

The Polk County Courthouse: a \$47 million IAQ disaster.

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Overview

The Polk County Courthouse was completed in 1987 in central Florida at a cost of \$27 million. After four years of occupancy, 80% of its inhabitants complained of sick building syndrome. Over 100 people have been diagnosed with building related illness. A handful of people have been diagnosed with a permanent, debilitating, and sometimes fatal lung inflammation. All of these complaints stem from exposure to bioaerosol contaminants; mold, mildew, and bacteria. The excessive mold growth was caused by a leaky building envelope, misplaced vapor barrier, and negatively pressured building. The building was abandoned and repairs were begun in 1991. Repairs are nearing completion, and the costs continue to escalate. Not including the original Contract Amount, the cost of repairs to date is \$47 million. While certainly significant, the direct physical causes for this building failure tell only half the story. This presentation and paper describe both the physical causes of the disaster and the project environment surrounding this case.

Project Background and History

The Site The site is in central Florida, some 40 miles south of Disney World in Polk County. The industries in this county are primarily phosphate, citrus, and tourism. In the years of the explosive growth accompanying the development of Disney world and the theme park region surrounding it, Polk County's population grew from under 200,000 to 423,000. The largest city in the county is Lakeland, with a population of 208,000. The county seat is Bartow, a sleepy country town of 15,000. Although Bartow itself has been largely unaffected by the tourism boom, it still must provide the services required of a county seat for an area that has experienced very rapid growth.

The Building The building was designed and built with a ten story core, with two three story wings running east and west. Floor to floor height is slightly more than 14 feet. The structure is a concrete frame with two-way slabs, CMU infill, and brick veneer. Originally the 3 in 12 pitch roof was finished in 'Spanish' tile. The HVAC system is a classic four pipe, hot and chilled water with remote variable air volume air handlers. The new courthouse



The Participants The idea for the project was conceived in the late 1960's, when Polk County first began to realize the impact of the newly planned Disney World complex. Like many areas in the Sun Belt, central Florida was experiencing rapid growth; the Disney phenomenon catapulted the area into national and international prominence as a tourism destination. Though not critical at the time, the coming need for more judicial office space was clear to the county planners. Polk County itself is not a tourist destination. The county's livelihood has been citrus, phosphate and service as a distribution center for much of the state. The business culture was casual and somewhat insulated; deals negotiated and agreed to by handshake were functional and common. In this environment, the architectural firm was hired (more on this hiring follows) to begin the new courthouse project. The project stalled, restarted, and stalled over the next decade. During this time, the county authority for this project went through the expected changes inherent in a client composed of an elected group. At the same time, the county experienced the heady economic growth that all of central Florida was enjoying. Programming requests became more elaborate, and the vision for the facility expanded to fill the perceptions of affluence. In the social environment of a small town, desires for space were easily communicated to the architect through informal lines.

During this time, the architectural consultants underwent significant changes. The senior partner separated from the group; another partner followed several years later. The remaining partner retained the courthouse commission.

The project eventually gained momentum, aided in part by the discovery of friable asbestos raining down on the heads of the occupants of the old courthouse building. By the time the project went to bid, the scope had mushroomed. Bids came in significantly above the county's preconception of the cost. A construction management agreement was negotiated with Barton-Malow from Detroit.

Almost immediately after the project was completed, cracks in the brick veneer began to develop. Within a year, the county began repairing these cracks. At the same time, occupants of the building began to complain of sick building symptoms; watery eyes, respiratory difficulties, itchy skin, rashes, etc.

The Problems

The simplest way to describe this building failure is to say that the building leaked, excessive amounts of Florida air infiltrated, the HVAC system didn't dehumidify, and massive amounts of mold grew. Proliferation of mold and mildew was the fundamental problem in the Polk County Courthouse.

SBS and BRI As mentioned earlier, within one year of the occupancy of this building, over 80% of its 500 occupants complained of various symptoms associated with sick building syndrome. Sick building syndrome is a condition consisting of a group of symptoms presumably associated with exposure to environmental contaminants in a building. SBS tends to present as a set of relatively mild and varied complaints; it is frequently labeled

Summary of Costs as of Dec. 1993	
Original Construction Contract	\$27 million
Fixtures, Furnishings, and Equipment	\$7 million
Repair Costs to Date	\$33.6 million
New Ducts	\$3.2 million
Legal Fees	\$3.3 million
Renovation Costs	\$40.1 million
Insurance collected	\$29 million
Settlements Collected	\$7.1 million
Current Cost	\$74.1 million

'mass hysteria', or written off as psychological. SBS can only be diagnosed by comparing the statistical incidence of symptoms reported by a building's occupants with a control group not associated with the building in question. BRI, or building related illness, in contrast, is a set of symptoms attributable to some causal environmental agent. BRI can be diagnosed individually. In short, SBS means a group of people is ill *most likely* as a result of exposure to something in a building. BRI means an individual is ill *due to* exposure to some agent in a building.

Of the 400 occupants of the Polk County Courthouse who were diagnosed with SBS, to date, over 100 have been diagnosed with BRI. A handful of these have been diagnosed with a permanent and debilitating lung condition. Concerns about the safety and health of the building's occupants became the overriding focus of the renovation efforts.

The Physical Causes

A number of physical causes have been identified by consultants and remediation experts. A partial list is described here.

- *Skin failure* The cracking brick veneer was one of the first signs of trouble in this building. Brick veneers are typically one wythe thick, and are supported on shelf angles bolted to the spandrel beams at each story. In this case, many of the shelf angles were only loosely attached to the spandrel beams or were missing altogether. This meant that several stories of brick supported itself- something it does not do well in single wythes. As well, the spandrel beams were out of alignment vertically by as much as 8 inches. Masons had simply curved the concrete masonry units and the brick in and out to line up from one story to the next. The resulting unsupported, wavy walls cracked almost immediately, allowing direct water entry into the cavity.
- *Flashing at cavity walls* The cavity in a cavity wall is designed to shed condensation downward to a flashing, where it is exhausted to the exterior through weepholes. Although direct water entry is not a planned event, it can also be vented at the bottom of the cavity. In the case of this courthouse, the flashing was frequently missing at both the shelf angle supporting the brick, and at the intersection of the ten story core and the roof of the three story wings. This allowed water - entering through cracks in the brick veneer and the CMU infill - to flow into the building.
- *Missing vapor barrier* The specifications called for a liquid applied vapor barrier on the face of the CMU infill wall, inside the cavity. Much of the vapor barrier was thinly applied or not applied at all.
- *Roof leak* The roof developed leaks for three reasons. First, the tiles that were specified are not recommended for less than 4 in 12 pitch. The roof of the Polk County Courthouse was a 3 in 12. Second, the tiles were shown in the contract documents, and installed accordingly, in areas where access to rooftop equipment required workers to walk on the tiles. Again, this is beyond the material capabilities of the tile. Last, the roof deck panels supporting the tiles were manufactured with faulty adhesive. Some of the deck panels delaminated and sagged, causing additional fracturing of the tile roof.
- *Window installation and infiltration* Normally, windows are installed in openings just slightly larger than the window frame. To level the window, the installer 'shims' around the frame using thin pieces of wood. After the window is leveled, it is fixed in place and insulation is inserted into the gap around the window to prevent air infiltration. The masonry rough openings in this building were, in some cases, as much as 8 ½ inches larger than the window units. This large gap was not filled with insulation, and allowed massive infiltration of hot, humid, outside air.
- *Roof drainage/ gutter overtop* Rain in central Florida can be quite predictable; in summer, midafternoon downpours of several inches are a regular occurrence. The gutter detail on the courthouse is a large trench formed onto a flat slab which covers a walkway around the ground floor. Above the slab is a framed sloping roof. The drains from the gutters were undersized, and the gutters overtopped

- regularly. When the gutters overtopped, the water ran both over the edge of and underneath the framed roof. This water ponded under the roof, and leaked into the building. It brought with it the microbes that “flourish in hot, dark and damp conditions.
- *Negative pressure* Florida design conditions are 95 degrees F, and 90% relative humidity. The building was operating under negative pressure, that is, the air pressure or psi inside the building was less than the psi outside. With plenty of opportunity to enter - cracking walls, no vapor barrier, large gaps around the windows - the building was drawing in air ideally conditioned to grow mold.
- *Oversized chilling capacity* It is tempting to oversize systems in building design. In a structural system, if a 10 inch column will work, a 12 inch column will work even better. This logic can backfire in HVAC design. The chilling capacity in the courthouse was oversized by a factor of 2. This meant that the system only had to blow a small amount of chilled air to achieve the desired ambient temperature. However, dehumidification occurs during the chilling cycle, and since the time spent chilling the air was so short, building dehumidification was grossly inadequate.
- *Lined ducts and air handlers* The industry standard fiberglass insulation lining in ducts and air handlers is a good medium for microbe growth. Once contaminated, there are two basic approaches to cleaning; mechanical brushing and chemical disinfectants. Neither method fully penetrates or cleans the lining, leaving bioaerosol contaminants embedded in the fiberglass. The remediation team initially opted to clean the ducts in this building. Tests conducted after the cleaning showed contamination at or above the original levels, consequently all ducts were replaced at an additional cost of \$3.2 million.

Net results In summary, numerous physical defects in construction and design combined to produce a leaking building envelope and a building which, by design, drew in outside air in prime condition to grow mold. Once inside the building, the water and humid air were not dehumidified. The moisture being drawn in through the walls tended to stop at what became the de facto vapor barrier - the vinyl wallcovering. When the vinyl was removed, massive colonies of mold, mildew and bacteria were evident. In large quantities, the spores produced by these organisms are toxic, causing allergic reactions and respiratory distress. If exposed for long periods of time, people develop permanent lung inflammations and hypersensitivity to molds. All of these effects were observed in the occupants of this building.

The Project Environment

While the physical causes of this cost and health disaster are fascinating and educational of themselves, the indirect causes are important to identify in order to avoid similar outcomes on projects in the future. The question becomes, what management and project environment factors set up a situation that allowed this disaster to develop so thoroughly? The contributing factors are complex and, in this project, include all parties.

- *Change in scope* This project had a long history of ideation. Over the course of its decade long programming phase, the project grew with the economic optimism of the geographic location. As well, the Owner - the county - had multiple voices authorized to add to and change the project requirements. With each round of elections, further wishes by new owners were added to the program. Additionally, the population of the county doubled, along with its needs for judicial services. All of these factors produced a decade long ‘conceptual design’ phase in which the scope of the project increased dramatically. Naturally, the perceived budget did not increase at the same rate.
- *Unclear agreement* As described earlier, the business culture of the region was somewhat casual. The architect never had the industry standard for an agreement; a signed AIA B141 Standard Form of Agreement between Architect and Owner. There are numerous letters and amended letters of agreement,

but no clear scope of services or fee structure.

- *Decreasing capacity of Architect* At the time the project scope was increasing, the capacity of the “ architect was decreasing. The original office of three partners had become a one partner office, with ‘proportionally reduced staff. Moreover, with an errors and omissions policy limit of approximately \$300,000, the architect was underinsured for this size of project.
- *- Owner: uneducated unprepared and under pressure* Generally, elected county commissioners in small towns have little experience with building projects of this size. Further, politicians are not generally known for being mild mannered followers. Consequently, a group of distinct personalities, each with the desire and mandate to be a leader and decision maker, but none with building project management experience, directed this project.
The county also was under extreme pressure to get out of the existing facilities. By the time the project was in the design phase, the county had discovered that the white flakes on everyone’s shoulders in the old courthouse were not pandemic dandruff, but rather friable asbestos. This put enormous pressure on the time to deliver the project. Under such conditions, project decisions often go undocumented, and the costs of decisions take back seat to time considerations.
- *Cost surprises at bid* Not surprisingly, the project came in some “\$7 million over the county’s initial budget of \$20 million. This setup a tense architect-owner relationship and set the stage for poorly managed last minute cost reductions.
- *Change in project delivery method* In order to contain the construction costs, the county decided to move to a construction management project delivery method. This delivery method works well when the CM is a part of the design decision making from the outset. However, when the CM tries to retroactively value engineer a project that is 40% over budget at bid, under tight time constraints, some intended project outcomes must be compromised. Barton Malow, a Detroit based CM firm with a good reputation, was hired to deliver the building. Interestingly, one year after the building was occupied, the county took bids for correcting the failing brick veneer, and Barton Malow submitted a bid for \$11 million to correct the problems. The trail of rationale for this is hard to extract and seems unfathomable in hindsight. In any case, the county attempted to block Barton Malow from the repair project, Barton Malow sued the county, and the parties eventually settled out of court, with Barton Malow agreeing not to bid on the repairs.
- *Reduced contract administration services* The county, like other owners faced with the necessity of severe cost controls at the construction phase, eyed the architect’s fee for construction review as a source of extra funds. According to the architect, the county proposed eliminating his services during construction, to which he countered that the county would need three full time employees to cover necessary administration tasks. The county hired one person, part time and somewhat inexperienced, to inspect the project.

While this portion of design services fees is often an attractive ‘savings’ target in the owner’s eyes, (“the drawings are done, your design is good isn’t it, we’ll make sure the contractor does a good job...”) in reality, this portion of the fee has little to do with the final cost of the outcome, and much to do with the final quality. Through the first four phases of design services, the Owner spends in the neighborhood of 4% of the total project budget. This 4% effects the ease of and clarity of bids, the performance of the final building and the ultimate cost of the project. The output of this 4%, however, is not tested until construction begins. In other words, the Owner will spend 94% of its budget testing the product of the designer. The last 10% of the Owner’s budget is spent on the design service phase called Contract Administration. This is the last chance for the design consultant to catch and correct design errors and omissions, and it is the phase during which an interested party - other than the Owner- observes the quality and progress of the work. Eliminating this quality

assurance phase at a savings of 10/0, produces a greatly magnified potential for increased costs. This oversight is a factor in other "building disasters, notably the Hyatt failure. Indeed, most E&O policies are invalid unless " the Architect/Engineer includes construction review in the scope of services.

Conclusions

This building failure has had a profound and catastrophic impact on the people of Polk County. The taxpayers face an enormous burden, faith in public leaders is eroded, many elected officials are out of office, and the judicial system operates out of rental spaces and cardboard boxes all over the county. Virtually all of the county's records are contaminated and hazardous. Most importantly, hundreds of people are now hypersensitive to mold. Many of these people will be permanently disabled with a condition that has been likened to emphysema, and a few have a 'potentially fatal' lung condition.

It is important to remember that as building designers, our work can have a direct and profound impact on the lives of many people. Building failures don't always look or sound like a collapse; disasters can be very quiet. We must be alert to the subtle signs that a project is heading for trouble, and be prepared to do what is necessary to protect the health and well being of the people who live and work in our products.

References

Much of the information for this analysis of the Polk County Courthouse disaster has been gathered by direct observation of the site and conversations with involved parties, attendance at the Sick Building Symposium in Orlando, June 1993, conversations with remediation consultants on the project, and discussions with attorneys involved in the project. An additional source of information has been articles in the Lakeland Ledger newspaper. These articles can be misleading interpretations of the data. For example, the paper states that the architect failed to make inspections of the building. This is certainly true, however, architects generally do not make inspections; rather, their contractual duties during construction are observation, specifically, "to become generally familiar with the progress and quality of the work and to determine, in general, if the work will . . . conform with the contract documents when completed." Furthermore, the county curtailed the involvement of the architect during the construction phase of the project. So, the reports in the paper require some interpretation. Cost figures have largely come from this newspaper source; some interpretation is required. A class action by effected occupants of the building goes to trial in 1997 (according to the Ledger). Until then, most contacts have stopped being willing to chat about details of the case.

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