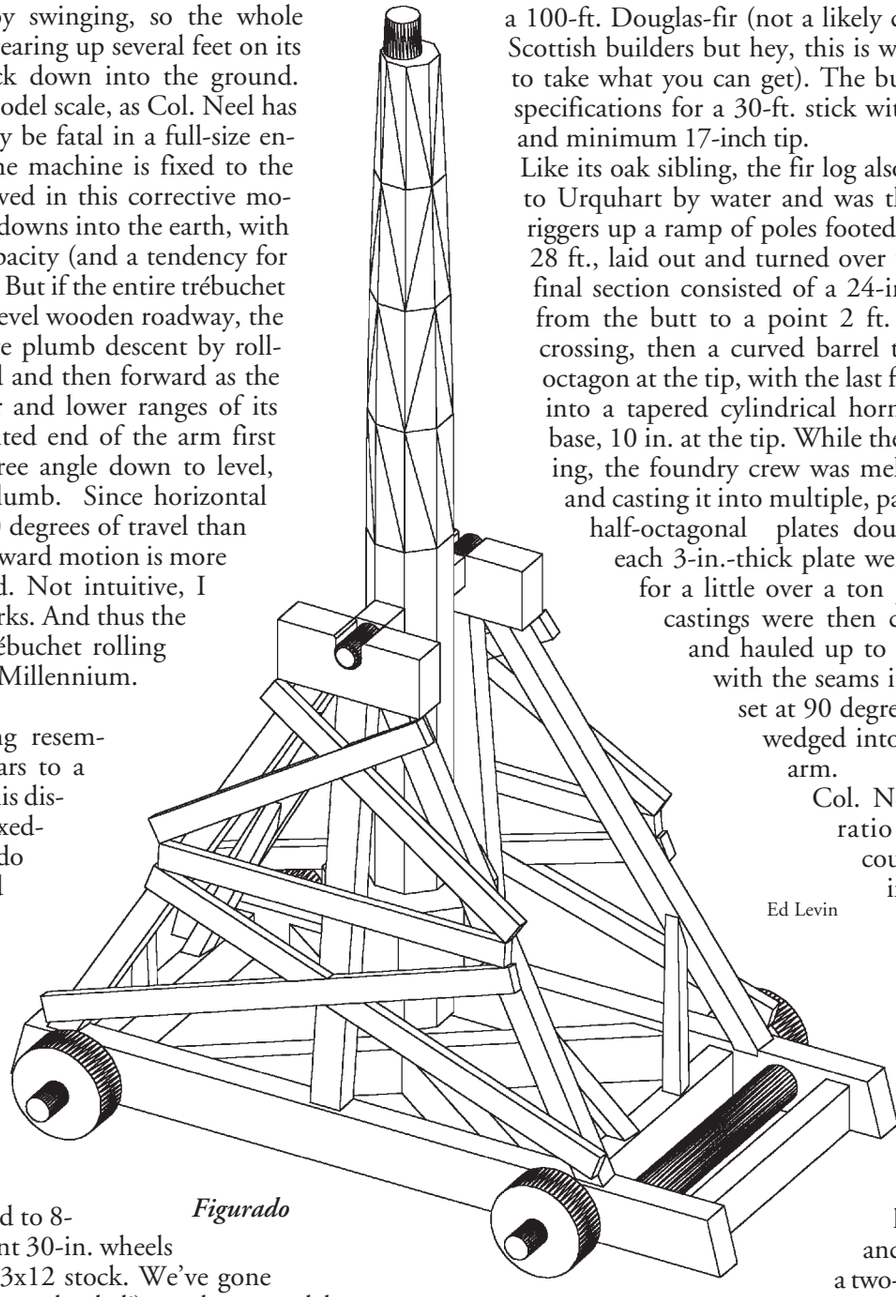
The physics responsible for this has everything to do with how the counterweight is mounted. Fully loaded, Bella's basket tips the scales close to 20,000 lbs. Given the mass of the ballast, all other forces are insignificant relative to that of gravity on the counterweight. So the counterweight wants to fall towards the center of the earth, that is straight down. In the case of a hinged machine, assuming that the arm is cocked at 45 degrees, the path of the basket axle starts out forward and down until the arm is level, then moves backward and down until the arm is vertical. (In this context, forward refers to the downrange direction or toward the target, while backward means away from the target.) So in order for the basket to fall straight down, its center of mass wants to shift backward during the first part of the swing, then forward once the arm passes horizontal, which the basket does by swinging first back and then forward. This motion accounts for some of the residual basket swing left in the system after the trébuchet has been fired.

The few medieval illustrations of fixed trébuchets often show their bases on wheels. These are usually thought to have been for moving the machines from place to place, but when one considers the weight of a large, loaded trébuchet together with the bearing capacity of medieval roads and battlefields, this explanation seems pretty unlikely. So how to account for the wheels?

A fixed counterweight cannot compensate for the horizontal

component of arm motion by swinging, so the whole machine attempts to do so by rearing up several feet on its hind legs, then slamming back down into the ground. This is quite exciting even at model scale, as Col. Neel has demonstrated, and would likely be fatal in a full-size engine. On the other hand, if the machine is fixed to the ground, then the energy involved in this corrective motion is transferred via the hold-downs into the earth, with a resulting loss of throwing capacity (and a tendency for the machine to tear itself apart). But if the entire trébuchet is built on wheels atop a firm, level wooden roadway, the counterweight can approximate plumb descent by rolling the machine first backward and then forward as the arm moves through the upper and lower ranges of its swing. Upon firing, the weighted end of the arm first rotates from its initial 45-degree angle down to level, then continues on until it's plumb. Since horizontal travel is greater in the lower 90 degrees of travel than in the upper 45 degrees, the forward motion is more pronounced than the rearward. Not intuitive, I admit, but this is the way it works. And thus the genesis of the first piece of trébuchet rolling stock in the second half of the Millennium.

IN recognition of the strong resemblance its throwing arm bears to a Figurado cigar, henceforth in this discussion I will so refer to the fixed-counterweight machine. Figurado is constructed along standard trébuchet lines, carrying a counterweighted arm on two triangular trestles supported on a wheeled, rectangular base. The base (or perhaps we should say chassis) of the machine is very ruggedly built as befits its mobility: 10x18x24 main sills, X-braced and joined by 8x15x14 axles reduced to 8-in. rounds at their ends to mount 30-in. wheels 12 in. wide, laminated out of 3x12 stock. We've gone for all the options here (talk about loaded!), so these are deluxe wheels. Thanks to the initiative of Mike Goldberg and a labor of love by framers and family members, they come complete with lithesome carved Celtic sidewalls (artwork courtesy of German journeyman Nils Rossner).



Ed Levin

Figurado

At the back end of the base, a roller turned from a 12x12 serves to redirect paired 1 1/2-in. Manila haul-down lines out to independent twin capstans used to cock the machine. The sling is made of 1-in. manila with a net woven of 1/2-in. line, and it takes off from a 3-in. plank runway. Trestles are framed with 8x8 struts rising at the traditional 60 degree angle, stiffened with overlaid 4x8 girts and X-bracing gained and bolted (yes, they did apparently use threaded fasteners in the Middle Ages). To shorten the main axle span, the sides lean inward 7 degrees from vertical, with struts set into canted housings and mortises in the plumb sills and journal blocks (12x20x4), which in turn are trenched to bear the 10x10 main axle over a 4-ft. clear span. Given the rigors of overland transport during the heyday of the trébuchet, coupled with the size and bulk of the throwing arm, it seemed a fair assumption that, absent easy access by sea, builders would likely find the log and fabricate the arm close to its point of use. This argument dovetailed nicely with Nova's desire to film the felling of a throwing arm log in a nearby woodlot. The tree in question turned out to be a 100-ft. Douglas-fir (not a likely choice for 14th-century Scottish builders but hey, this is war, right? and you have to take what you can get). The butt log nicely fitted our specifications for a 30-ft. stick with 26-in. butt diameter and minimum 17-inch tip.

Like its oak sibling, the fir log also completed its journey to Urquhart by water and was then parbuckled by our riggers up a ramp of poles footed in the lake, crosscut to 28 ft., laid out and turned over to the hewing crew. Its final section consisted of a 24-in. octagon (flat to flat) from the butt to a point 2 ft. beyond the main axle crossing, then a curved barrel taper down to a 15-in. octagon at the tip, with the last foot of the arm reshaped into a tapered cylindrical horn 11 in. through at its base, 10 in. at the tip. While the broadaxes were swinging, the foundry crew was melting tons of scrap lead and casting it into multiple, paired, roughly C-shaped half-octagonal plates double the arm diameter, each 3-in.-thick plate weighing in at 1,009 lbs., for a little over a ton per layer. The finished castings were then carted over to the treb and hauled up to nest and bolt together, with the seams in alternating layers offset at 90 degrees, and the whole stack wedged into a slot in the throwing arm.

Col. Neel started out using a ratio of 1:1.618 between counterweight and throwing arms, a relationship familiar as the Golden Section, but the actual proportion ended up closer to 1:1.8. The proportionately longer counterweight arm (possible here since the designer does not have to allow for clearance of a hinged basket) is a two-edged sword.It gives the ballast much greater leverage (more range for the pound), but at the same time makes the machine much harder to cock. To obtain the maximum haul-down line load (at the point when the arm is horizontal), take the 16,000-lb. design counterweight load, decrease it by the 1:1.8 arm ratio, then increase it to account for the angle of the line between horn and roller (around 30 degrees), make allowance for friction in the system, and you get a total force around 12,000 lbs., or 6,000 lbs. per line, over twice the pull needed to cock the larger hinged machine.

When firing, the free end of the sling is tied into a loop and slipped over the horn. Surface quality of the horn and tightness of the loop can be varied to affect the release point of the sling, and hence the flight of the projectile. Other variables affecting the range of the shot include mass of counterweight and ammunition and length of sling. Increasing ballast or firing a smaller missile tends to delay the point of release, giving a flatter arc. Conversely, lightening the counterweight or using a heavier ball makes for an earlier release angle and hence a higher trajectory. Flight path can also be modified by shortening or extending sling length to advance or retard the release point. Changes that bring the release angle closer to the optimum 45 degrees will increase range, those that shift it away from 45 degrees (in either direction) will decrease range.

Dave Gaker

Above, the hinged-counterweight machine cocked and readied for firing. At right, about half-way through its discharge swing. The ball will leave the sling at about 45 degrees to the horizontal, facing downrange (to the right in this photo).

OUR hinged-counterweight machine was born and bred in committee. To begin with, Nova commissioned the husband-and-wife team Paul Denny and Julia Douglass to research the Villard trébuchet, build a model and prepare drawings and scantlings. They were quite clear that their expertise was in history and archaeology, not engineering or joinery, so the producers also sought input from engineer Neel, who contributed his own sketch and timber tally. It was then my task to turn this lot into a timber order, which I did by essentially following the lines of the Denney-Douglass version while beefing up timber sizes from 6x6 to 8x8 and larger.

There were some irreconcilable differences between the two designs: the Denny-Douglass machine called for a rectangular box, Col. Neel showed a quadrant basket like that of the Lexington Bellifortis; the historians specified metal arbors and journals and a two-part rectangular arm, the engineer called for wood throughout and a one-piece arm. In these cases, I worked up tallies for both options and ordered enough timber to go either way, since the producers insisted that resolution of the final design questions was an important part of the film and could not happen ahead of time.

But there was one issue that could not be so easily accommodated, and which overshadowed all others—the matter of size. Rumors, sketches and lists were circulating for trébuchets with arms ranging in length from 32 ft. to 45 ft., depending on the interpretation taken of the historical evidence on the one hand and the available timber budget and limited time schedule on the other. We patiently explained to the producers that one could not simply upsize an arm on a given base and trestle, but that any change to the arm must flow proportionately through the whole system. And, after waiting until the last possible moment and then a little bit longer, I recalculated the scantlings based on a 34- ft. throwing arm and faxed in the order.

The next task was to visit the mill, Somerscales, Ltd. in South Humberside, to inspect the timber and select the oak throwing arm log for the hinged machine. The quality of the sawtimber made me seriously consider applying for immigration, an inclination that was only reinforced by clambering about the 30-ft. piles of oak logs. The spec called for a 36-ft. log with a 30-in. butt diameter and minimum 20 in. tip, while the best log measured over 42 in. at the untrimmed butt, with acceptable taper over its 50 ft. length. Even better, it was quite straight for most of the way, and what crook there was near the top would disappear after crosscutting.

Stuart Somerscales asked me to mark the log for end trimming and I suffered a fateful moment of hesitation. If the truck and barge could handle the full-length log, then why cut it? Given the size of the load, the weight saved would be insignificant and we could saw it to length on site after careful inspection and consideration. When, at the 11th hour, Nova handed the Honnecourt baton over to the French master-builder of siege engines (30-plus and counting), Renaud Beffeyte (see his account on page 12), we found ourselves building a trébuchet with a 42-ft. throwing arm.

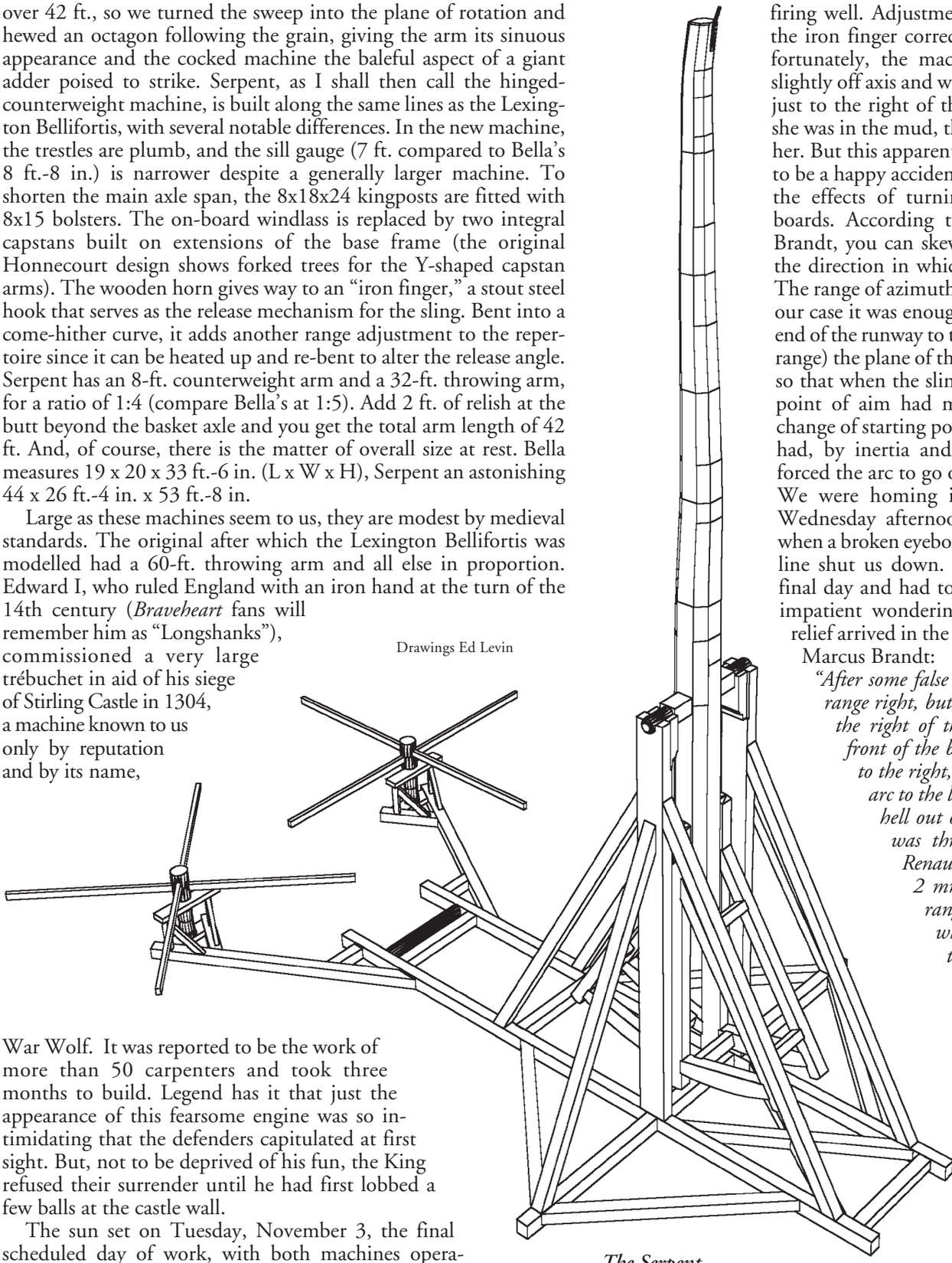
Like the Denney-Douglass version, Renaud's model used composite wood-and-steel axles and bearings, a laminated rectangular arm and also featured double passing braces clasping the trestle kingposts to shorten the main axle span, none of which passed the twin tests of historicity and availability. So it was back to the drawing board one last time, Renaud employing classical *Compagnon* techniques of *le trait* to arrive at dimensions while I effected the best possible synthesis between these new specs and the timber pile, then translated the result into working drawings, like Rossini tossing pages of the overture down to the copyists as the orchestra was tuning up.

But we got it done. There was no avoiding that crook in the log

over 42 ft., so we turned the sweep into the plane of rotation and hewed an octagon following the grain, giving the arm its sinuous appearance and the cocked machine the baleful aspect of a giant adder poised to strike. Serpent, as I shall then call the hinged-counterweight machine, is built along the same lines as the Lexington Bellifortis, with several notable differences. In the new machine, the trestles are plumb, and the sill gauge (7 ft. compared to Bella's 8 ft.-8 in.) is narrower despite a generally larger machine. To shorten the main axle span, the 8x18x24 kingposts are fitted with 8x15 bolsters. The on-board windlass is replaced by two integral capstans built on extensions of the base frame (the original Honnecourt design shows forked trees for the Y-shaped capstan arms). The wooden horn gives way to an "iron finger," a stout steel hook that serves as the release mechanism for the sling. Bent into a come-hither curve, it adds another range adjustment to the repertoire since it can be heated up and re-bent to alter the release angle. Serpent has an 8-ft. counterweight arm and a 32-ft. throwing arm, for a ratio of 1:4 (compare Bella's at 1:5). Add 2 ft. of relish at the butt beyond the basket axle and you get the total arm length of 42 ft. And, of course, there is the matter of overall size at rest. Bella measures 19 x 20 x 33 ft.-6 in. (L x W x H), Serpent an astonishing 44 x 26 ft.-4 in. x 53 ft.-8 in.

Large as these machines seem to us, they are modest by medieval standards. The original after which the Lexington Bellifortis was modelled had a 60-ft. throwing arm and all else in proportion. Edward I, who ruled England with an iron hand at the turn of the 14th century (*Braveheart* fans will remember him as "Longshanks"), commissioned a very large trébuchet in aid of his siege of Stirling Castle in 1304, a machine known to us only by reputation and by its name, War Wolf. It was reported to be the work of more than 50 carpenters and took three months to build. Legend has it that just the appearance of this fearsome engine was so intimidating that the defenders capitulated at first sight. But, not to be deprived of his fun, the King refused their surrender until he had first lobbed a few balls at the castle wall.

Drawings Ed Levin



The Serpent

The sun set on Tuesday, November 3, the final scheduled day of work, with both machines operational, but only one having been fired, and only one direct hit having been scored on the wall. So Nova laid on a couple of extra days of shooting to get the job done. The British team had dispersed, the Americans were headed home and only a handful of hardy volunteers remained. Absent the large crew, it was no longer possible to cock the machines by hand and, given the site conditions and available equipment, barely possible to do it by machine. Given the huge haul-down force required, firing Figurado was out of the question. And in any case, Serpent had yet to fire, so we focused our energy there. And by the end of Wednesday, after lobbing an initial dud reminiscent of Bella's first shot, Serpent was firing well. Adjustments to the sling and to the iron finger corrected the range but, unfortunately, the machine had been set up slightly off axis and was shooting consistently just to the right of the target. Embedded as she was in the mud, there was no way to turn her. But this apparent misfortune turned out to be a happy accident, enabling discovery of the effects of turning the ammo trough. boards. According to artilleryman Marcus Brandt, you can skew the runway and alter the direction in which the ball is launched. The range of azimuth change is minor but in our case it was enough. By shifting the front end of the runway to the right (looking downrange) the plane of the launch arc was turned so that when the sling whipped around, the point of aim had moved to the left. The change of starting position, Marcus inferred, had, by inertia and the mass of the ball, forced the arc to go off centerline.

We were homing in on the wall as the Wednesday afternoon light began to fade when a broken eyebolt and parted haul-down line shut us down. I couldn't stay for the final day and had to endure several days of impatient wondering before a measure of relief arrived in the following account from Marcus Brandt:

"After some false starts, we finally got the range right, but it was throwing a bit to the right of the wall. We shifted the front of the ball trough several inches to the right, which caused the ball to arc to the left, and started smacking hell out of the wall. The first hit was through the hoardings, so Renaud adjusted the hook about 2 mm and that dropped the range about 2 ft . . . . and when the next ball hit, it turned the battlement into a red mist . . . splintered wood and smashed stones everywhere. One of the last shots hit the wall so squarely that it broke the treb ball into several pieces and you could see the tool marks of the treb ball imprinted in the shattered stones of the wall. The only thing that tempered our joy was the thought of all you who made it possible not being there to see it."

IF timber frames could talk, they would tell you that behind the cutting of every frame, the planning and the carving, the intuition and the sweat, the fine craftsmanship and the errors, there are human stories, replete with worry and joy, courage and fear, skill and love. And of these the Highland Fling had more than its share.

During our time there, Mike Goldberg baptized Castle Urqu-

hart Castle Workhard, and the conceit of competition between machines and teams paled before the real struggle to get the job done in minimal daylight and under abominable conditions. It rapidly became clear that the appeal of artificial competitive tension didn't hold a candle to the authentic drama playing out of a band of people pulling together, inventing workarounds and devising artful solutions in the face of an improbable task. A tale of success against long odds, a war story founded on cooperation, not conflict.

Our modest tent city on the shores of Loch Ness can't have been much different from a medieval encampment of itinerant tradesmen gathered together to besiege a castle. Here the blacksmith strikes another lick as a new tool takes shape in the forge, there the foundrymen and women haul down the lift line of their timber derrick, tipping another lead casting out of the mold. With his helpers cranking for all they're worth at the great flywheel, the turner bears down on his lathe hog, the shavings fly and another axle begins to take shape, the framers tap, the flag maker takes another stitch at her banner, the rigger calls time to his capstan crew as one more great baulk is hauled aloft, and all tread the muddy paths of the little village, swapping trade secrets and sharing quiet moments with fellow carpenters, carvers, cooks, engineers, framers, hewers, landscapers, leadheads, masons, millwrights, riggers, seamstresses, smiths, sailors, stonecutters, turners, weavers.

After a meal or before a big lift we would pause for an exhortation from General ("Less cackling! More eggs!") McCarty to the troops, to work safely, and the recitation of a poem, speech or prayer. Fling poet laureate Al Thomas made several trips to the podium, Paul Denny's "Charge of the Unfunded" brought Tennyson up to date, Bill Keir contributed wicked lyrics, German journeymen Michail and Nils delivered an epic poem and a wine-quaffing demonstration from atop Figurado's trestles, Marcus and I declaimed "We Happy Few" and the children sang "The Twelve Days of Urquhart." But my favorite was David Crocco's prayer, "A Timber Framer's Petition," before the raising of the Figurado's throwing arm.

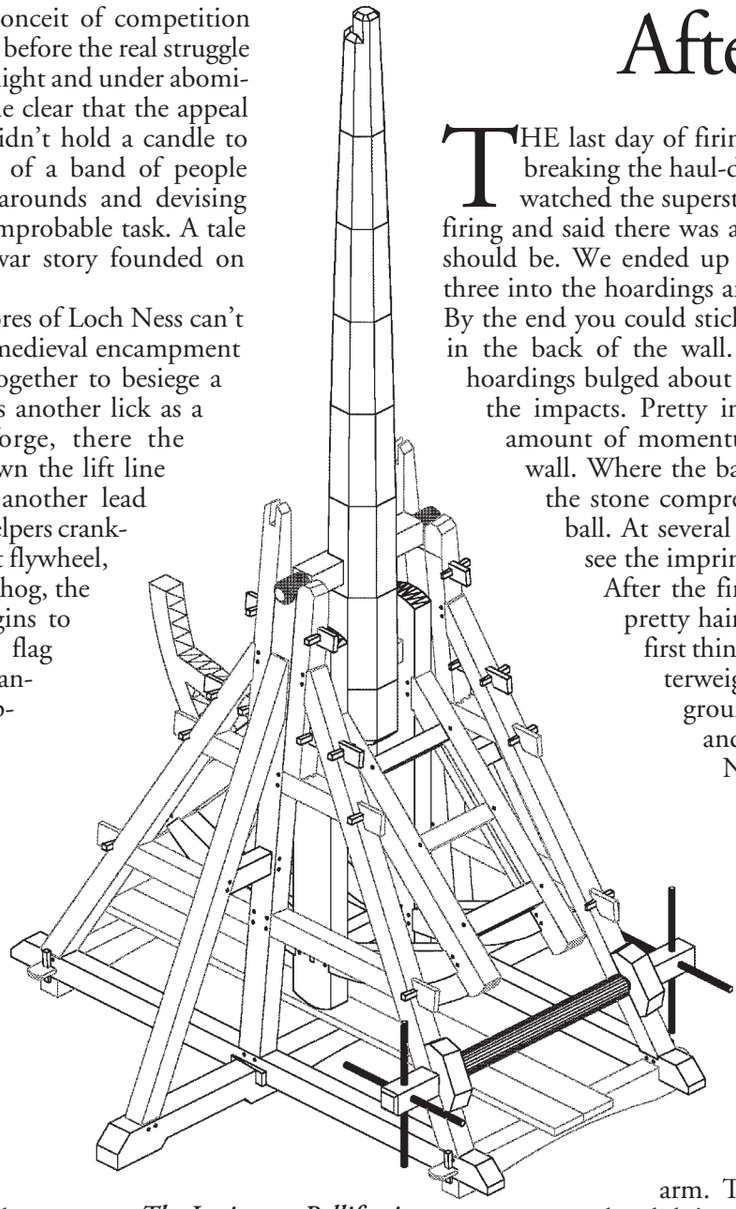
Thus:

Yo! Bossman! Listen up, please! It's us again, Bossman, the raggedy-ass timber framers. As usual, we need your special help. You know that our work is full of risk. The timbers are heavy and dangerous to handle. Most of our tools could kill or maim us. The potential for disaster in our raisings is daunting to contemplate.

Keep us always humble enough to remember our limitations as well as our accomplishments. Make us gracious in the acceptance of compliments as well as deserved criticisms. Help us focus on fixing the error rather than finding fault. Above all, Bossman, never let us forget that by the example of our dedication to excellence and our love for one another, we draw souls to you!

And so, Bossman, bearing in mind our wish to bring to you a wealth of souls, we support each other by saying "Work faster! We must make the Boss a wealthy man!"

—Ed Levin



The Lexington Bellifortis

Aftermath

THE last day of firing went pretty well. We ended up breaking the haul-down rope again. Dave and Martin watched the superstructure of the machine during the firing and said there was a little more movement than there should be. We ended up sending eight balls into the wall, three into the hoardings and pretty well destroying the wall. By the end you could stick your hand in between the lintels in the back of the wall. The entire wall underneath the hoardings bulged about 4 in. backwards from the force of the impacts. Pretty impressive when you consider the amount of momentum it takes to move a 5-ft.-thick wall. Where the balls had hit the wall you could see the stone compressed to fit the exact shape of the ball. At several different spots you could actually see the imprint of dimples carved in the ball.

After the firing we started the disassembly, a pretty hairy thing from my perspective. The first thing necessary was to unload the counterweight charge and dump it all over the ground. I think this was the only high and dry spot on the site at this point. Next the sides came off and were gently dropped to the ground with Dave Gaker's masterful touch. We had asked for a crane for taking the arm off and disassembling the trestles, but WGBH balked at the price so we had a go of it with the telescoping lift. We got a small one, but it wouldn't do the job aside from taking the basket sides off. The next toy to appear on the site was a lift with a non-working stabilizing arm. They also threw in a green driver who didn't understand hand signals. For some reason I get the feeling that every Guild event includes at least one giant curve ball, but it would be unusual to have just one curve ball. Is this status quo, or is it me?

After the basket, the next thing was to take the arm down. We put some compression bracing in the structure and rigged a sling part way up the trestle so we could lower the arm down partway, rest it and then lower it the remaining distance. Unfortunately, since the stabilizing pad on the big Maniscopic lift didn't work, we had to hold down the lift with the second smaller telescopic lift and control the light end of the throwing arm with the forklift. Of course we

Dave Gaker

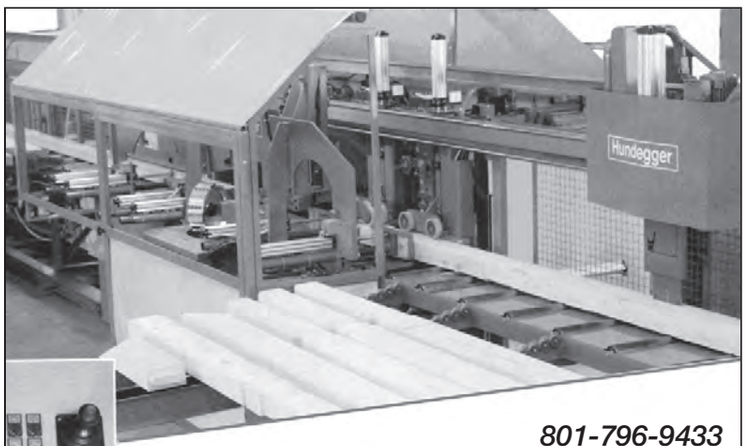
Al Thomas and the hole in the target.

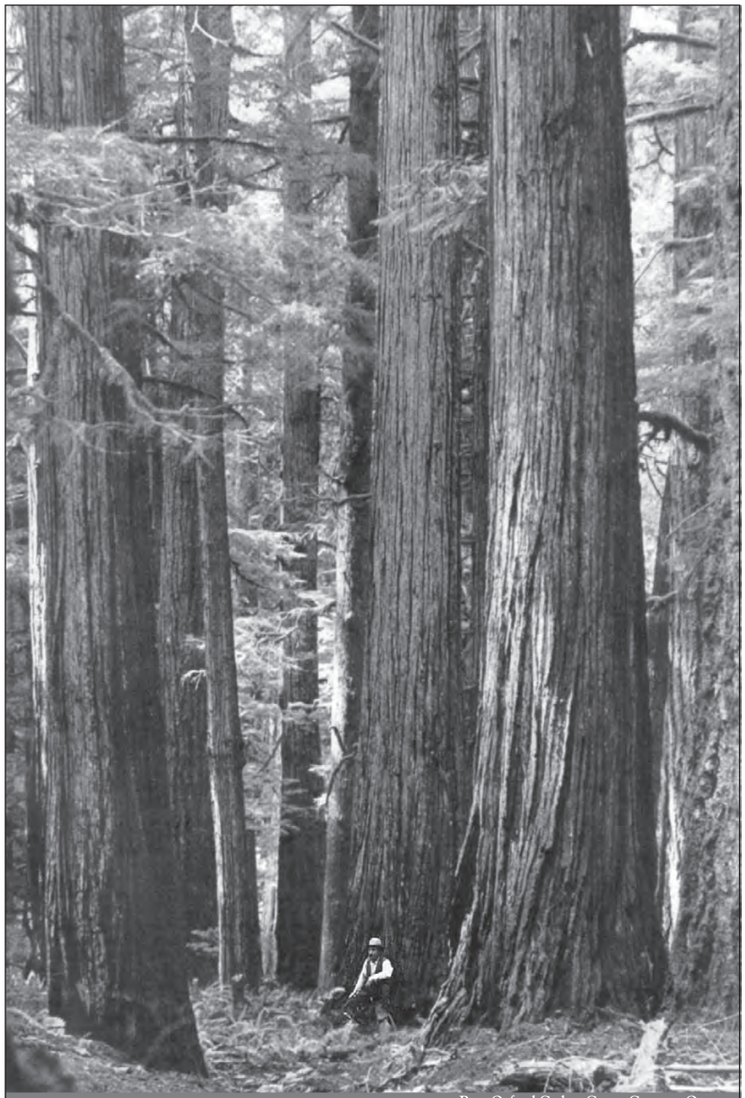
learned this only when the arm had been picked up and proceeded to go down the backside of the structure. Needless to say, the driver was a little nervous at this point because we had not yet thought to hold down the big lift with the little lift, and he was not allowed out of his machine. I think he learned a little bit about himself, his machine and what crazy things Americans are capable of when they have little choice. The arm made it to the ground in one piece without anyone getting hurt, so that was a success.

The next day, the trestles came down without too many problems. During this process, I marked the base, basket, and trestles because there was so much mud on the machine I wasn't sure that the thing had been marked before assembly. After that the machine went back onto the barge and the arm was lashed to the side. It was pretty interesting lashing the arm to the side of the barge because I had to toss the rope to the throwing arm, climb out onto the arm by way of the telescoping lift and tie the rope on the arm. More than once my rope had not made it from shore to the arm so Martin had to climb from the lift to shore and then throw the rope to me. What made it even more fun was the barge rocking and trying to knock me off the arm while I was trying to secure the two of them together. When I left, the waters were getting a little rough, so I don't know whether the arm made it over to the pier to be taken by truck to the castle or if it now resides at the bottom of the loch.

We tried to repack the rope in the barrels. Two sets of the block and tackle made it back into the big barrels, but there was no chance of making the remaining sets go back into the small barrels. Martin said he was going to take care of getting all that sent back, even if we had to pallet the block and tackle. Only after I got back to the States did someone point out that rope will swell when wet. So much for common sense, huh? All of the 1-in. Manila rope not in the pulley systems was pretty much the worse for wear and was to be left on the site. By the time we were done we couldn't tell if any of the rope was still good, and we really didn't want to chance sending a bad rope back to the States. We reasoned that when the haul-down rope broke on the big machine, it was because of individual fibers breaking inside the rope, until total failure. Kind of a scary thing to see an empty trébuchet start swinging, knowing that it could destroy itself without the projectile to take energy out of the system. Thank god no one got hurt in the entire firing process or the disassembly. —Andy Smith

Andy Smith is a mechanical engineering student at Virginia Military Institute, where he has assisted significantly in all treb affairs.





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