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LESSONS IN THE RUBBLE: THE WORLD TRADE CENTER AND THE HISTORY OF DISASTER INVESTIGATIONS IN THE UNITED STATES

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The World Trade Center collapse stands as a singular event in American history. As such, it might also stand to reason that the technical investigation into the circumstances of the collapse also stands alone. Clashes over authority among powerful institutions both public and private, competition among rival experts for influence, inquiry into a disaster elevated to the status of a memorial for the dead: these are the base elements of the World Trade Center investigation. These elements, however, are not unique. This article illustrates—drawing on case studies including the burning of the United States Capitol Building (1814), the Hague Street boiler explosion and building collapse in New York (1850), and the Iroquois Theater Fire in Chicago (1903)—that conflicts over authority, expertise, memory, and ultimately the attribution of responsibility suffuse the history of disaster in the United States. The "disaster investigation," far from proving itself the dispassionate, scientific verdict on causality and blame, actually emerges as a hard-fought contest to define the moment in politics and society, in technology and culture.

Keywords: World Trade Center; Iroquois Theater; US Capitol Building; Disaster; Benjamin Henry Latrobe; John Ripley Freeman

One week after the destruction of September 11, Dr Abolhassan Astaneh-Asl, a professor of structural engineering at the University of California at Berkeley, arrived in New York City to find out *exactly* why the World Trade Center towers collapsed. Funded by the National Science Foundation to work alongside a joint investigation team assembled by the American Society of Civil Engineers (ASCE) and the Federal Emergency Management Agency (FEMA), Dr Astaneh-Asl unexpectedly began work on his first night in town.[1] Looking down from his hotel window he spotted a flatbed truck parked outside, a truck loaded down with mangled and charred steel beams. Realizing that these were beams from Ground Zero, he began an improvised catalog of his findings. Dr Astaneh-Asl, just like his fellow investigators, felt sure that careful research among the ruins of the World Trade Center would eventually yield the specific chronology and causality of the collapse. Preparing for the on-site work certain to come, he added to the catalog over several nights until, abruptly, the trucks changed their route from downtown to the west-side docks. Dr Astaneh-Asl had no idea then how serendipitous, and how surprisingly rare this meeting between investigator and wreckage would come to seem in the weeks and months ahead.[2]

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In late September, the FEMA/ASCE investigators were stunned to learn that the city's Department of Design and Construction, in charge of removing the debris at Ground Zero, had decided to send the estimated 310,000 tons of steel columns, trusses, and beams—beams like those catalogued by Dr Astaneh-Asl—away for immediate recycling. Investigators had no power to protest the decision. In fact, their initial request to inspect the steel had been lost in the confusion by city officials still pressed with the responsibility of looking for bodies. So, instead of ending up at the Fresh Kills Landfill in Staten Island where the other debris was being sifted and studied, most of the steel was being shipped to scrapyards in New Jersey and melted down, some of it traveling as far away as Asia to be recycled. "If we don't collect the unbelievably valuable data, it will be a second tragedy," charged Dr Astaneh-Asl.[3] Invoking the dead of September 11, and raising the stakes of the FEMA/ASCE investigation from the scientific to the sacred, he declared that "For the sake of those . . . people we should learn something about it."[4]

The recycled steel was only the beginning. In the key first few weeks after the September 11 attacks, the FEMA/ASCE team was not granted full access to the disaster site. With great frustration the engineers found they also lacked the authority to interview witnesses, or to subpoena critical documents such as the World Trade Center blueprints. They were denied the opportunity to review distress calls recorded by the fire and police departments, calls that provide clues about the timing of the buildings' disintegrations.[5] By Christmas, institutional tensions between the ASCE engineers and their FEMA colleagues had surfaced, leading one anonymous engineer to complain that "FEMA is controlling everything . . . just give us the money and let us do it, and get the politics out of it."[6] A FEMA spokesman defensively cited the agency's first priority as victim and disaster-site assistance, and to confess "We are not an investigative agency."[7] An odd claim, considering that a similar joint FEMA/ASCE team published an investigation report on the 1995 bombing of the Murrah Federal Office Building in Oklahoma City. This was a clear sign of trouble. Overwhelmed, and looking to abdicate its role in the investigation, FEMA now informally invited a third major institutional player into the mix: the National Institute of Standards and Technology (NIST). Formerly the National Bureau of Standards, NIST operates a research campus in Gaithersburg, Maryland, supervising national standards and conducting materials testing research, along with performing building design and fire safety studies.[8]

With the public outcry for answers increasing, the House Committee on Science convened a hearing in March 2002, in which the failures and successes of the World Trade Center investigation to date were fully exposed to the public for the first time. Representatives from the ASCE, FEMA, and NIST sat on a panel of disaster, structural engineering, and fire safety experts that testified in front of an overflow crowd, with many families of September 11 victims present. Committee Chairman Sherwood Boehlert of New York reviewed the primary complaints of the investigating engineers, especially their difficulties in obtaining information, uncertainties about the future of the investigation, and the confusing criss-crossed lines of authority. Boehlert pointed to a need for clear and undisputed federal control in major building collapse investigations, and demanded, "investigative protocols and procedures right now, so we don't have to 'reinvent the wheel' each time we face a building failure."[9]

The most bizarre, and perhaps most telling, moment in the hearing occurred when Representative Anthony D. Weiner of New York, addressing the panel of experts, asked for the person in charge of the investigation to raise his hand. When three hands went up, Weiner demanded to know "Where does the buck stop on this . . . investigation?"[10] NIST director Dr Arden L. Bement claimed authority, but then admitted he actually possessed no power to demand testimony or to subpoena evidence related to the disaster.[11] After the hearing, a man whose son-in-law had died in the collapse complained, "It has been six months, and nobody knows who is responsible for what. It is a disgrace."[12] On the whole, the hearing testimony

indicated that in all of the wrangling over investigative authority, many of the technical particulars of the World Trade Center collapse remained obscured. These particulars would prove necessary in the struggle over where to place the blame for the disaster, and in proposing new material standards and building codes, new emergency response methods, and perhaps even offering peace of mind for victims' families. Six months after the World Trade Center collapse, the greatest structural disaster in modern history, people were still seeking to answer the question: why *exactly* had the Towers collapsed? Such questions would lead the way to the slightly more troubling and associated concern: *could it happen again* in another skyscraper? The ASCE/FEMA team members held no doubt that they could deliver the answers, but they would have to first overcome the collapse of their authority before they could decipher the collapse of the Twin Towers.

In many respects, the World Trade Center disaster stands as a singular event in American history. In the staggering number of civilian lives lost, the saturation of media coverage, the extent of the jobs and dollars lost in New York City, and the magnitude of the political shockwaves felt around the globe it was an event without precedent.[13] The intensity of debate over the proper way to remember September 11 has also proven unusual, with suggestions ranging from creating a national holiday and a memorial park at Ground Zero, to the reconstruction of the Twin Towers just as they were, but with the defiant addition of a 111th floor for each.[14] As such, it might likewise stand to reason that the World Trade Center investigation stands alone.

Clashes over authority among powerful institutions both public and private, competition among rival experts for influence, inquiry into a disaster elevated to the status of a memorial for the dead: these are the base elements of the World Trade Center investigation. And yet, even a brief historical review shows us that these elements are not unique. In this article I will show that conflicts over authority, expertise, memory, and finally the attribution of responsibility suffuse the history of disaster in the United States. History shows that, with time, a given community of engineers and scientists has generally proven able to explain the technical particulars of a structural collapse. Yet, the demands placed on an investigation have as much, or more, to do with defining the dominant investigator and quickly addressing the fears and anger of the press, government, and an outraged public than they do with discovering the definitive technical truths of a catastrophic event. Blame, memorial, and reconstruction tend to outpace technical consensus. Moreover, in any number of disasters over the past two centuries, the "disaster investigation," far from proving itself the dispassionate, scientific verdict on causality and blame, actually emerges as a hard-fought contest to define the moment in politics and society, in technology and culture. By reviewing the history of disaster investigations in the United States, we therefore gain a broader context for understanding the early pitfalls and the future prospects for the World Trade Center investigation.

Historians of the city and historians of technology have presented numerous compelling studies of urban-technological disasters. Exemplars of this literature organize disasters in ways that highlight their similarities, while at the same time accounting for differences by region and by their particular political, social, and cultural contexts. Carl Smith, for example, uses the Great Chicago Fire of 1871 as a case study through which to understand certain late 19th century Americans, people who "saw in the smoke and flames a fulfillment of their deepest fears about urban life."[15] While at the same time he finds some Chicagoans celebrating the fire as a rebirth, rejoicing that "show and frivolity were abandoned, and democracy became the fashion."[16] A condensed moment of shared loss, the Great Fire may not at first glance seem to teach us much about "life as usual" at the time. The narrative, though, of the struggle to define the disaster's causes and its transcendent lessons opens up much broader questions about class divisions, urban culture, and the frenetic pace of capital

expansion in the industrializing city. Mike Davis does the same for 20th century Los Angeles in *Ecology of Fear: Los Angeles and the Imagination of Disaster* (1998), while Christine Meisner Rosen, in *The Limits of Power: Great Fires and the Process of City Growth in America* (1986), connects the Chicago Fire of 1871, the Boston Fire of 1872, and the Baltimore Fire of 1904 with a similar eye for the construction of meaning via the destruction of buildings. [17] The study of disaster investigations builds on such works, focusing on the one commonly overlooked aspect of a disaster's aftermath that generally asserts the highest level of social and political neutrality. To see the process at work we will re-visit the burning of the Capitol Building in 1814, the 1850 Hague Street boiler explosion in New York City, and Chicago's Iroquois Theater Fire of 1903.

THE BURNING OF THE US CAPITOL BUILDING, 1814

> The excessive haste with which the work was urged occasioned the employment of wood where brick and stone was intended. Oeconomy was also consulted. But in public works there is no oeconomy where there is not durability . . .[18]

The War of 1812 remains one of the least understood conflicts in American History, a curious point considering that it marks one of the rare instances—including the Revolutionary War and September 11—when the United States mainland has come under direct attack. If we do remember anything from the War of 1812, it is usually Georgetown lawyer Francis Scott Key's legendary vigil, waiting on a ship in Baltimore Harbor to see if American defenses would buckle in the face of an all-night cannonade. Yet, collective memory rarely lingers on the fact that only a few weeks prior to this triumph the nation's young capital city on the Potomac was invaded, occupied, and sacked, with the light from the blazing Capitol Building visible in the night 40 miles away in Baltimore.

In the first decade of the 19th century American ships tried, often unsuccessfully, to avoid trade restrictions imposed by the warring British and French empires. Numerous incidents occurred involving the British impressment of American sailors, stolen from ships on the high seas and placed into service in the Royal Navy. Open hostilities emerged in 1811 when events on the frontier signaled that the British were actively supporting Native American attempts to unite against US westward expansion. The conflict reached a peak in 1814. British command was eager to avenge the burning of York (Toronto), a stunning and unexpected American victory in 1813, after which the victorious soldiers looted the city and burned down the legislative and judicial buildings. Sailing into the Chesapeake Bay in the summer of 1814, the British set their sights on Baltimore, and on Washington. The order was given to destroy any towns along the coast that were vulnerable. Only the lives of unarmed Americans would be spared.

Secretary of War John Armstrong advised President James Madison not to worry, that the British were far more interested in Baltimore than Washington. Acting quite to the contrary, the British sailed up the Patuxent River, and on August 24 engaged American militiamen just north of the capital at the Battle of Bladensburg. The militiamen, under questionable leadership, were easily routed by the seasoned British, and withdrew chaotically. Washington, DC was now entirely exposed; and, at this point, the scene in the capital was one of incomparable pandemonium, as people fled to the countryside carrying whatever they could. According to legend, First Lady Dolley Madison, who had prepared an afternoon banquet for the President and the Cabinet, stayed behind until just shortly before the advancing British entered the town. It was then that she made a dramatic escape, taking with her the famous Gilbert Stuart portrait of George Washington. Meanwhile, British soldiers had reached Capitol Hill, and shortly set to the work for which they had come.[19]

The Capitol, begun in 1793 but still partially unfinished, consisted of two buildings, the House of Representatives on the south and the Senate to the north, each standing sixty-seven feet high and linked by a covered wooden walkway. The House chamber "was shaped like an oblong octagon and measured eighty-five feet by sixty feet. Ten feet inside the outer walls were another set of semicircular walls . . . topped by ten fluted Corinthian columns." The soldiers entered the building led by Admiral Sir George Cockburn, and proceeded inside "below vaulted brick ceilings, through arched entrances and up grand staircases into elegantly domed vestibules."[20] Finding it difficult to ignite the domed wooden roof of the House chamber with their rockets, they piled the mahogany desks, tables, and chairs in the center of the room and started an impromptu bonfire. Ornate sculptures in Virginia freestone baked and cracked, friezes of agriculture, science, art, and commerce split and toppled as the heat mounted; finally the roof collapsed. Meanwhile, Cockburn roamed through the building, and in one of the adjoining offices found President Madison's copy of the government's finances for the year 1810, which he kept as a trophy. The soldiers carried on into the north building, where they managed to burn the Senate and the Supreme Court chambers, along with the fledgling Library of Congress.[21] With the flames cascading up into the warm night, the soldiers left the Capitol grounds and proceeded to the President's deserted house. Here Cockburn and his men were delighted to find Mrs. Madison's banquet on the table, which they hungrily consumed, dispatching all of the wine, ale, and cider on hand as well. "Never," recalled one of Cockburn's Lieutenants, "was nectar more grateful to the palates of the gods than the crystal goblet of Madeira and water I quaffed off at Mr. Madison's expense."[22] Fire followed, and the Treasury Building next door was a next easy target for the flames; the few architectural symbols of US federal power soon lay in embers.

Benjamin Henry Latrobe received the news of the fall of Washington at his home in Pittsburgh. Latrobe, 50 years old, was the most famous engineer living and working in America at the time. The building destroyed in 1814 was primarily the work of Latrobe. Born in England, he received a classical education, and spent time in Germany, France, and Italy learning languages, and learning architecture. In 1784 he apprenticed at the office of distinguished engineer John Smeaton in London, and later took up a position in Samuel Pepys Cockerell's architecture office in 1787–1788. Latrobe set out for America in 1795 with the considerable skills gained from these years of training, and with his personal library of 1,500 volumes, subsequently lost in transit, to make a name for himself.[23]

It was a good time for a European-educated engineer to find work in America. In a nation of rapidly expanding boundaries and budgets, expertise in the management of water, of steam, of stone and iron was in high demand. Engineering education in the United States was unavailable until 1802 when West Point began informal military engineering courses, naturally suited to military needs.[24] As such, civilian immigrant engineers not only helped enable the first wave of infra-structural growth in the Early Republic, they also helped to establish the cultural role for the engineer as "master builder" in America. The ambitious Latrobe accepted the commission for the Virginia State Penitentiary in 1796, bringing him into contact with Thomas Jefferson for the first time. In 1799 he began the Philadelphia waterworks, a response to the city's frequent and deadly outbreaks of yellow fever. With his reputation, and the size of his commissions growing, his first interaction with the federal patron came in 1802 when Jefferson selected him to design the new Navy Yard Dry Dock in Washington, DC.

The nation's capital was not much of a city in 1802. French engineer Pierre Charles L'Enfant designed the city's unique street grid, sliced with diagonal avenues and interspersed with green spaces. But, conflict with the Commissioners of the Federal Buildings led to the temperamental L' Enfant's dismissal in 1792, before he could provide concrete plans for the Capitol building. A public competition to design the Capitol was announced, won along with $500 in prize money by physician and self-taught architect William Thornton's plan for a simple sandstone

structure with two wings and a low central dome. Jefferson was the first President inaugurated in the Capitol, still unfinished in 1801; and it was Jefferson who decided to bring in a new architect to finish the project. In 1803 Congress finally appropriated $50,000 for completion of the Capitol building. Jefferson, familiar and confident with Latrobe's work, and impressed with his mastery of the neoclassical style, appointed him to the position of Surveyor of Public Buildings. Jefferson was keen to have Latrobe start work immediately, and assuming correctly that he would take the job, implored him, "if you could make a flying trip here to set contractors to work in raising freestone, it would be extremely important . . . ."[25]

What Latrobe found in Washington was a mess of a building on political quicksand. Thornton's original plan, supposedly preserving the spirit of President Washington's intentions, was to serve as Latrobe's guide in completing the Capitol Building. But, by 1803, there was no surviving written plan, and the building that stood exhibited a jumble of ideas taken from Thornton, Jefferson, and others. The Senate Chamber in the north wing went into use in 1800, but the House of Representatives and Supreme Court were forced into temporary quarters. The poorly ventilated and hot House chamber quickly earned the nickname the "bake oven." Latrobe found that even the "completed" north wing needed major renovations, with its structural timbers already rotting and a leaky roof.[26]

The mistakes made before his arrival were unavoidable, according to Latrobe, who bristled against the introduction of popular democracy into the realm of expert construction. Using a public contest to design a great building, he argued:

> . . . brings into competition all the personal vanity of those who think they have knowledge and taste in an art which they have never had an opportunity to learn or practice . . . and it keeps out of the competition all who have too much self-respect to run the race of preference with such motley companions, and especially of all regularly educated professional men,—who understand their business too well not to know that a picture is not a design, and that to form and elaborate the design of a public work so that it shall be capable of being executed from the papers they present, requires so much expense of time, labor and clerkship, as no reward that is usually offered can compensate.[27]

Latrobe insisted that the Capitol building should be a durable structure, and one of great artistic distinction. No one argued with him over these precepts, in principal, but he was thwarted time and again over the next fifteen years as he tried to define them in practice. He imported Italian sculptors, for example, to carve the Corinthian columns, to provide dramatic stone friezes, and to render a stone bald eagle with a 12 ft wingspan. In construction he demanded experts up to his standards of accuracy, "not the villainous Quacks in whose hands the public works have hitherto been . . . ." His right-hand man, Robert Lenthall, brought with him from England experience in carpentry, mining, cotton machinery, and drafting.[28] The search for capable workmen, however, was a constant struggle. "Now and then," he wrote to his brother in 1804, "I pick up a ready made English artisan, the rest I manufacture out of American Carpenters, who, to do them justice are incomparable Jacks of all trades."[29]

His most important concept, that of durability, put him at odds with a Congress that wanted the building completed quickly and on budget. Instead, Latrobe insisted on fireproof masonry construction, having introduced the masonry vault to America as a means of securing the life of his buildings. The masonry vault—a method of creating a floor or roof span without using combustible wood—was an English innovation of the 18th century, and was the first type of construction to be accurately termed "fireproof."[30] Latrobe displayed the method in the Virginia Penitentiary and at the Bank of Pennsylvania, and now brought the difficult, costly, and time-consuming technique to Washington. Despite his close collaboration with Jefferson, the engineer now felt the sting of criticism, and regretted his promise of a completed structure on a short timetable. He issued a letter in 1806 explaining the slow progress of the work. In it, he cited the inordinate amount of effort necessary to remove the rotten timbers. And, he explained the trouble in securing good labor: "during the most promising term of the infancy

of these works, Washington might boast of artisans unrivalled [sic] in the United States. When however the original funds declined . . . all those who were thrown out of employ, and had not fixed themselves to the soil by permanent improvements of lots, left the city to seek employment elsewhere."[31]

In his view, Latrobe's reputation was suffering for mistakes made by his predecessors. Any imperfections in the work finished directly under his supervision, Latrobe asserted, must have their root in the failure of Congress to fund a structure of the highest integrity. The House dome, for example, Latrobe planned to build of brick, but was forced to abandon the vaulting and use wood in the interest of saving money. Accepting defeat, he reasoned that the "present roof however will last for many years, it is less expensive than a brick dome would have been, and took less time in its construction."[32] Overall, he predicted that the Capitol Building ". . . excepting those parts necessarily made of wood, will be as permanent as the hill on which the building is erected."[33] As a palliative for his directness, Latrobe concluded that his criticism of the shoddy buildings he inherited "cannot possibly be intended to offend."[34]

But many were offended by Latrobe's unflinching confidence in the vaulting method, and by his profligate spending. When the vaulting in the new Supreme Court chamber collapsed in 1808, crushing Lenthall to death, Latrobe came under attack in the press from an old rival, John Hoban, the original designer of the President's house. Latrobe "sports with the public money, and the feelings of its citizens," with his "blundering works," charged Hoban.[35] After a thorough investigation of the collapse, Latrobe defended himself to Jefferson, citing that Lenthall had not followed his instructions, had made alterations of the plans without Latrobe's supervision, and therein lay the cause of the collapse. Jefferson was placated, but Latrobe's reputation suffered. Still he carried on in his position and substantially finished both wings of the building before Congressional appropriations ceased in the summer of 1811. With war just over the horizon, Latrobe's tenure as engineer of the Capitol came to an unceremonious end.

After the invasion and burning of Washington, the old debate about moving the capital to New York or Philadelphia flared up again. Why was the capital city left undefended? Madison was attacked mercilessly by Federalists who had opposed the war in the first place. And, what of the public buildings, could they have been any more resilient? Latrobe, without even having seen the destruction, wrote to Pennsylvania Senator Abner Lacock:

> . . . as soon as I heard that the Capitol, that is the wood work was burnt, I took it for granted that the Hall of Representatives was irreparably ruined, and regretted more than ever that the solid brick dome for which that room was prepared and would have prevented the possibility of destruction . . . gave way to the wooden roof which covered it. It is too late now to indulge unavailing regrets . . . altho' I have been, on the subject of extravagance most unjustly condemned . . . my own feelings, are entirely absorbed in the public calamity, and what remains in me of talent, experience, and useful knowledge, may be at any time commanded by the administration.[36]

Feeling that he was the most experienced engineer available to investigate the failure, and to restore the building, Latrobe wrote to Madison and offered his services. Recognizing Latrobe's intimate knowledge of the Capitol, Madison agreed. Latrobe returned to Washington in April, 1815. His first tour of the "melancholy spectacle" at the Capitol proved bittersweet. He wrote that despite the disheartening wreckage, "many important parts are wholly uninjured . . . Some of the Committee rooms of the southwing are not even soiled . . .. They were the whole night about it, setting fire separately to every door and window, with the inflammatory composition of their rockets. In fact the mischief is much more easily to be repaired than would appear at first sight, and I was less chagrined than I had prepared myself to be."[37]

The Commissioners of the Public Buildings, a three-man team with nominal supervision over Latrobe, asked him to report on the state of the building, and to recommend plans to the

government for reconstruction. Though his technical assessment of the collapse was never formally called an "investigation," Latrobe's methods of inquiry would make sense to engineers today. He carefully examined each room, marking individually the successes and failures of each component—the windows, the walls, the ceilings—developing a narrative of the disaster, and noting accordingly the performance of the various materials under progressive stress.

> The ruin of the Hall of Representatives arises from the effect of fire on the freestone . . . a stone which cannot bear heat. Now as there was a double floor of light pine wood, both in the house and gallery, and a roof of pitch pine plank, forming almost a Solid Mass, it was impossible for ingenuity to have contrived a fire which could have been more certainly destructive to the stone than so tremendously fierce a conflagration as such a quantity of small timber loosely heaped together produced. A gradually increasing heat would have been less destructive.[38]

His reports and plans for reconstruction met with approval, but it was not long before Latrobe ran into the same troubles that he had years before: an impatient congress, difficulty in securing materials, and financial uncertainty. He continued to correspond with Jefferson, probably the only other person who read Latrobe's investigation reports with a complete knowledge of their relevance and accuracy. Jefferson, long out of office, was not closely associated with the reconstruction program. He did donate his personal library to bolster the charred collection of the Library of Congress. And, he helped derail a plan to hang a plaque in the Capitol commemorating the burning.[39] Jefferson's patronage, though, failed to bring Latrobe into favor with the Congress, or with Madison's successor, James Monroe. Weary of the constant struggle to finish his "durable" masterpiece, Latrobe resigned in 1817. In 1820, working in New Orleans on a waterworks project, Benjamin Henry Latrobe died of yellow fever.

Latrobe's expertise and unparalleled status as a professional engineer and architect in early 19th century America gave him a privileged level of authority, essential in undertaking grand works such as the US Capitol Building. His professional and cultural status as the master builder explains why Latrobe was selected to save the Capitol project in 1803, and also why he was invited back to Washington after the Capitol fire. It was indeed a rare moment in American history, when an engineer worked directly for the President and the Congress. Though Latrobe bemoaned what he saw as his bureaucratic handcuffs, the relationship he enjoyed with the federal government shared more in common with the age of the Medici than the modern highly bureaucratic world of government contracting. Latrobe used his authority as a license to demand a beautiful and impressive structure, but also to experiment with fireproof construction on a scale untried up to that point in the United States.

Latrobe's investigation tells us a great deal about how his contemporaries viewed the Capitol disaster. He had come under attack in 1808 for his controversial use of the vaulted masonry system. Yet certainly, the fact that the Capitol behaved in the fire exactly as he predicted it would as early as 1806 made him the unquestioned authority on the Capitol disaster. Latrobe might have used this authority, this "mastery of the failure," as a means of demanding that fireproofing be added to all government structures. However, people were less concerned with the actual physical collapse of the Capitol than with what its burning represented, and how it was ultimately enshrined in collective memory: an affront to decency, a transgression of gentlemanly behavior in war, and a devastating breach of national security. Perhaps, if the building had been complete, or full of legislators, then questions over the "durability" of the structure might have come under more rancorous debate. As it was, the master builder's technical explanation of *exactly* why the Capitol burned proved less interesting than his ability to simply rebuild it. Widespread fireproofing of government buildings would take years to catch on.[40] And, no investigation he could provide would change the fact that most Americans viewed the burning of the Capitol in 1814 as a diplomatic and military, not an engineering, disaster.

THE HAGUE STREET EXPLOSION, 1850

> Early on Saturday morning the Chief of Police and his . . . men were on the ground of the explosion and before 2 o'clock in the afternoon the excavation was concluded . . . . By a singular coincidence, the body of Samuel J. Crissey, the Engineer of the establishment, was the last one found . . .[41]

About eight o'clock in the morning on Monday, February 4, 1850, a powerful blast shook Manhattan's Lower East Side. The force of an exploding boiler in the basement of the six-story A.B. Taylor and Company printing press factory on Hague Street reduced the building to a "mass of ruins in less than one minute." It was, according to Horace Greeley's *New York Daily Tribune*, the "most terrible catastrophe that has occurred in this city for many years . . . a catastrophe involving a greater loss of life than ever before afflicted this City from a similar cause."[42] Many trapped workers were rescued at the scene; one boy was located by firemen who heard him calling to another boy, more perilously trapped, that firemen were there to save them. Another man was found "having been caught between two beams and covered with a pile of bricks. The beams had to be sawed, and the poor fellow kept waving his hand, which he had thrust through the aperture, in token that he still survived."[43] Firemen were often forced to stop looking for survivors in order to put out flames that flared up in the debris. One particular fireman, a young man named William M. Tweed of the Americus Volunteer Fire Company, was heralded in the papers as the first one on the spot, single-handedly saving five people from the rubble.[44] The disaster "took possession of the universal tongue."[45]

Rescue efforts carried on throughout the next day, with Mayor C. S. Woodhull, Police Chief George Matsell, Coroner Geer, and members of the City's Common Council at the site. The last person taken from the ruins alive, a boy named Samuel F. Tindale, died just a few hours after his rescue.[46] Meanwhile, families of the anonymous dead passed through the Fourth Ward Station House, many of the bodies so badly disfigured that they were identifiable only by their clothes. Mayor Woodhull deemed the tragedy "an event eminently requiring the notice and action of the municipal authorities," and the city's Common Council set to work at once raising a fund for the widows of the dead workers.[47] The numbers called for action: fifty were injured, and sixty-seven people died in the explosion and collapse.

Investigation of the incident, and determination of responsibility for the troubling number of lives lost, fell to the Coroner's Office, with assistance from the police. The press, though, also took an active role in the public discussion of the disaster, even discussing the technical aspects of the tragedy. Horace Greeley's *New York Daily Tribune*, while "not sufficiently informed to decide," speculated that the explosion was the result of the boiler's overheating, a fault of its attending engineer, rather "than from any defect in the boiler itself."[48] The Coroner, after signing out death warrants for the identified victims, took up the task of summoning seventeen jurors on Wednesday, and on Friday with a crowd gathered at the Fourth Ward Station House, began an inquest, "for the purpose of going into a thorough investigation in relation to the cause of the bursting of the boiler . . . ." He further "ordered the Police to secure as much of the boiler as can be found in order that it may be examined by the Jury, who are to judge respecting its strength and fitness for use."[49]

Sixty-four witnesses were called, and once the inquest was called to order, the Coroner led a procession of the jurors to the scene of the explosion, where they remained for an hour. Back at the Station House, accounts of the cause for the accident unfolded over the next few days as the jurors listened to a parade of machinists, boiler-makers, and "steam experts" of all types give testimony. The first witness, a boiler-maker with 25 years of experience, thought the boiler in question was safe to use up to 100 pounds per square inch of pressure. Having investigated the boiler, though, he thought the design was faulty. Next, the conductor of an iron works came forward, and thought the explosion was due to "undue" pressure and

bad design. He called the safety valve into question, as well as the thickness of the iron construction.[50] A chemist testified that the water level in the boiler must have been too low; another witness carefully explained the principles of steam and hydraulic power to the jury.

One man personally knew the engineer—Samuel J. Crissey—the man responsible for the daily functioning of the boiler at the Taylor Company factory. This witness talked to Crissey the day before the accident, and warned him against running the boiler at a high pressure because, "I had heard the boiler had been south, and was insufficient for the boat on which it had been used . . . ." This was tantalizing information, a prelude to the ultimate discovery of the boiler's checkered history. Head blacksmith at the Taylor Company, Joseph Brown, also knew Crissey, and recounted the events in the last fateful moments leading up to the blast:

> I think he (Crissey) understood when there was a proper head of steam and a full supply of water; [I] never knew him to be careless until the morning of the explosion; on that morning his neglect consisted in not attending to a proper supply of water in the boiler; I knew this by trying it myself probably four minutes before the accident occurred. I could not tell how much water was in the boiler, for the gauge did not show any . . . he stated that he knew his own business; I told him if that was the way he was going to carry steam I should soon be going . . . I stood then by my fire in the shop, thinking what I should do, having a boy upstairs of my own, and fearing that there was danger of the boiler bursting. I had but a minute or two to think before the boiler did burst; I then hallooed to the apprentice boy working with me, "jump Charles for the boiler is burst!"[51]

Brown noted that he found Crissey sober on the morning of the explosion, but that Crissey seemed "agitated" over an argument with another man in the shop, the fireman responsible for lighting the boiler.

The unexpectedly complex history of the Taylor Company boiler then emerged. James Montgomery came to the stand, a "practical engineer" who did not make the boiler, but invented its particular design. Montgomery had contracted the construction to the company of Walker and Milligan, but he was angry that it was not completed according to his directions. The parts were weak, according to Montgomery, the tubes were badly put in, and he demanded changes, but was refused. Montgomery worried that "if the tubes cracked from bad workmanship it would be ruinous to the reputation of my invention."[52] Montgomery stopped by their shop often, concerned that Walker and Milligan would sell the boiler over his objections. His fears proved realistic, as they did eventually sell it to the Georgia Steamboat Company in Savannah, telling Montgomery that the boiler was simply "in storage." The story then took another odd turn, when the boiler proved too weak to propel its intended steamer. So, the Georgia Steamboat Company then put the boiler up for sale again in New York City. It was sold by the firm of Pease and Murphy, and finally ended up in the Taylor shop. Montgomery, by this time, was ill, and had grown tired of chasing his fouled creation around. Another "practical engineer," lending some credence to the tale, claimed to having seen similar boilers put to use fail on steamships, and that they tended to come to bad ends. A steamboat inspector took the stand as well, arguing that excessive pressure caused the disaster.

A final issue surfaced when boiler-maker George Birkbeck, Jr. claimed to having examined the boiler on the Wednesday before the explosion and found cracks in it. He told Mr. Taylor then that it "was not safe to carry more than forty to fifty pounds to the square inch." Taylor evidently replied that this was not adequate for the power he required, and instructed Birkbeck to repair the cracks, which he did, apparently to little effect in ultimately saving the doomed boiler.

The keeper of the bar across the street from the factory testified that Crissey came in five or six times a day for a small glass of brandy. Crissey never appeared drunk, he said, but had come in twice on the morning of the explosion.[53] Towards the end of the inquest, Crissey's body was found in the yard behind the shop, caught apparently trying to step away from the

explosion at the last minute. At last, the jury adjourned to consider this confusing collection of personal and technical narratives. Late on the evening of February 12, the jury returned after deliberating for only about three hours. The verdict was "Censure" against nearly everyone involved in the life of the ill-fated boiler: against "A.B. Taylor & Co. for using more steam than they were informed the boiler would bear . . . Milligan & Walker . . . for allowing it to go out of their hands knowing it to be imperfect . . . Mr. Montgomery . . . for not publicly condemning it [and] Pease & Murphy for selling the boiler after being exposed for so long to the open air."[54]

This outcome would not have surprised those familiar with steam power, and its associated risks, in 1850. Steam power—to drive engines, locomotives, and ships—utterly transformed American economic and social life in the 19th century. With this promising technology, though, arrived a whole series of risks, catastrophic boiler explosions being the most dramatic, and the deadliest. Especially in the United States, where steam engineers tended to run their boilers at the highest pressures possible, the power of steam took on a double meaning, oscillating between benign provider and malicious killer. After a terrible explosion on the steamer *Aetna* in New York Harbor in 1824, Congress demanded an investigation. The exact causes of boiler explosions were as yet unknown to scientists, legislators, and engineers, whether you consulted "practical engineers" like Samuel Crissey or college-educated mechanical engineers. With some federal funding, the Franklin Institute in Philadelphia took up a formal study of the problem in 1830, the first time federal monies were expended in the name of scientific research. Congress enacted a law in 1838 creating a corps of boiler inspectors charged with ensuring the safety of steamships, but the level of expertise required for the job was never defined, and the explosions continued.[55]

In this context we return to Hague Street, where the safety of steam boilers in 1850 was left to the good judgment and moral responsibility of individual boiler-makers, salesmen, factory owners, and engineers. The investigation of this disaster highlights the fact that average people possessed a fair understanding of the technical issues at hand. The *New York Daily Tribune*, for example, reported the fine technical points up for debate throughout the course of the inquest. And, without resort to outside expert opinion, the *Tribune* editorial desk decided that the fault lay in "*pumping water into red hot boilers . . .*" and decried that it "ought to be manslaughter by statute to put fire under a steam-boiler when less than half full of water. Such a law would hit the mischief in the eye; nothing short of it ever will."[56] Strong sentiments like these were held by each of the witnesses called to testify, though they were divided as to what comprised the real "mischief." Was it the design of the boiler, or its checkered past? Did it reside in the boiler's construction, or its questionable handling by the chief engineer? The possibility that the building should have withstood the concussion remained unexplored. The idea that New York's steam boilers might be extinguished until the technical puzzle was solved was never even suggested.

The Hague Street inquest featured many experts, none with the authority to effect real change. The result was a blanket of blame that covered everyone, without mentioning the unfortunate engineer Crissey by name. City officials, perhaps recognizing that such an investigation was unsatisfactory as a memorial to the dead, chose to remember Hague Street in their much-publicized and quite successful fund-raising campaign for the victims' families. The federal government passed a revised boiler inspection law in 1852, upgrading the responsibility and expertise of inspectors, who now answered to the President. Since Latrobe's day, the level of technical expertise in the nation had broadened, cutting a surprisingly democratic swath across the press, the scientific institute, the university, and the shop floor. Other voices, the voices of the professional engineering community, insurance companies, and federal agencies, were as yet unheard. It would take another half century or so for the modern pattern of disaster investigation to take shape.

THE IROQUOIS THEATER FIRE IN CHICAGO, 1903

> The second act was begun. The scenery was gorgeous, the music delightful, the costumes magnificent. A double octet of male and female voices commenced to sing "In the Moonlight." I was looking at the moon showing just above the clouds in the scenery, when . . . at the left of the stage, about two-thirds up from the floor, I noticed a little puff of flame. It seemed to go out, but sparks kept falling to the floor. I was somewhat startled, but kept my seat. It flashed again a little further up, and I became aware that the scenery was on fire. People grew uneasy. I feared a panic, so I stood up, and said to those about us: "Don't be alarmed. This will be out in a moment."[57]

Comedian Eddie Foy walked to the edge of the Iroquois Theater's stage and announced to the almost 2,000 people sitting out in the darkness that they should remain in their seats. At Foy's command, the orchestra continued to play. The audience that day—mostly women and children—having braved the brutal cold of a late December Chicago were enjoying a special Christmas season matinee of the musical "Mr. Bluebeard, Jr." Open only since November, the Iroquois was both beautiful and "fireproof" according to its owners. The "American public now," they intoned, "more than ever before, demand elegance of environment for their amusements, as well as provisions for comfort and security . . . ."[58]

The crowd watched tensely as smoke slowly darkened the stage behind Foy and the elaborate stage scenery began to catch fire, oil paints exploding with color before passing on to the next flammable prop. Foy continued to speak, but was inaudible to all but those sitting closest to the stage. Joseph Peaks, a railroad commissioner in town from Maine was sitting in the audience with his young son. Peaks had heard that the new big city theaters all had fire curtains, asbestos reinforced shields that would drop in case of a stage fire, keeping smoke and heat from filling the auditorium. Peaks waited in his seat next to his son, waiting for the curtain to drop and the tension to lift. The Iroquois Theater's house fireman, formerly a member of the Chicago Fire Department, was trying desperately to extinguish the blaze. Unsuccessful in hoisting a pike to rip down the smoldering side-stage curtains, he moved on to his last resort. With a metal Kilfyre fire extinguisher canister in his arms, the fireman again confronted the flames. Aiming the canister, a cloud of white powder sprayed weakly from the nozzle. Peaks became agitated, the fireman's actions seemed desperate, futile. The vent above the stage, designed to allow smoke and heat to escape before spilling out into the auditorium remained closed. The fire curtain hung immobile, then started down, but was inexplicably caught up on one side.

"The confusion was indescribable," said Peaks later. "The screams of the women, the cries of the children, and the stampede of the whole audience created a bedlam of the entire place . . . . Suddenly we thought someone had opened wide a door in the rear, the wind blew the flames out from the stage into the theater so that our faces were burned and our clothes scorched."[59] Hundreds of people started rushing down from the balconies along either side of the main auditorium, and those with floor seats had crammed the aisles heading to the rear exits. The theater's design conspired with the rapidly thickening smoke and intensifying heat to change the Iroquois into a prison. The landings at the bases of the balcony sections were too small, and some lost their footing as those descending from behind trampled over them in their rush to escape. Several of the rear exits were inexplicably blocked, or even locked. Exit signs were not lit, and many were obstructed. Some of the doors opened inwards. People grasping for the doors were crushed as the crowd surged forward, the immense pressure from behind preventing their pulling the doors open.

A typical narrative of the panic was related by Mabel Strawbridge who was in the middle of the sixth row in the second balcony with her mother and two other women. When the fire started they "were calmed by Eddie Foy's assurances." Then when her mother said they had better go, the group climbed up the aisle, got caught in a jam, but pushed through to the balcony entrance. Going down the stairway they passed the entrance to the first balcony,

where the heat was so intense that a girl's hair caught on fire. They stumbled down the stairs, and Mabel was pulled over a heap of bodies by one of her party, then realizing she had lost her mother.[60]

Within thirty minutes it was all over. The Fire Department helped the frantic patrons open some of the exit doors, ushering them into the frozen streets outside. Joseph Peaks and his son miraculously escaped the building by walking along the backs of the chairs. Many others were not so lucky, found later immolated in their seats, having never imagined that an innocent "puff of flame" could grow so quickly, unleashing a fireball right into their faces.

Staggering and disheveled survivors searched the living, and the dead, for familiar faces, for a parent, or a child. Relatives arrived, and the slow process of extricating, and identifying the dead began. By the next day, the numbers were in, and they were far worse than originally thought possible. The *Chicago Daily Tribune* issued a not-so-subtle reminder that the city had not been prepared, in the most fundamental way, for such an abrupt and devastating tragedy. "In all quarters of the city," the paper reported, "the undertakers say there are not hearses enough to bear the dead to the cemeteries . . . Hearses may even be brought in from suburban and outlying cities, but the undertakers advise that, where necessary, services be postponed a day or so."[61] The dead numbered 571, and another 30 would die from injuries.

Mayor Carter Harrison acted quickly to reassure the public that action would be taken, that an investigation was underway. Building inspectors moved out into the city, ordinance books in hand. Individual theaters responded to the move quickly, trying to convince audiences that they were free from danger. The Grand Opera House, for example, closed voluntarily for an examination by city officials, arguing that "their playhouse is practically without defect, yet the public mind is so wrought up that nothing will reassure theater patrons except a complete official inquiry."[62]

The city aldermen made an investigation of the Iroquois, accompanied by architect Benjamin H. Marshall. They toured the charred building, still littered with scraps of clothing from the victims. Unwilling to admit that the Iroquois was less than a marvel of modern construction, Marshall explored the theater. "I cannot understand it at all," said the architect, looking around the rubble. "The theater was fireproof."[63] Mayor Carter Harrison made his own investigation with the Building Commissioner, and a few private architects. The Mayor toured the building, picking up scraps of the failed asbestos curtain, and pointing out code violations as he went along. Back in his office, he said: "I think exactly as I thought yesterday of the theater. I could not see any explanation for the calamity except the fatality connected with the lowering of the curtain. I tried a lot of the doors and they seemed to open and shut readily. I got into the rigging loft and everywhere else except into the cellar." The Mayor then decided to call in outside experts for advice, inviting The Builders Club, The Mason and Builders Association, The Architects' Business Association, The Traders and Builders' Exchange, and The Illinois Chapter, American Institute of Architects to each make reports on the fire.[64]

With a law on the books requiring sprinklers above and under the stage, it turned out on quick inspection that none of the city's theaters were so equipped. The city building commissioner also presented to the Mayor a list of theaters without asbestos curtains. On New Year's Day, by "5 o'clock orders for the closing of eighteen theaters . . . were being taken to the managers of the playhouses by . . . policemen."[65] This represented half of the theaters in the city, and a seating capacity of 20,000. Such a dramatic and profit-destroying action was required, according to the Mayor, as he refused "to take additional responsibility for further calamities."[66] A group of theater managers went to the Mayor's home and asked him to repeal his order. "I told them that it should not be necessary for me to tell them what they ought to do."[67]

The *Chicago Daily Tribune* sponsored a "Theater Commission," with members including engineers, architects, and building contractors. On January 2, the *Tribune* published a list of

the city theater ordinances that had been violated by the Iroquois, as well as a list from November, of all of the faults found in Chicago theaters by the Buildings Commissioner. The *Tribune* claimed that had "the building laws of Chicago been strictly complied with in the Iroquois Theater the loss of life should have been comparatively small, if there had been any loss at all." The list of infractions was startling, and included provisions:

> That a theater must have direct fire alarm connection with fire headquarters; That all lights must be protected so adjacent material cannot touch them; That suitable fire extinguishing apparatus be on the stage; That all exits shall be suitably marked with large signs; That all galleries shall have independent entrances and exits; That the number of auditors in a theater shall be limited by the size and number of its exits; That no auditorium seating over 1,000 persons shall be connected with any building not entirely fireproof; That automatic sprinklers shall be used over all stages; That a suitable flue be in the roofs of all stages to carry out smoke and fire; That the apparatus and fittings of all stages and rigging lofts be fireproof; That all theaters must face on three open spaces.[68]

Such an astounding list of violations called into question the integrity of the entire building code system in Chicago, and launched an argument as to who, ultimately, was responsible for enforcing the codes. The same day, Mayor Harrison summarily closed all of the city's theaters. But it was too late, the damage to public confidence in Chicago's theaters was done. Allegations or lawsuits, or both, were soon leveled at the Mayor, city building inspectors, Will J. Davis, owner of the Iroquois, and house manager Harry J. Powers.

The most thorough investigation of the Iroquois Theater Fire was conducted by one of the nation's foremost authorities on fireproof construction and fire safety engineering, John Ripley Freeman. Freeman, a graduate of MIT, spent most of his career as an inspector and executive for the Associated Factory Mutual Fire Insurance Companies in New England. He was an expert in fireproof construction, having inspected factories for decades. An early advocate of sprinkler systems, Freeman also innovated in hydraulics, fireproof construction, and the assessment of structural risks. Prominent Chicagoan Charles Crane wrote to Freeman asking him to come and investigate the Iroquois Theater Fire. Wealthy, and active in reform politics, two of Crane's nieces had perished in the fire.[69] Crane's demands were simple: Freeman was offered a budget for research into the causes of the fire. On completion of his investigation, Freeman was to publish his work at Crane's expense. Freeman arrived by rail via the 20th Century Limited near the end of the first week of January and set immediately to work. What Crane probably did not know was that a large international community of engineers, insurance inspectors, and manufacturers of fireproofing materials would also be very keen to hear what John Ripley Freeman would say about the Iroquois.

Freeman spoke freely and at great length of his concerns over fire safety in America, and met the Mayor, who granted him an unrestricted pass that might allow him to enter and move unmolested through any part of any theater in the city. "The City Club of Chicago," reported the *Chicago Record-Herald*, "has secured the services of John R. Freeman . . . to make an exhaustive examination of the existing conditions of the Chicago theaters and to report on the proper requirements for fire protection, and also the proper methods of enforcing these requirements. Mr. Freeman is probably the best qualified man in the United States for this purpose, and will, of course, be entirely unaffected by local influence or personal considerations."[70] Though his entire career had been devoted to avoiding fires, ostensibly for the profit of insurance companies, Freeman's status as a professional engineer lifted him above the arguments between city officials and their detractors.[71]

Freeman designed an easily reproducible inspection form, and set out with a small staff to evaluate the city's theaters. Wanting to assure the public that their theaters were safe from such carnage as had visited the Iroquois, many theater owners welcomed Freeman in. Others were reluctant, however, and sought to evade him however possible. One of Freeman's assistants, towards the end of the investigation, resorted to sneaking into one theater that had consistently barred him entry, despite the "access" granted by the Mayor.

Freeman widened the investigation by writing letters to theater owners and building inspectors across the nation and in Europe. Gathering facts about other cities in terms of safety codes was not a new practice among insurance engineers—in fact, such cross-listings and tabulated lists of "risks" nationwide were instrumental in helping the insurance industry rationalize its premiums and standards of coverage by the turn of the century. Next, he isolated the key technological parts that had failed during the Iroquois Fire. First, the stage scenery had been troublesome—why had it caught fire so readily? Also, the fire extinguisher had performed poorly when put to the test. The fire vent had never opened, and the asbestos curtain had never come down completely. Lastly, Freeman keyed on the exits, the paucity of fire escapes, and the poor design of the inward-opening doors, portals that had refused exit to the frenzied patrons. Freeman wrote letters to the top manufacturers of each of the above products, stating plainly his fears that there had been flaws in design, installation, and use of each at the Iroquois. Asking each to submit samples for examination, Freeman threw down the gauntlet to an entire industry—fire protection supplies—that had emerged within only the previous twenty or so years. Only since fire insurance companies and cities had pushed through building and safety codes on public structures, and public venues such as theaters and churches, had there been a need for products like asbestos curtains and large quantities of fire extinguishers. The industry had not yet had time to winnow out makers of shoddy products, and Freeman's investigation was aimed as squarely at exposing such firms, as it was at the theater owners in Chicago, and the graft-taking local building inspectors.

Freeman's technical mission in Chicago was, most certainly, the most complex element of his investigation. This is not due to the difficulty of understanding the technological systems involved. On the contrary, the hydraulic and structural engineering details that Freeman examined in Chicago's theaters were well within his grasp as an engineer. The complexity emerged in the sheer volume of information that he planned to amass. Here he received help from an unexpected direction: Underwriters' Laboratories.

The nation's stock insurance companies (competitors of Freeman's Mutuals), organized as the National Board of Fire Underwriters (NBFU), decided in the early 1890s to take a first step into the world of laboratory science, by hiring engineer William H. Merrill to investigate any small fires that might occur during the run of the World's Columbian Exposition in Chicago. Pleased with his work and fresh ideas about risk mitigation it gave Merrill a small lab space, a small staff and an even smaller budget. After the fair had closed and the crowds had gone home, NBFU executives built Merrill a larger lab, and set him to work investigating the relationships between electrical machinery and fire risks. This institution was christened the Underwriters' Laboratories (UL) and took up residence as the first major fire safety research lab in the United States.

By the time Freeman arrived in Chicago, UL had just started to gain local attention among politicians and building inspectors as a place where some interesting research was being conducted. Though they represented rival arms of the insurance industry and though the UL feared that Freeman might push fire safety research in directions in which it could not compete, the UL pledged to help, and aided by providing research and materials testing space to augment Freeman's investigation.[72]

Freeman took the specimens he received from manufacturers, as well as those that could be salvaged from the Iroquois wreckage, and sent them out to UL for testing and analysis. He also sent specimens to MIT's materials labs, and even back to his own labs at the Mutual office in Providence. Not waiting for the results, however, he began to agitate for the most ambitious aspect of his investigation program: re-enactment. Freeman proposed to build a fire on the Iroquois stage, to recreate as closely as possible the conditions of the "real" disaster. The press and many engineers were enthusiastic, sensing an opportunity not only for spectacle, but also to expand their horizons of the epistemology of fire disasters.[73] The plan

was blocked, however. In a letter outlining his company's objections, one insurance executive wrote, "as an official of this Company, responsible to the stockholders who put me here to make money for them, I could not justify myself in saying to you that you could start a fire on the stage of the Iroquois Theater and the Continental would pay its share of any resulting loss, either to the theater or adjoining buildings."[74] There were limits to the zeal for safety, and for investigation.

The Iroquois Theater Fire marked a new era in the history of disaster investigations in the United States. Notions of public responsibility for private safety were highly evolved by this time, hence the fact that a coroner's inquest indicted Mayor Harrison and a full slate of city officials for complicity in the deaths of the Iroquois victims. They were eventually cleared of wrongdoing, a situation much like that at Hague Street, where so many players appeared guilty that none could be singled out for punishment. Still, an outraged public and an investigating press had demanded public investigation, and public action to insure safety in the expanding metropolis. Iroquois also points the way towards a new network of investigators—engineers, insurance companies, testing labs, and inter-industry organizations—symbolized by the work of John Ripley Freeman. The Freeman Investigation spurred innovation in building designs, fireproof materials, and building codes around the country. But each would evolve incrementally, moving at the pace of research, experiment, marketing, and legislation. Freeman's final report, *On the Safeguarding of Life in Theaters*, was printed and re-printed by a great number of newspapers and celebrated in many of the technical journals. Yet, when he re-visited the site of the Iroquois blaze a few years later, Freeman complained that not enough technical progress had been made, not enough consensus over the dangers of the flammable city achieved, and that another disaster might easily occur in the same building. Local government, the press, and the public had long since moved on, sanctifying Iroquois as a painful memory, but still attending the theater. That building codes were still violated in Chicago and across the country after Iroquois is perhaps less interesting than the fact that the study of disasters had emerged as both a practical art and a laboratory-based science. The Iroquois Theater Fire remains on the books as the most deadly of all structural fires in the United States in the 20th century. With the exception of federal oversight, Iroquois set the tone for investigations of modern disasters from the Baltimore Conflagration (1904) to the World Trade Center collapse.

CONCLUSION: THE WORLD TRADE CENTER INVESTIGATION

By May of 2002, the long-awaited answers about the World Trade Center were forthcoming in the form of the FEMA/ASCE co-authored *World Trade Center Building Performance Study.* They were not reassuring, or especially enlightening answers. Some things were known. The fireproofing material surrounding the beams failed, apparently as a result of the airplanes' fuselage tearing through the buildings and sweeping everything away in their path, including the beam insulation. Emergency exits, elevators, and communications systems were overtaxed, and failed to perform as designed. On a more positive note, the *Study* took pains to point out the remarkable fact that each building had withstood the jarring impact of a collision with a commercial jetliner.[75] This success, though, only sharpened the point on the real question: if we could build such strong structures in the first place, why could we not put out a fire in those buildings? Indeed, the most critical point explained by the *Study* involved the startling fact that it was the tremendous heat—a conflagration that reached 2000 degrees Fahrenheit, fed by thousands of gallons of burning jet fuel—that apparently caused the structural steel beams to buckle and give way. Amazingly, the buildings might have stood, albeit in shambles, had the fire emergency systems performed effectively. This leads to the

unsettling conclusion that other skyscrapers, worldwide, may suffer the same fate as the Trade Towers, whether or not they absorb the impact of jet airliners, whether or not they are the targets of terrorist action. Considering the compressed period of time, the institutional squabbling, and the intense public scrutiny of the investigation, one might realistically conclude that the FEMA/ASCE report was a good first effort.

Still, many troubling questions remained. The generally accepted methods of fireproof materials' testing, such as those conducted at Underwriters Laboratories, for example, came under scrutiny for being perhaps outdated and "out of touch with a computer age understanding of the devastation caused by the fury of a real fire."[76] The scale of the report as well seemed out of date, too limited by fascination with the relatively good safety record of modern skyscrapers to accept the reality of tall buildings as targets of international terrorism. *New York Times* reporters James Glanz and Eric Lipton, having continually covered the ASCE/FEMA investigation over the preceding months, lamented the anemic tone of the report. Apparently, despite the technical acumen of the nation's investigators, a lack of funding and authority had rendered the investigators unbelievably "unable to provide a comprehensive analysis of how well the buildings and their structural elements performed, and as a result, they cannot say if the buildings had specific weaknesses."[77]

Congress sensed that the report would prove unsatisfactory to those seeking a timely response to the collapse, especially the friends and families of those killed on September 11, a population that had grown increasingly vocal. As Monica Gabrielle, Co-Chairperson of the Skyscraper Safety Campaign put it frankly: "The time has come for us to say 'NO MORE'. No more needless deaths, no more excuses, No more sorrow. The time has come for change to a system that has failed us on so many levels. To our elected officials: IT IS YOUR JOB TO MAKE SURE THAT THIS COUNTRY AND ITS CITIZENS ARE SAFE" [her capitalization].[78] Congress had in fact already called for a more extensive investigation, in order to provide a "comprehensive analysis." This time, the study will be conducted at the NIST labs. Furthermore, Congress plans to give NIST complete and unequivocal authority to investigate any future catastrophic building collapses in the United States under the authority of the National Construction Safety Team Act. Satisfied that the investigation is now in good hands, Congressman Boehlert recently announced that the National Construction Safety Team Act is, "in many ways, a memorial to those who lost their lives on September 11 and a tribute to their families who have joined together to advocate for this measure in the Campaign for Skyscraper Safety."[79]

Will a federally funded investigation of technological failure serve as a suitable "memorial" to the 3,047 dead of September 11?[80] Certainly the move to NIST places a great premium on the power of "investigation" as not only a technical, but also a moral tool, a sacred act, assigning a higher meaning to the tests and calculations that must ultimately assign causes and fix blame—but this is nothing new in American history. While the investigator's tools may have sharpened since Latrobe's study of the Capitol, the Hague Street inquest, or the Iroquois Fire, disaster investigation still pits expert against expert, the demand for patient study against the will to rebuild and forget. With a budget of $16 million, the World Trade Center investigation is expected to last for at least two years, and probably much longer.[81] As it turns out, engineers working for insurance concerns were permitted on-site long before the ASCE/FEMA teams were permitted to begin their investigation. Currently, their results provide the reportedly most "sophisticated and complete" accounts of the disaster available, but they are tied up in court. Perhaps, though, such analyses of the collapse derived from private investigators will someday soon augment the NIST study.[82] Meanwhile, plans for the reconstruction of the 16-acre World Trade Center site gather speed. Having faced strong public resistance to early proposals that lacked creativity and seemed overly beholden to commercial interests, the Lower Manhattan Development Corporation—the institutional body charged with the task of "rethinking" a new

Lower Manhattan—stands ready to shepherd plans from the drawing table to Ground Zero. Almost certainly tourists will file through a September 11 Museum before the full technical narrative of the collapse is written. That the federal government now bears this research and moral burden opens a new perspective on an America transformed by September 11.

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NOTES

1. In addition to dispatching an Urban Search and Rescue Team to New York City and establishing a disaster field office on-site, FEMA began assembling a Building Performance Assessment Team (BPAT) immediately after the World Trade Center collapse. Such teams usually respond to building collapses after natural disasters, but a BPAT was important in the investigation of the 1995 bombing of the Murrah Federal Office Building in Oklahoma City in 1995. Team members are generally drawn from state and local government agencies, along with engineering and design consultants familiar with the structure under review. On September 11, the ASCE formed a Disaster Response Team to conduct its own investigation of the collapse. The ASCE team members were formally named as the World Trade Center BPAT in late September, and received $600,000 from FEMA in addition to $500,000 from the ASCE to conduct an investigation. The 23-member team was headed by Dr W. Gene Corley, who also headed the 1995 Murrah Building inquiry, and included a member representing the National Institute of Standards and Technology (NIST). The National Science Foundation also allocated $300,000 for research into the collapse. For a complete explanation of this institutional structure, see: United States. Congress. House of Representatives. Committee on Science. *Learning from 9/11: Understanding the Collapse of the World Trade Center*, March 6, 2002 (Washington: GPO, 2002); also available on-line at www.house.gov/science/
2. Kenneth Chang, "Scarred Steel Holds Clues, and Remedies," *New York Times*, October 2, 2001, F1.
3. James Glanz and Kenneth Chang, "A Nation Challenged: The Site; Engineers Seek to Test Steel Before it is Melted for Reuse," *New York Times*, September 29, 2001, B9; James Glanz and Eric Lipton, "A Search for Clues in Towers' Collapse; Engineers Volunteer to Examine Steel Debris Taken to Scrapyards," *New York Times*, February 2, 2002, B1.
4. Chang, "Scarred Steel Holds Clues and Remedies," F1.
5. James Glanz and Eric Lipton, "A Nation Challenged: The Towers; Experts Urging Broader Inquiry In Towers' Fall," *New York Times*, December 25, 2001, A1; Eric Lipton, "Ground Zero: Building Standards; Mismanagement Muddled Collapse Inquiry, House Panel Says," *New York Times*, March 7, 2002, B7.
6. Glanz and Lipton, "A Nation Challenged: The Towers; Experts Urging Broader Inquiry in Towers' Fall," A1. The FEMA/ASCE team was first allowed to enter the Ground Zero site on October 6, 2001.
7. Glanz and Lipton, "A Nation Challenged: The Towers; Experts Urging Broader Inquiry in Towers' Fall," A1.
8. For the history of the National Bureau of Standards and the National Institute of Standards and Technology, see: Rexmond Cochrane, *Measures for Progress; A History of the National Bureau of Standards* (Washington, DC: National Bureau of Standards, 1966); and Elio Passaglia, *A Unique Institution: The National Bureau of Standards, 1950–1969* (Gaithersburg, MD: National Institute of Standards and Technology, 1999).
9. United States. Congress. House of Representatives. Committee on Science. *Learning from 9/11: Understanding the Collapse of the World Trade Center*, 25–27.
10. Ibid., 127.
11. Ibid., 128–129.
12. Lipton, "Ground Zero: Building Standards; Mismanagement Muddled Collapse Inquiry, House Panel Says," B7.
13. On April 24, 2002, the *New York Times* reported: "Officials estimate that as of yesterday, 3,047 people had died, or were missing and presumed dead, as a result of the attacks on Sept. 11, not including 19 hijackers. AT THE WORLD TRADE CENTER: 2,823 dead or missing, with 147 dead on two hijacked planes; 128 missing; 974 death certificates issued by medical examiner's office; 1,721 death certificates issued at request of families in cases in which remains have not been identified; AT THE PENTAGON: 184 dead or missing, with 59 dead on hijacked plane; IN PENNSYLVANIA: 40 dead on hijacked plane." "A Nation Challenged; Dead and Missing," *New York Times*, April 24, 2002, A13.
14. Public discussion over the future of the World Trade Center's 16-acre site was the centerpiece of a one-day "open forum" hosted by the Lower Manhattan Development Corporation (LMDC) in June. Responsible for planning the site's reconstruction, LMDC found that none of its six initial redevelopment plans captured the public imagination. One recent poll suggests that half of New Yorkers want to see World Trade 1 and 2 re-built,

and that such a construction project would function as the best possible monument to the dead. This viewpoint and this percentage was corroborated by an informal poll of about 200 engineering students at Drexel University in Philadelphia, Spring 2002. "Half of New York Wants the Twin Towers Rebuilt," *New York Post*, July 14, 2002, 4.

15. Carl Smith, *Urban Disorder and the Shape of Belief: The Great Chicago Fire, The Haymarket Bomb, and the Model Town of Pullman* (Chicago: University of Chicago Press, 1995), p. 55.
16. Smith, p. 39.
17. Mike Davis, *Ecology of Fear: Los Angeles and the Imagination of Disaster* (New York: Metropolitan Books, 1998); Christine Meisner Rosen, *The Limits of Power: Great Fires and the Process of City Growth in America* (Cambridge: Cambridge University Press, 1986); See also: Ted Steinberg, *Acts of God: The Unnatural History of Natural Disaster in America* (Oxford: Oxford University Press, 2000); Steven Biel, ed., *American Disasters* (New York: New York University Press, 2001); and Karen Sawislak, *Smoldering City: Chicagoans and the Great Fire, 1871–1874* (Chicago: University of Chicago Press, 1995).
18. Benjamin Henry Latrobe, "Letter to Abner Lacock, 24 September 1814," John C. Van Horne and Lee W. Forwalt, eds., *The Correspondence and Miscellaneous Papers of Benjamin Henry Latrobe, Volume 3, 1811–1820* (BHL) (New Haven, CT: Yale University Press), p. 575–576.
19. Anthony S. Pitch, *The Burning of Washington: The British Invasion of 1814* (Annapolis: Naval Institute Press, 1998), pp. 71–98.
20. Pitch, pp. 104–105.
21. Pitch, pp. 108–111.
22. Pitch, p. 117.
23. Edward C. Carter II, *Benjamin Henry Latrobe and Public Works: Professionalism, Private Interest, and Public Policy in the Age of Jefferson* (Washington, DC: Public Works Historical Society, 1976), pp. 4–7. For discussion of Latrobe's role in the importation of British engineering practice, see: Edward C. Carter II, "The Engineer as Agent of Technological Transfer: The American Career of Benjamin Henry Latrobe," in Barbara E. Benson, ed., *Benjamin Henry Latrobe and Moncure Robinson: The Engineer as Agent of Technological Transfer* (Eleutherian Mills, DE: Hagley Foundation, 1975), pp. 11–32.
24. Terry S. Reynolds, "The Engineer in 19th-Century America," in Terry S. Reynolds, ed., *The Engineer in America: A Historical Anthology from Technology and Culture* (Chicago: University of Chicago Press, 1991), p. 11.
25. "From Thomas Jefferson (Public), March 6, 1803," John C. Van Horne and Lee W. Forwalt, eds., *The Correspondence and Miscellaneous Papers of Benjamin Henry Latrobe, Volume 1, 1784–1804* (BHL) (New Haven, CT: Yale University Press, 1985), p. 260.
26. "The Surveyorship of the Public Buildings, Editorial Note," John C. Van Horne and Lee W. Forwalt, eds., *The Correspondence and Miscellaneous Papers of Benjamin Henry Latrobe, Volume 2, 1805–1810* (BHL) (New Haven, CT: Yale University Press, 1987), pp. 257–259.
27. BHL, vol. 2, pp. 305–306.
28. "To Samuel Harrison Smith, Editor of the National Intelligencer, September 20, 1808," BHL vol. 2, pp. 663–664.
29. Carter, p. 7.
30. Sara E. Wermiel, *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City* (Baltimore: Johns Hopkins University Press, 2000), p. 12; Talbot Hamlin, *Benjamin Henry Latrobe* (New York: Oxford University Press, 1955), pp. 560–563.
31. BHL, vol. 2, pp. 298–299.
32. "A Private Letter to the Individual members of Congress, On the Subject of the Public Buildings of the United States at Washington, 28 November 1806," BHL, vol. 2, p. 310.
33. Ibid., p. 312.
34. BHL, vol. 2, p. 303.
35. BHL, vol. 2, p. 668.
36. "Letter to Abner Lacock, 24 September 1814," BHL, vol. 3, pp. 575–576.
37. "Letter to Mary Elizabeth Latrobe, 17 April 1815," BHL, vol. 3, pp. 643–644.
38. "Letter to Abner Lacock," 24 September 1814, BHL, vol. 3, pp. 575–576; for discussion of Latrobe's technical reports see also: Paul F. Norton, *Latrobe, Jefferson and the National Capitol*, dissertation: Princeton, 1952, reprinted (New York: Garland Publishing, Inc., 1977), pp. 232–238.
39. Andrew Tully, *When They Burned the White House* (New York: Simon and Schuster, 1961), p. 215.
40. Wermiel, p. 22.
41. "The Explosion, Sixth and Last Day's Work," *The Evening Post*, February 11, 1850, 2.
42. "Awful Catastrophe! Explosion and Dreadful Loss of Life!!," *New York Daily Tribune*, February 5, 1850, 2.
43. Ibid., 2.
44. *New York Daily Tribune*, February 7, 1850, 2. This refers, of course, to the infamous "Boss Tweed," who began his notorious political career as a volunteer fireman on the Lower East Side. Tweed was elected to the New York City Board of Aldermen in 1851.
45. *New York Daily Tribune*, February 5, 1850, 2.
46. "The Explosion," *New York Daily Tribune*, February 6, 1850, 2.
47. *Report of the Special Committee Appointed by the Common Council of the City of New York, Relative to the Catastrophe in Hague Street, on Monday, February 4th, 1850* (New York: McSpedon and Baker, Printers, 1850), p. 3.

48. *New York Daily Tribune*, February 5, 1850, 2.
49. "The Explosion," *New York Daily Tribune*, February 6, 1850, 2.
50. "Steam Explosions," *New York Daily Tribune*, February 9, 1850, 2.
51. "The Hague Street Catastrophe," *New York Daily Tribune*, February 11, 1.
52. Ibid., 1.
53. "Hague Street Catastrophe," *The Evening Post*, February 12, 1850, 2.
54. "Verdict of the Coroner's Jury in the Hague St. Affair," *New York Daily Tribune*, February 13, 1850, 1.
55. For a full discussion of steamboat explosions, and the work of the Franklin Institute in setting safety standards for boilers, see: Bruce Sinclair, *Philadelphia's Philosopher Mechanics: A History of the Franklin Institute, 1824–1865* (Baltimore: Johns Hopkins University Press, 1974), pp. 170–194; and Burke, "Bursting Boilers and the Federal Power," *Technology and Culture* (Winter 1966) 7 (1): 1–23.
56. *New York Daily Tribune*, February 9, 1850, 2.
57. Joseph Peaks, "Tells of Horrors of Iroquois Fire," *Boston Herald*, January 11, 1904, 1.
58. "Iroquois Theater Souvenir Programme, Dedicatory Performance, 23 November 1903." Irquois Theater Collection, Chicago Historical Society.
59. *Boston Herald*, January 11, 1904, 1.
60. "Search All Day For Their Dead," *Chicago Daily Tribune*, January 2, 1904, 4.
61. "Burial for Dead Next Sad Duty," *Chicago Daily Tribune*, January 1, 1904, 1–8.
62. "Many Theaters Violating Law Shut by Mayor," *Chicago Daily Tribune*, January 2, 1904, 1.
63. "Find Much for Censure: Aldermen Scathing in Their Criticism of Theater," *Chicago Daily Tribune*, January 2, 1904, 2.
64. Ibid., 2.
65. *Chicago Daily Tribune*, January 2, 1904, 1.
66. Ibid., 1.
67. *Chicago Daily Tribune*, January 2, 1904, 1.
68. "Laws Violated at the Iroquois," *Chicago Daily Tribune*, January 2, 1904, 4.
69. "John Ripley Freeman to Jno. B. Schoeffel, February 5, 1904," John Ripley Freeman Papers, box 32, folder 2, MIT Archives; David Hapgood, *Charles R. Crane: The Man Who Bet on People* (Philadelphia: Xlibris, 2000), 9–11, pp. 25–26.
70. *Chicago Record-Herald*, January 8, 1904, p. 1.
71. Freeman did have detractors, including William Clendenin, outspoken editor of *Fireproof* magazine, who questioned his "objectivity." Clendenin was an opponent of the Associated Factory Mutuals' philosophy on sprinkler protection and "slow-burning" construction. His criticism, though, represented a minority voice.
72. MIT JRF Papers, 32: CTFire, correspondence, Jan.–Feb., 1904. Letter, John Ripley Freeman to E.A. Fisher, City Engineer, Rochester, NY, January 29, 1904.
73. *Chicago Chronicle*, January 10, 1904, p. 1.
74. "Henry Evans to John Ripley Freeman, February 5, 1904," John Ripley Freeman Papers, box 32, folder 1, MIT Archives.
75. Gene Corley *et al*.,*World Trade Center Building Performance Study: Data Collection, Preliminary Observations and Recommendations*, Ed. Therese McAllister (Washington, DC: Federal Emergency Management Agency, Federal Insurance and Mitigation Administration, 2002), pp. 3–4.
76. Eric Lipton and James Glanz, "A Nation Challenged: The Trade Towers; Towers' Collapse Raises New Doubts About Fire Tests," *New York Times*, April 8, 2002, A1.
77. James Glanz, "Report on Towers' Collapse Ends Mostly in Questions," *New York Times*, May 1, 2002, B2.
78. "Washington, DC—Rally for a Federal Investigation into Events of 9/11 by Monica Gabrielle, Co-Chairperson/ Skyscraper Safety Campaign, 06/11/02" www.skyscrapersafety.org
79. United States. Congress. House Committee on Science, *Floor Statement on H.R. 4687, Congressman Sherwood Boehlert*, July 12, 2002.
80. *New York Times*, April 24, 2002, A13.
81. James Glanz, "Wider Inquiry into Towers is Proposed," *New York Times*, May 2, 2002, B1.
82. James Glanz and Eric Lipton, "Vast Details on Towers' Collapse May be Sealed in Court Filings," *New York Times*, September 30, 2002, A1.