WHAT WE LEARNED AS OWNER-BUILDERS DURING OUR ADOBE BUILD IN THE MIDST OF THE COVID-19 PANDEMIC

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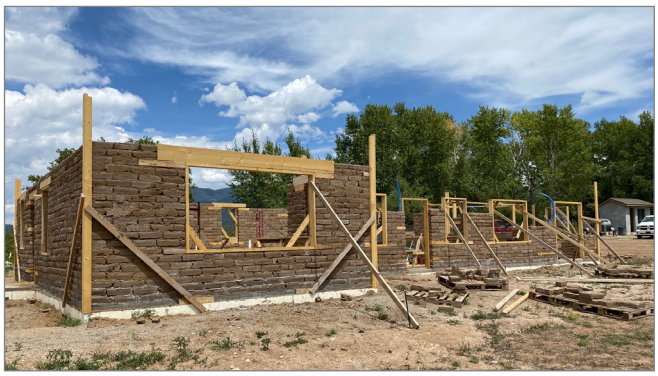
We broke ground for our adobe home near Taos, NM at the end of April 2021. This was my third owner-built project and the first for my wife and I together. First was a stick-built home in Colorado and the second was an adobe in the Arizona desert. The relative success of this project is due to many factors including a determined and capable crew, keeping a safe and healthy environment, managing the project's momentum, fast decision-making, sticking to those decisions, and carefully watching our funds while making necessary trade-offs between cost, quality and maintaining project momentum. Generally speaking, other than costs being so high, and being personally exhausted, our project ran well. My professional background is in an area that most people had hardly heard of until the COVID-19 pandemic and subsequent aftermath. I recently retired in June 2022 from a decades long academic career dedicated to Supply Chain Management with a significant emphasis on buyer-supplier relationships. My wife regularly brags about my skill set having a significant effect on the success of our project. And from stories I hear of others' struggles, there may be some truth to her assertions.

We purchased our land in early summer 2020. In September 2020, we had a driveway installed, a well drilled, and had electric and related conduit pulled to the build site. We purchased an 8' x 20' shipping container and brought it on site to serve as storage and a lockable tool shed. We also purchased a small Kioti tractor with front end loader and backhoe. We think this machine likely paid for itself.

We knew supply chain issues would be a struggle when we went to purchase the Kioti tractor and the local dealer in Alcalde, NM had tractors but no tires, and had no idea when he would have tires. Tough to sell a tractor with no tires! Ultimately, we purchased the tractor from a Colorado dealer. They too had supply chain issues. The tractor was delivered, but we received the backhoe several months later.

At the end of September 2020, we broke ground for a ~9' x 13' adobe outbuilding/shed which was small enough to not require a building permit. In early October 2020, we had ~6,000 adobe blocks delivered to our lot by Mel's Adobe Factory in Alcalde, NM. We used Foxblocks ICFs for the foundation forms and poured the shed foundation in late November. In early December we began laying adobes, but winter weather stopped us soon after.

Building the small shed allowed us to assess our relationships with the two individuals who were working with us. One of the two guys who started with us left about this time. He said it had to do with me telling him his radio was too loud, but it probably was more likely I asked him to do things he felt were beneath his qualifications, e.g., mixing mud. Our other guy (who stayed with us through



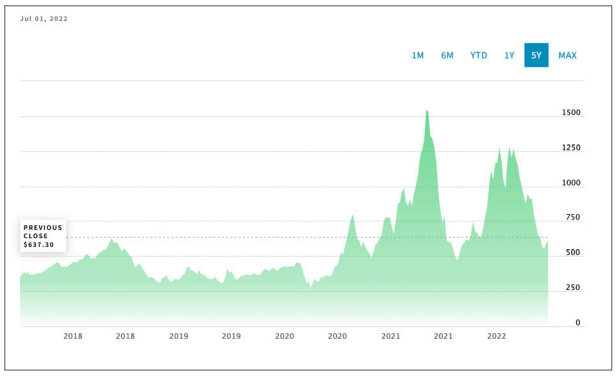
the completion of the project) took time off for hunting trips. The hunting expeditions were frustrating because I was concerned about the upcoming winter weather and wanted to maintain project momentum. Ultimately, we finished the little shed with adobe walls, bond beam, and stick-framed a pitched roof.

The COVID pandemic delayed the submission and review of our plans. Taos County offices were closed and/or had limited access during fall 2020. The regs for owner-builders are quite demanding. For a small fee, we hired a former building inspector, retired from Taos County, to help us navigate the approval paperwork/process. Due to COVID delays, the plans weren't approved until the last business day of 2020. By then, winter had set in and we took the seasoned advice of a local builder who stated "the winds can be so awful," so we waited for late spring to break ground.

From January through March 2021, we revisited our plans based on site considerations such as solar orientation, views, the newly installed driveway, and the prices of material, which were skyrocketing. We spoke briefly with an architect, asked a local adobe builder for his opinions of our plans, and visited adobe build sites in the area. These interactions provided many good ideas about the height of our adobe walls, sizes of windows, which sub-contractors to use and which ones to avoid, where to purchase various items such as windows, cabinets, roofing material, etc.

Prior to breaking ground, Taos County building inspectors provided code-related information and helped us decide to make a significant design change in our plans. We had originally planned to build the house with "Faswall ICF Building System." Manufactured in Oregon, Faswall blocks are made with cement-encapsulated woodchips. County building inspectors lacked familiarity with the product and asked for engineering specs which the company was reluctant to provide. An engineer's stamp would have come at significant cost. In contrast, Foxblocks ICFs were sold by the local lumber yard in Taos, and the ICF company provided significant installation guidelines and phone support. Thus, county building inspectors were quite comfortable with this product. Our takeaway was to be wary of products with little local familiarity.

We broke ground on April 26, 2021. My wife was traveling for work. That week a local guy unexpectedly delivered 20 trees to the property. I was thankful for the backhoe on the tractor! In May, we dug trenches for our stem walls, poured the footers and set up the ICF stem walls and related rebar reinforcement. We poured the stem walls on the first of June. By early June 2021, the price of lum-



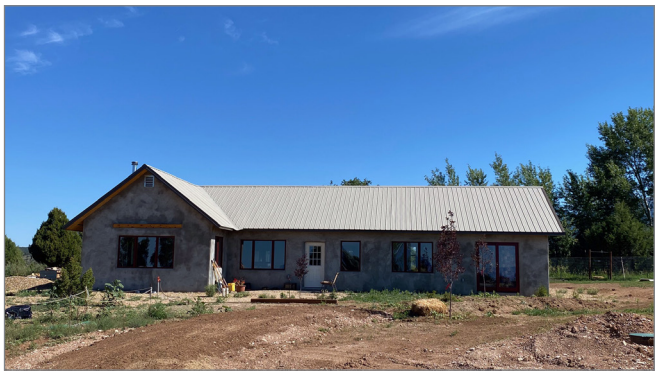
ber had increased by four-to-five times the pre-COVID prices. This increase encouraged us to look for alternative sources. Ultimately, we purchased timbers for our lintels and various other dimensional lumber (e.g., to use for story poles) from a semi-local sawmill in southern Colorado. For a small fee, they grade-stamped the timbers.

My own qualifications and preparation for this project include the following: a life-long love for building built somewhat on working with my grandfather on various projects; community college courses in masonry, layout and carpentry; early career experience in carpentry, masonry, roofing and general building; a doctorate in business administration with a focus on operations and supply chain management from Arizona State University; two design and adobe building courses from Joe Tibbets' Southwest Solar Adobe School, a previous adobe house build in the Arizona desert, and a Certificate in Adobe Construction from Adobe in Action (2020).

This project was essentially a 3-person build. During the 50-week build, I took fewer than 10 days off. In addition to my job of teaching on-line and writing, I ran the project, ordered and picked up supplies, and fully participated in all aspects of the build. After the first worker walked off the job early in the project, the remaining worker introduced us to another local. We employed these two local tradespeople day-to-day throughout the rest of the project. They were experienced in carpentry, adobe laying and general building knowledge and skills. Of the two, one gentleman was primarily a skilled carpenter, who asked pertinent questions and focused on quality over quantity. The other gentleman was capable of huge amounts of physical labor and while bringing an extensive background in laying adobes, stucco prep and plaster, and carpentry, needed more direction and oversight.

To state that this was a 3-person build provides a rather incomplete picture because my wife often ran for supplies, helped with daily clean-up, and in addition to her full-time job, provided us with three square meals per day. We also had the benefit of owning the tractor, which helped with moving dirt, digging trenches for utilities, and moving partial pallets of adobes around the work site. While the 3-person crew did most of the work, we also hired outside contractors to do the plumbing, electrical, insulation, countertops and to install the septic system.

My operations management and supply chain experience and teaching history also helped me plan and manage the build. During 2021, the pandemic was fully underway, and society had changed. Many people were sick or scared and stayed home. One of the key challenges in supply chains is



how to match supply with demand. Many supply chains operate optimally when demand is relatively stable and predictable. COVID affected both. Demand for many items, including gasoline, went down due to decreased travel. However, demand for lumber and many related building supplies increased as people stayed home and decided to tackle home improvement products. At the same time, the lumber supply chain suffered from work force disruptions. Employees were sick and in some cases lumber mills temporarily shut down. As mills shut down, some employees looked elsewhere for work. Thus, when mills attempted to re-open, many found themselves short on workers and thus unable to produce at full capacity. At least in part due to these factors, the price of dimensional lumber and related products like plywood shot up to 5 times the pre-COVID price. The lumber futures chart below illustrates this dramatic price increase.

Notice that the high in the futures price occurred in early May 2021. By August 2021, prices had dropped significantly but rose again to significant highs in early 2022. We attempted to counter these price increases by buying when prices were low and storing some lumber and timbers for lintels. We also shopped locally, using a semi-local lumber mill in southern Colorado that provided timbers for lintels and also grade stamped their products for a small additional fee. We ordered a significant amount of 2”-by material that we used for story poles and other non-structural uses. We found that the mill’s lumber was equal to or better in quality than what was available at lumber yards and the price was roughly half. Storing these items under tarps and keeping them separated with stickers allowed them to maintain their shape.

One topic I’ve frequently taught in my classroom is Lean, a.k.a., “Lean Thinking.” Lean is basically focused on minimizing waste, including inventory, inside a company and across its supply chain. One small component of Lean is good housekeeping skills. Based on a Japanese approach, the 5S approach is, in U.S. context and English language is to Sort, Straighten, Shine, Standardize and Sustain your operation, in this case, our building site. Basically, you keep what you need and constantly get rid of what you don’t need (or store it), neatly arrange what’s left, keep the work area clean, formalize these into daily rituals and do it forever. We worked to clean up each day and prep for the next by running for materials if needed, cleaned our tools and put everything away. Good housekeeping represents a safe way to operate and makes it easier to get things done the next day, especially when the focus of work might change from day to day, resulting in setting up and taking down, say, a chop saw or cement mixer. Even the electrical cords strewn throughout the worksite were picked up and unplugged daily.

Buying items early and storing them proved to be a worthwhile approach, especially as lead times increased. Items we purchased well before we needed them included a woodstove and related pipe, all of our appliances, lights, lumber, trusses and garage doors. While we had to pay storage fees, which increased our costs, we felt this specific cost outweighed the costs inherent in having the project shut down. We wanted to keep our workers busy; otherwise they might find work elsewhere.

For our kitchen and bath cabinets, we first attempted to use a local cabinet maker. However, most were fully booked for three to five months and many weren't taking new orders. One local cabinet maker did provide a bid, but at $35,000 for fairly standard cabinets in addition to a 3-4 month lead time, we realized we had to look at alternative sources. After shopping around, we went with ready-to-assemble cabinets and chose shaker-style cabinets from their standard color offerings. Lead-times were approximately 5 weeks and the price was approximately 35% of the local bid. Delivery came via Fed-Ex truck to our door. Assembly was easy and quick, quality was good and we are quite happy with this decision.

Many of our materials choices were made based on multiple factors such as health considerations, quality (as we perceived it), and cost. In the previous adobe build in the Arizona desert, I left the 14" adobe walls raw adobe, both inside and out. For this build, we wanted a bright interior, and chose breathable lime plaster sourced from BioLime in Texas. We didn't want a smooth finish, but something that looked a bit old and rustic. We are happy with that decision. Our ceilings are all T&G Doug Fir, sourced from the sawmill in southern Colorado, and we love the way they look next to the lime plaster walls. We used SoyCrete stain and sealer from Eco Safety Products for our concrete floors. This required a multi-step process to clean, color and seal the concrete slab, but we are happy with the result and this floor treatment was relatively cheap compared to, say, tiling the whole place.

My wife is a banker. She wanted to keep an itemized budget as we got rolling on the project. I didn't. I knew how much money we had to work with and knew roughly how much things would *typically* cost. Right out of the gate, our land cost more than what we were planning to spend. We thought if we found a lot that already had a well, septic, driveway, etc. we could pay more, but our lot had little except for irrigation rights. Thankfully, we built on a relatively flat spot that required little clearing which certainly made the project easier and less costly. The land alone was our biggest spend at ~33% of the overall cost of the project. Labor costs were the second highest spend at ~ 20%. The installation cost of the well, dirt work, driveway and underground utility pulls was approximately 8%. Plumbing and electrical contractors were ~ 7%. As an aside, the only sub-contractor issues we experienced were with the electrician. His original bid was very informal, although in writing, but then many items became "extras" – which was very frustrating and costly. Thankfully, his quality of workmanship was good. We categorized him as a bit of a pain the day we met him, but he was willing to work on an adobe build and ultimately his work was satisfactory even though expensive. A metal roof, trusses and timbers were ~ 7%. Windows, doors and garage doors were about 5 pecent. An additional five percent went to outfitting the kitchen and bathrooms (cabinetry, countertops and appliances). Foundation and slab were roughly 4% and the adobes were about 2%. The remaining portion constituted the non-stop runs to the local lumber store for lumber, screws, caulk and everything else imaginable.

Summarizing, many of our lessons learned may be unrelated to the COVID-19 pandemic, but the pandemic in some cases exacerbated issues that we might have experienced regardless. My brother, who has owned a construction firm for years and now works either alone or with one or two people, once gave each of his employees' t-shirts emblazoned with the message "The Torture Never Stops." It was a joke, of course, but with a hint of truth. There were days during this project that I just wanted to quit. The endless physical work, lining up materials, and non-stop decision-making all took their toll. But the torture does indeed stop! We were awarded our Certificate of Occupancy fifty weeks after we broke ground.

Daniel Krause *is a recently retired Professor of Operations and Supply Chain Management. During his career, he taught at several universities including Arizona State University, the University of Victoria (B.C., Canada), Queen's University Belfast (Northern Ireland, UK), and Colorado State University. This is his third owner-built house. His wife says this is the final house!*