A Virtue Ethics Analysis of Engineering Practice and the Hyatt Regency Walkway Collapse

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By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

The collapse of two elevated walkways in the atrium of the Hyatt Regency Hotel in Kansas City, Missouri went down in history as one of the US's deadliest structural failures. The load on the walkways proved to be too much during a dance in July of 1981 and the suspended walkways collapsed, killing 114 and injuring over 200 (ASCE, 2007). In the years since the incident, scholars have scrupulously analyzed the technical causes of the structural failure and attributed blame for the walkway collapse to physical deficiencies in the walkway design and materials. Others have noted the impact of perceived legal liability of the structural engineers involved in the construction of the hotel as the cause of their negligence throughout the design process. However, these viewpoints overlook the morality of the two structural engineers, Jack Gillum and Daniel Duncan, or in this case the lack thereof. If we continue to ignore the moral obligations of these structural engineers in the course of their work on the Hyatt Regency hotel, then we will forfeit a greater understanding of the vital role of morality in engineers, and particularly civil engineers.

I will examine the case of the Hyatt Regency walkway collapse from the perspective of virtue ethics to assess the immorality of the project's structural engineers. I will employ three distinct virtues of responsible engineering practice to illustrate the structural engineers' immorality throughout the duration of the project, which are as follows: the habit of clear documentation, a commitment to quality, and the ability to see the big picture while also appreciating the details. To support my analysis, I will draw from scholarly studies and accounts of the Kansas City Hyatt Regency walkway collapse.

Background

The construction of the Hyatt Regency Hotel in Kansas City, Missouri was completed in July of 1980. The hotel's modern style was centered around its open atrium-style lobby with three walkways suspended from the fifteen-meter high ceiling. The third floor walkway was offset from the second and fourth floor walkways and had its own suspension system from the roof framing. The second floor walkway, on the other hand, hung below the fourth floor walkway and the two were connected via steel rods (Baura, 2006).

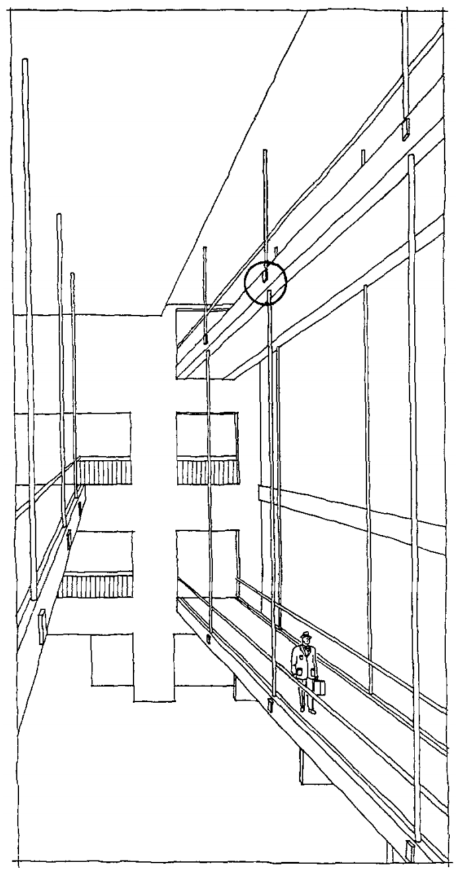

Figure 1. Schematic of walkways as viewed from the North wall of atrium

The original design for the connection of the second and fourth floor walkways involved six individual, continuous rods threaded through the fourth floor walkway's box beams, thereby supporting the second floor walkway. However, these continuous rods were found to be impractical and unbuildable, so the design of the connections was changed. The fourth and second floor walkways' final design comprised two separate rods instead of single continuous ones. The fourth floor walkway was suspended from the roof truss system via six rods terminating under the walkway through a box beam and held by a nut and washer. The second floor walkway hung below the fourth floor by six additional rods, each bolted adjacent to the upper rods in the fourth floor box beam and similarly terminating below the walkway's surface through the box beams (Rubin & Banick, 1987).

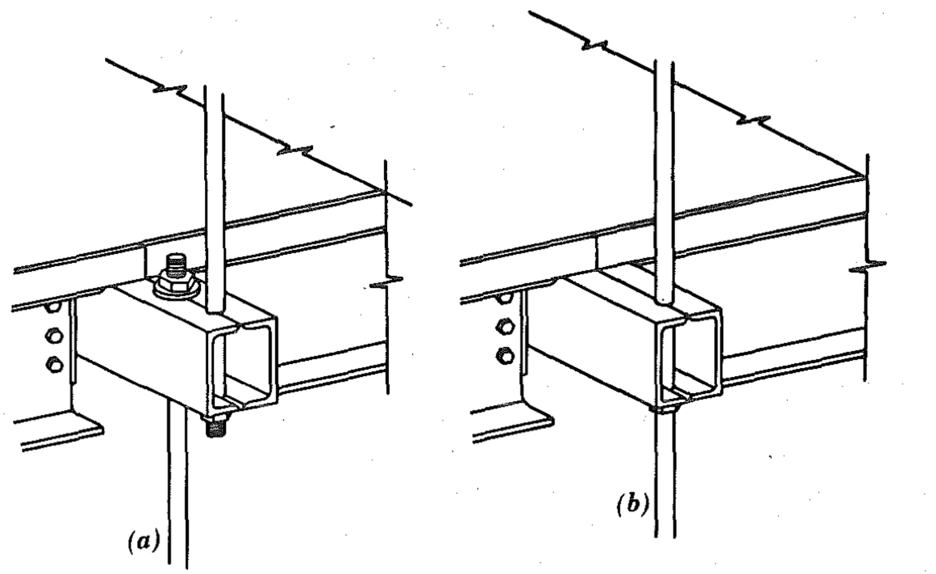

Figure 2. Fourth floor walkway box beam connection detail: (a) as-built; (b) original design

Jack Gillum was the president of the GCE International, the structural engineering firm hired for the project. He was the Engineer of Record, a licensed professional engineer whose seal appeared on the project's structural drawings. Daniel Duncan was GCE International's project engineer assigned to the Hyatt Regency project, and was responsible for preparing the structural drawings (Baura, 2006).

Literature Review

There exists a plethora of scholarly sources on the subject of the Hyatt Regency walkway collapse due to its significant loss of life and the abject failure of the walkways' structural integrity. These analyses detail the structural failure of the walkway connections, but lack the application of any moral judgment to those responsible for the structural design. Others identify the perceived legal liability of the structural engineers of the project as responsible for the engineers' actions, but the law is simply the moral minimum and these sources neglect to consider the degree of the engineers' morality.

In their article entitled "Engineering process failure: Hyatt Regency Collapse" in the *Journal of Performance of Constructed Facilities*, Piotr Moncarz and Robert Taylor offer evidence of a structural engineering failure of the walkway connections. They explain how the design change from one rod per connection to the two-rod system effectively doubled the load on the connections. They also provide the results of a finite-element analysis (FEA) performed on the box beams at the connections, finding that the two rod connections were "already at failure with only the dead load." The FEA also revealed significant plastic deformation at the connections, which the authors note would have been difficult to identify in the structures. The inability to observe the deformations, they claim, was a contributing factor to the deadly collapse. Their final conclusion attests that the cause of the collapse can be traced to the inadequacies in the design process of the walkway connections as well as the doubling of the load on the connections caused by the implementation of the two-rod system (Moncarz & Taylor). This paper makes no mention of the moral disposition of Gillum and Duncan and simply attributes the collapse to structural failure.

C. Richard Walter takes a different viewpoint about the walkway failure in his article about liability and quality control in engineering. He acknowledges that the actions of Gillum and Duncan are the underlying cause of the walkway failure, but claims that their actions were a result of Scope of Service provisions in their contracts. The reason Gillum and Duncan did not adequately check the viability of the two-rod connections, he maintains, was that they reviewed the shop drawings of the connections for "design concept" only. This idea of reviewing for "design concept" is a disclaimer associated with the stamp of approval given by the Engineer of Record (EOR) to the shop drawings for a project. The EOR for the Hyatt Regency case was Gillum, who placed his stamp of approval on the shop drawings with the consent of Duncan, the associate structural engineer in charge of the project. Walter concludes that this disclaimer lulls EORs into a false sense of security about their liability to the public or the owner, causing them to forego essential quality control (Walter, 1987). While this perspective recognizes the impact of Gillum and Duncan's actions on the failure of the walkways, it still neglects to consider the structural engineers' morality.

Conceptual Framework

The ethical framework of virtue ethics will be employed as a method of examining the morality of Gillum and Duncan, the structural engineers of the Hyatt Regency Hotel. As a rule, virtue ethics places emphasis on the nature of the person in question, with nature being the way humans as humans are meant to live. This creates Aristotle's idea of "the good life," or *eudaimonia* in Ancient Greek, which prescribes using the unique human ability to reason as the benchmark for the state of being a good person. This "good life" can be achieved through the exercise of reason as well as virtues, which are qualities of excellence that define morally good individuals. These virtues are the middleground between a dearth and an excess; for example, the virtue of courage forms a state of equilibrium between cowardice and recklessness.

These virtues, according to Aristotle, are not innate; rather they are learned and can be practiced like any other skill or art. They must be performed when called for, meaning that one must recognize the opportunity to practice a virtue and manifest it accordingly. This propensity for virtuous judgment is what Aristotle identifies as the intellectual virtue of "practical wisdom,"or the ability to discern the right action that will lead to a virtuous life (van de Poel & Royakkers, 2011).

While virtues such as the cardinal virtues of prudence, temperance, justice, and fortitude are requisites for moral humans in general, this paper focuses on the morality of engineers in particular. As such, this necessitates the inclusion of engineering-specific virtues. Michael Pritchard, a professor emeritus of philosophy, developed a list of virtues which, when in the context of engineering, can indicate morally responsible engineers. These eleven virtues are listed in Figure 3 below.

1. Competence
2. Ability to communicate clearly and informatively
3. Cooperativeness (being a good "team player")
4. Willingness to compromise
5. Perseverance
6. Habit of documenting work thoroughly and clearly
7. Commitment to objectivity
8. Openness to correction (admitting mistakes, acknowledging oversight)
9. Commitment to quality
10. Being imaginative
11. Seeing the "big picture" as well as the details of smaller domains

Figure 3. Pritchard's Virtues for Morally Responsible Engineers

It is important to note that possessing one or many of these virtues does not necessarily indicate morality in an engineer. The absence of one or more of the virtues, however, indicates a clear departure from responsible engineering practice (Pritchard, 2001).

I will examine the actions and intentions of the structural engineers Gillum and Duncan in the context of the following virtues: the habit of clear documentation, a commitment to quality, and the ability to see the big picture and appreciate the details. With virtue ethics as a guide and under the overarching idea of practical wisdom, I will determine whether Gillum and Duncan may be considered morally responsible for the collapse of the Hyatt Regency walkways.

Analysis

Despite being successful structural engineers, neither Gillum nor Duncan can be said to model three important virtues of responsible engineers, namely the habit of clear documentation, a commitment to quality, and the ability to see the big picture while also appreciating the details. In the following paragraphs, I will illustrate how the engineers' actions and intentions are in direct opposition to responsible engineering practice. As Pritchard warns, the presence of these virtues does not guarantee morality, but the absence of even just one virtue is grounds for questioning an engineer's morality.

Thorough, Clear Documentation

The structural engineers of the Hyatt Regency, and Duncan in particular, cannot be said to exhibit the engineering virtue of thorough, clear documentation of work. In the context of the construction industry, there is no room for ambiguity or carelessness with regard to records such as architectural drawings, structural drawings, and shop drawings. Of particular importance to this case are the structural drawings and the shop drawings produced for the ultimate two-rod connection design for the second and fourth floor walkways.

To allow for a fuller understanding of the lack of clarity in the documentation of Duncan's work, I will provide necessary background about the process and terminology surrounding the technical drawings. Structural drawings are produced by structural engineers and contain information about load-bearing elements of a structure, including specifications for connections. Shop drawings are produced by fabricators from the information provided in the structural drawings, and they indicate how certain structural elements should be fabricated and installed. The connections specified in structural drawings can be classified as simple, complex, or special depending on the type of loads they bear. Simple connections have prescribed instructions for their design in the American Institute of Steel Construction (AISC) manual due to their basic loading, while complex connections bear atypical loads and require detailed loading and stress information for proper design. Special connections are simple connections that support concentrated loads in combination with lack of redundancy, and like complex loads require adequate information on loading to be designed accurately. The structural drawings depict connections as either complete or incomplete. Incomplete connections indicate that the structural engineer intends for the fabricator to design the connection because he or she has included information detailing loads and stresses on the connection in the structural drawings. Conversely, complete connections indicate for the fabricator to develop the connection using general AISC guidelines due to the omission of specific load information (Banset & Parsons, 1989).

When the design for the walkway connections was changed, Duncan prepared the final version of the structural drawing for the connections, incorporating the two-rod design. This drawing, however, contained ambiguities by omission and resulted in confusion on the part of the fabricator. Duncan failed to include adequate information about the loads on the connection, yet intended for the fabricator to design the connection. The unclear documentation that Duncan produced led the fabricator to assume the design was complete, and thus he chose a standard grade of steel, a standard nut and washer combination, and a "minimum assembly weld" for the construction of the walkway connections (Roddis, 1993). This combination of standard materials and basic welding did not even meet the design requirements for Kansas City building code. No one is able to read an engineer's mind, so thorough and clear documentation is crucial for engineers to be able to convey their intentions. Here, Duncan's lack of virtue meant the construction of elevated walkways that did not attain basic qualifications for safety, endangering those standing on the structure as well as in the surrounding area.

Given Duncan's authority as the structural engineer in charge of the hotel project, his unclear documentation puts him in the position to bear the brunt of blame for the lack of virtuous engineering. However, it is reasonable to assume some may argue that the fabricator should have been responsible for realizing the connection was atypical. Following this logic, the fabricator should have notified the structural engineer of the nonstandard connection or taken it upon himself to design the connection to code. The fabricator did indeed alert Duncan to the potential for reduced connection strength with the two-rod system (Rubin & Banick, 1987). However, this viewpoint makes excuses for Duncan's ambiguous structural drawings and neglects their impact on the project, and it also emphasizes Duncan's lack of commitment to quality, discussed further in the following section. I acknowledge that the fabricator may have some culpability in association with the negligence of the entire project team, but I also maintain that the construction of the inadequate walkway connections is a direct result of the lack of clear documentation. Therefore, I continue to assert my claim that Duncan failed to behave virtuously in his preparation of the project's structural drawings.

Commitment to Quality

Quality is important in any engineering situation, but a dedication to quality is what sets virtuous engineers apart. In the context of structural engineering, quality is akin to structural integrity. In the case of the Kansas City Hyatt Regency walkways, quality and structural integrity translate to the safety of hotel patrons. Neither Gillum nor Duncan exhibited any dedication to quality in their work on the walkway connections.

Load and stress calculations are critical to proper structural engineering and steel design. They consider both dead and live loads to determine if a structure is capable of supporting its own weight and the weight of people in accordance with building codes. However, after producing the structural drawings for the two-rod connections, Duncan did not perform any calculations to check the connections' structural integrity. Had he been dedicated to the safety of the structure he was designing, he would have found that the new rod system could not even support the dead load (Baura, 2006). If this discovery had been made, the walkway connections would undoubtedly have been reworked to improve their structural integrity, and potentially prevented the collapse of the walkways. Duncan's decision to forego precautionary calculations presents a lack of moral judgement and a disregard for the safety of the hotel patrons.

A commitment to quality in civil engineering also manifests itself in the incorporation of multiple independent safety barriers, and specifically redundant design (van de Poel & Royakkers, 2011). Redundancy in structural design enhances the safety of a structure because it allows for loads to be transferred and redistributed along the structure if a member, or in this case a connection, fails. In creating the final structural drawing for the two-rod connections of the walkways, Duncan chose to omit any form of redundant measure, such as stiffeners or bearing plates. If implemented, these two forms of redundancy would have provided protection against deformation and added additional load distribution. However, Duncan submitted the structural drawings to the fabricator for completion without the incorporation of stiffeners or bearing plates, which resulted in the failure of the two-rod connections to meet the requirements of Kansas City building codes (Banset & Parsons, 1989). This lack of redundant design demonstrates an insouciant attitude towards safety on Duncan's part. Correspondingly, as Duncan's superior, Gillum was responsible for Duncan's actions and therefore vicariously lacks a commitment to safety.

Big Picture and Attention to Detail

For construction projects of any size, the ability to put the project into perspective is just as important as being mindful of the minutiae. This virtue is absent in Gillum and Duncan throughout the course of the project, beginning with a structural failure incident that happened before the construction of the hotel was even completed. In 1979, while the building was still under construction, a section of the atrium roof 2,700 square feet in area collapsed. This collapse warranted an investigation into the atrium structure, which was conducted by Gillum as well as an independent structural engineering firm. The other firm's contract required only a check of the roof structure to identify the cause of the collapse, creating no obligation to inspect any other structures within the atrium as a whole (Roddis, 1993). If Gillum were a practitioner of the virtue of considering the big picture, this was the ideal opportunity in which to perform it. However, despite putting in writing to the architect and the owner his intention to review the design of the entire atrium structure and its elements, no such check was performed. Gillum chose to view the roof collapse as an isolated incident and did not consider the structure in its entirety as worthy of concern.

Additionally, Gillum lacks virtue on a micro level with his ignorance of the details of the two-rod connections. As mentioned above, Gillum was the Engineer of Record for the Hyatt Regency project, meaning he was responsible for reviewing and approving the details of the design documents. Instead of committing to a thorough attention to detail, Gillum chose to place his stamp of approval on the plans without personally checking them (Pfatteicher, 2000). Not only does this violate the stipulations of Gillum's Professional Engineer license, but it is also a display of egregious indifference towards the details of the Hyatt Regency project. Had Gillum acted virtuously and conducted a thorough review of the project's design documents, he very well may have identified the inadequacies of the walkway connections, leading to a redesign and decrease in the risk of collapse.

Conclusion

The two structural engineers on the Kansas City Hyatt Regency Hotel project are the antithesis of responsible engineering practice. Their actions and thus their dispositions reveal the lack of virtues that compose a moral engineer, namely the habit of clear documentation, a commitment to quality, and the ability to see the big picture while also appreciating the details. Through the lens of virtue ethics, the two structural engineers can be declared morally responsible for the ultimate collapse of the second and fourth floor walkways in the atrium of the hotel and the lives lost as a result.

This case demonstrates the vital importance of ethical engineering practice. Though the Kansas City Hyatt Regency walkway collapse is a very high profile case, it can still offer insight into the value of virtuous engineering at any level. Regardless of the scale of the engineering project or the professional level of the engineer, a capacity for moral judgment and the personification of engineering virtues promote the safety and wellbeing of end users and allow for the engineer's achievement of "the good life."

Word Count: 3222

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