Fire Protection Engineering Education in Germany

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Abstract:
The goal of the IQP was to show that the implementation of performance-based fire protection practices accompanying a transition from a "meet the code" approach to fire protection towards a system which establishes explicit performance goals requires a specific fire protection engineering education and a change in fire safety culture. Interviews with experts on fire protection in Germany conducted during the author's year abroad at the Technical University Darmstadt supplied the bulk information necessary to write this paper.
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1 Introduction:

During the 2004-2005 academic year the author took part in an exchange program at the Technical University of Darmstadt (better known as TUD) in Darmstadt, Germany, where, in addition to taking courses at TUD in his major field, he also began work on this IQP. The goal of the IQP was to show that the implementation of performance-based fire protection practices and a transition from a “meet the code” approach to fire protection towards a system which establishes explicit performance goals requires a specific fire protection engineering education and nothing short of a completely new way of thinking about fire protection. This was achieved mainly using interviews.

Although fire protection engineering has arguably been in existence for more than 100 years, few universities worldwide offer fire protection engineering degrees today. There are a few in the United States, including Worcester Polytechnic Institute (WPI). The University of Wuppertal in northwestern Germany offers the closest thing to a fire protection engineering degree in Germany - a degree in safety engineering which covers all types of engineering and industrial accidents. There are a handful of other German universities that offer something similar to a fire protection engineering degree, but none of them offers a genuine “fire protection engineering degree” like the one offered at WPI. “Das ist ein trauriges Kapitel in Deutschland.” “That is a sad chapter in Germany,” said Professor Ries, Chief of Operations of the Frankfurt Fire Department and a professor at the Fachhochschule Darmstadt, during his interview with the author. Professor Ries has been struggling for several years to bring about the creation of a separate fire protection engineering degree equal to a degree in civil, mechanical, electrical, or chemical engineering. But despite his hard work and the hard work of others, there still is no fire protection engineering degree anywhere in Germany. As an architect and a senior fire service officer, Ries straddles the gulf between fire protection engineering and fire fighting, which has given him a unique perspective on the industry, performance-based fire codes, and the necessity of creating a fire protection engineering degree at one or more of Germany’s major technical universities.

Tragic fires such as the World Trade Center Fire in New York City and the Düsseldorf Airport Fire in Düsseldorf, Germany serve as painful reminders of what may occur tomorrow if we continue to ignore the lessons of yesterday. Tragic fires in history have been behind technological advancements in the field, providing the impetus for research and development into better education and industry standards. As history shows, building and fire codes tend to be made safer after tragic fires. That’s the value of tragedies such as 9/11 and the Düsseldorf Airport Fire to engineers; they help to improve engineering practices. Whereas changes to building and fire codes might have sufficed in the past, a tragedy like 9/11, however, demands a more far-reaching solution, though it is arguable fire protection engineering could have prevented 9/11. But the necessity of adopting performance-based fire protection practices to improve building fire safety can no longer be ignored.

To be sure, nothing was wrong engineering-wise with the Twin Towers of the World Trade Center. September 11th represented an act of extreme terrorism. If nothing else,
9/11 has taught the world that while some men and women use their God-given talents for good, there are others just as willing to use theirs for destructive ends.

But the drive to replace the outmoded prescriptive fire codes with performance-based fire codes predated 9/11. Some countries have already adopted performance-based practices. Notable examples are Sweden and Australia. 9/11 only provides the most poignant example of the wisdom of going performance-based. Performance-based fire codes go beyond a “meet the code” approach to fire protection by establishing explicit performance goals for building fire design. Prescriptive codes, which delineate specifications for buildings based on type, occupancy, and size, do not offer the possibility of comparing alternatives. A switch to performance-based fire codes inevitably means that a new breed of fire protection professional would have to be created, different from the breed of fire protection professional under the prescriptive code system.

To summarize, the IQP was about the value of performance-based fire codes and how implementing performance-based practices in building fire safety design would necessitate changes in fire protection education in Germany, more specifically, the creation of a separate fire protection engineering degree at one of more of its major technical universities. The industry is currently transitioning from a prescriptive “meet the code” approach towards a more performance-oriented system that establishes explicit performance goals for fire safety design (Proceedings of the Second Conference on Fire Safety Design in the 21st Century). This transition cannot take place without a specific fire protection engineering education. Experts in different facets of the industry were asked to offer their opinions on whether Germany needed a specific fire protection education and what this specific fire protection engineering education would have to look like. The interviews with those experts supplied the bulk of the data used to write the paper.
2 Background:
The purpose of the Background section of the IQP is to define the scope of the research and makes clear the author's position on the subject. It also provides the reader with the necessary background to understand the author's argument in the Results and Conclusion sections.

2.1 Building and Fire Codes

2.1.1 The Beginning of Fire Codes
"Building Codes" is the generic term given to legislation regulating construction industry practices. Building codes were first conceived as a way to standardize construction and to distinguish between legal and illegal - safe and unsafe - building practices. This concept has an ancient precedent in the Code of Hammurabi, the legal code of ancient Babylon. Under the Code of Hammurabi, an engineer who designed a house that collapsed and killed the owner, would himself be put to death (Ching 2). The Code of Hammurabi allowed little room for error. Babylonian engineers had to be thorough; a careless mistake often meant the difference between life and death.

Professor Fitzgerald's book, Building Fire Performance Analysis, provides a good picture of the environment in which modern building codes developed, as well as describes the fundamental differences between prescriptive codes and performance codes. Modern building codes and standards dealing with fire emerged around the turn of the twentieth century shortly after the second industrial revolution. Fire was recognized as a potent threat to the businesses, commercial interests, and the inhabitants of growing cities. In a single period in late-March of 1916, for example, three American cities in Georgia, Tennessee, and Texas were destroyed by major conflagrations that reduced to ash 2,700 buildings in all. Needless to say, the devastating social and economic impact was felt throughout the region. The fires and their impacts sent shockwaves throughout the country, and it soon became clear that something had to be done to protect other communities from meeting the same fate. (Fitzgerald 1).

The insurance industry stimulated the idea of taking on the problem of fire through the building code system. According to Professor Fitzgerald, the building codes that existed at the time were ineffective at dealing with fire, leading many to the conclusion that what was needed was nothing short of a major overhaul of the existing codes. It took almost a decade and a couple more devastating fires which occurred around World War I to rouse the construction industry to action. It wasn't until 1927 and the publication of the first edition of the Uniform Building Code (UBC) of the International Conference of Building Officials that the elements of the modern codes were put into place. The subsequent code framework established by the UBC has become the foundation for all subsequent codes. (Fitzgerald 2).

2.1.2 Prescriptive vs. Performance
In modern building codes, the provisions for the design and construction of structural, mechanical, and electrical systems and their components all tend to be performance-
oriented. That is, instead of a prescriptive “meet the code” approach where codes and standards delineate specifications based on type, size, and occupancy, a performance-oriented system establishes explicit performance objectives for design. Provisions for fire safety have historically been prescriptive-based, principally because of the fact that fire safety design is arguably more complex than the other building design disciplines and also because the rudimentary technology available to code-writers nearly a century ago made the development of a performance-based fire code impractical. Fire was considered an “abnormal” rather than a “normal” design function, and “fire protection” designers didn’t even exist when the first codes dealing with fire were written. (Fitzgerald 2). “Existing practices in the building industry combined with historical precedents in the wording of building codes provided a way to structure and enforce fire safety requirements. This environment and a recognized urgency to solve the fire problem became driving forces toward the expediency of developing prescriptive rather than performance codes for fire.” (Fitzgerald 2).

According to Professor Fitzgerald, the prescriptive code system put into commission more than eight decades ago has been a major factor in improving fire safety and preserving economic values in the United States. Efforts by enforcement officials in code administration were a major factor in its success, since their diligent policing of the code and the threat of penalties provided a good incentive to abide by the code. The same time period was also witness to tremendous advances in fire equipment and knowledge, code improvements, better code administration, the establishment of a professional fire service, and increased insurance protection, helping greatly to assuage the general public’s fear of fire. (Fitzgerald 2).

The prescriptive code system, however, is not without its shortcomings. In the words of Professor Fitzgerald: “Prescriptive fire regulations developed by consensus committees may be described as a compilation of good practices that have a weak technical basis,” giving them the peculiarity of being “easy to administer” but “difficult to control.” (Fitzgerald 2). Code changes only apply to new construction, and rarely are existing buildings required to be updated to meet new code requirements. As a result, cities contain buildings conforming to widely varying sets of requirements (Fitzgerald 2). Overwhelmed by modern regulatory requirements, designers often find themselves between a rock and a hard place in trying to negotiate a middle ground between regulatory conformance and building functionality. Questions involving the justification of certain requirements for a site-specific building condition are seldom easy to answer, because cost and effectiveness are viewed differently by code officials and designers. In the absence of an analytical framework for evaluating building fire performance, disagreements over code compliance are rarely resolved by rational, analytical procedures. (Fitzgerald 2).

Prescriptive codes, their strengths and deficiencies notwithstanding, provide whatever fire safety is available to the citizen. When the idea of the fire code was first conceived, the technology to implement a performance-based code had not yet existed (there are doubts whether it even exists today), and the prescriptive fire code offered engineers the possibility of getting around the problem of designing for fire, an idea which puts even
today's engineers ill at ease, by still addressing the question of fire safety. But, despite all the criticism that has come its way, the observed reduction in the frequency and scale of fires over time is only evidence to the success of the prescriptive fire code. (Fitzgerald 2).

In contrast to a prescriptive approach to fire protection, a performance-based approach establishes explicit performance objectives for design. That means designers use engineering tools to prepare performance evaluations, providing them with a consistent, rational basis for comparing alternative design proposals. (Fitzgerald 4). Under a performance-based system, designers can determine the effect on performance of sprinklers, early detection and alarm, smoke management systems, etc., and evaluate the risk to life safety, property damage, and operational continuity (Fitzgerald 4). Design determines the best course of action to take given whatever constraints (Fitzgerald 4).

In fairly recent times, there has been a veritable explosion in knowledge about fire, its complex behavioral patterns, and fire defenses that make a performance-based code a possibility in this lifetime. The SFPE Handbook of Fire Protection Engineering, the NFPA Fire Protection Handbook, published standards of practice, computer programs capable of simulating fires and predicting the complex behavior of fires, as well as a myriad of books on the subject provides a solid foundation for implementing a performance-based fire code and conducting performance evaluations. Fire performance is dynamic. As Professor Fitzgerald explains in his book, one can be sure of only thing, that everything will go wrong at least once. But at least this new wealth of knowledge gives designers the option of preparing for that inevitability. (Fitzgerald 5).

Under a prescriptive code system fire safety remains a loosely defined concept and an almost intangible idealism. Prescriptive fire codes assume the responsibility for fire safety. If the design meets code, so to speak, then insofar as the code officials are concerned, the building is said to be a “fire safe building.” If a fire occurs to challenge that assumption, then the code is revised and a new threshold of fire safety is established. But a prescriptive fire code does not offer a quantifiable measure of fire safety. The level of safety provided by the fire code is a moot question.

Prescriptive codes are an anachronism in the modern world. Most of the industrialized world is showing signs of making a transition from a prescriptive “meet the code” approach to fire safety to a more performance-oriented system which establishes explicit performance goals for fire safety design. For a performance-based fire code to be successful, what is required is nothing short of a comprehensive effort to change the way fire professionals think about fire. The way of thinking necessary for performance evaluations is altogether different from the way of thinking that has dominated the industry throughout the life of the prescriptive code system. That ultimately means research and development of better engineering tools and specific fire protection engineering education.
2.2 One Meridian Plaza and the Düsseldorf Airport Fire and the Process behind Prescriptive Codes

Prescriptive codes are at a clear disadvantage when it comes to making decisions about building performance under fire conditions. Prescriptive codes are intended to prevent outcomes of past fires from reoccurring, but that is the extent of their protection. The body of knowledge amassed in the minimum requirements of prescriptive codes nevertheless provides good strategies for designing fairly fire-safe buildings, but a major criticism is that they don’t offer the possibility of comparing different alternatives. To an observer with an engineering background, they look more like rules of thumb; there’s no engineering in prescriptive codes to speak of. The prescriptive codes offer more-or-less a single solution to all buildings of the same size and occupancy. The following examples illustrate well both prescriptive codes’ positive and negative attributes.

One of the most significant fires in United States history occurred on February 23, 1991 on the 22nd floor of One Meridian Plaza, an 18-year old 38-story office building in Philadelphia, Pennsylvania. The fire is believed to have begun at approximately 8 a.m. and raged on for more than 18 hours. At the end of the day, three firefighters had lost their lives and 24 others were injured. Before 9/11, it had been the single, largest high-rise office building fire in modern United States history. Eight different floors were entirely consumed by the fire, which spread vertically from the fire floor to the floors above it. This act is known as autoexposure. After the windows failed on the 22nd floor (the floor of fire origin), the flames began making their way up the side of the building. Witnesses recalled watching in horror as the fire fighters were unable to contain the spread of the fire, which continued to make its way up the building from the windows of one floor to the next as the fire department fought the flames from both the inside and outside of the building. (http://www.iklimnet.com/hotelfires/meridienplaza.html).

Exterior vertical fire spread or autoexposure poses a major fire protection challenge in the construction of modern-high rise buildings. Many modern (international style) and post-modern high-rise building designs, which tend to incorporate smooth exterior facades and large glazing areas, are at high risk for exterior vertical fire spread. Variegated exterior facades and larger noncombustible spandrels provide a significantly greater resistance to exterior fire spread by increasing the distance for the radiant and conductive heat on the fire floor to reach the exterior windows or materials in windows on overlying floors. In existing buildings, where retrofitting the aforementioned features designed to restrict fire spread might be too difficult to manage, the installation of automatic sprinklers would be the best alternative. Automatic sprinklers would restrict fire growth, greatly reducing the risk of exterior vertical fire spread. (Routley 36).

The prescriptive codes, reactive by nature, could only react to the threat of autoexposure. That the prescriptive codes in effect today are safer than those that were in effect at the time of the fire at One Meridian Plaza is a patently obvious fact, but the prescriptive codes’ reactive nature underscores a major weakness of a prescriptive-based approach to fire protection engineering. What is needed is more than a reactive fire code, but one that lets designers anticipate and explore the implications of new threats as well.
Another fire which lays bare the weakness of prescriptive codes is the Düsseldorfer Airport Fire, which occurred on April 11, 1996. Arguably the most influential fire in German history, the Düsseldorfer Airport Fire is said to have begun at approximately 3:31 p.m., when witnesses reported seeing sparks on the ceiling of a flower shop at the east end of the arrivals hall on the first floor. Noticing a strong odor emanating from inside the building, the Airport Fire Brigade which was parked curbside asked an electrician to check on the motors of the automatic doors because they had given them problems in the past. Five minutes later, however, smoke was seen coming through the vents in the flower shop and burning structural members began falling down from the ceiling which was now glowing. The situation was declared an emergency and all airport personnel were requested and were at the scene by 3:40 p.m. (http://www.iklimnet.com/hotelfires/nfpaduss.htm)

Little did anyone know it at the time, but the Airport Fire Brigade as well as the other airport personnel on hand were grossly ill-equipped and wholly unprepared for that which was soon to follow. At 3:58 p.m., after a sudden fire build-up on the first floor of the terminal, the Düsseldorfer Fire Brigade was called. By the time the Düsseldorfer Fire Brigade arrived at 4:07 p.m. with two engines, a ladder, a water tanker, and a command officer, heavy smoke and fire on the first floor were visible through the doors from the outside of the building, prompting the Düsseldorfer Fire Brigade to issue what ultimately amounted to a second alarm at 4:15 p.m. This alarm, which came a full 44 minutes after the initial alarm, called on all city units to respond immediately to the fire which by now looked as if nothing short of a city-wide response could bring it under control. Indeed, it had taken a monumental effort by the city of Düsseldorf and neighboring suburbs to contain the fire. By the time the fire had been extinguished, 701 personnel and 215 service vehicles from 12 different municipalities had responded. (http://www.iklimnet.com/hotelfires/nfpaduss.htm)

It was 7:20 p.m. before the fire was ultimately declared dead. It took nearly four hours since the sparks on the ceiling of the flower shop were first noticed to extinguish the fire. According to the official report filed by the Düsseldorfer Fire Brigade after the incident, seven of the seventeen victims died in two elevators. The report states that those seven victims had been on the roof of the parking garage watching the planes take off, and when they noticed smoke rising from the terminal, they decided to evacuate the building using the elevators. This was a fatal instantly. Eight more victims died in a VIP lounge on the third floor, which was basically a mezzanine overlooking the departure level of the building on the second floor. The two remaining victims died in lavatories, one of whom survived the fire but died several weeks later, succumbing to injuries sustained during his/her ordeal. Out of respect for the families of the victims, the NFPA report on the Düsseldorfer Airport Fire, on which this segment of the paper is based, did not mention anything that would offer any clues about the identities of the victims. (http://www.iklimnet.com/hotelfires/nfpaduss.htm)

German authorities ultimately determined the cause of the fire to be a welder working on expansion plates in a roadway above the lower level of the terminal. Sparks from the welding ignited the polystyrene insulation used in the void above the ceiling on the first
The smoke and flames spread throughout the first level, and then spread to the second level through unprotected stairwells and escalator openings. Significant fire damage was observed in the vicinity of the stairwells, and heavy smoke filled nearly two-thirds of the second and third floors. One of the reasons that the fire spread so quickly and became so unmanageable was that there weren’t any sprinklers on the floor of fire origin. Although dry stand pipes were located in the stairwells on the curbside of the terminal building, they weren’t connected to the municipal water supply and had to be charged by the fire brigade. The terminal was equipped with an automatic smoke detection system, but smoke detectors were absent in the voids between floor levels since they were not used as return air plenums.

(http://www.iklimnet.com/hotelfires/nfpaduss.htm)

The investigation after the fire identified several factors which above all were responsible for the significant loss of life and extensive property damaged, not all of which can be remedied by code changes, such as the negligence of the workmen welding the expansion plates or poor communication between fire fighters. Those kinds of issues need to be fixed by a change of culture, such as a greater awareness of safety in the work place or the introduction of better communication between fire fighters. The investigation did, however, also identify several factors influencing the rapid spread of the fire that had to be addressed by the fire codes, including the presence of combustible insulation in the ceiling void above the lower level of the terminal, the lack of automatic suppression systems in the void as well as the occupied area of the terminal, unprotected vertical openings, inadequate means of egress from the VIP lounge on the mezzanine level, and two elevators that opened directly into the fire area.

(http://www.iklimnet.com/hotelfires/nfpaduss.htm)

The two historical fires above illuminate the process behind prescriptive fire codes. When a fire occurs, the codes react by introducing more stringent requirements for newer construction, and sometimes require existing buildings to do some retrofitting. But performance-based codes would offer designers the opportunity to adapt building designs to perform under fire conditions using computer-generated models. This way, solutions can be found to fire problems before they are allowed to claim lives.

2.3 New Zealand’s Performance-Based Fire Code

According to Richard W. Bukowski, author of Fire Risk or Hazard as the Basis for Building Fire Safety Performance Evaluation [Fire Risk or Fire Hazard – Building Fire Safety] and a researcher at the Building and Fire Research Laboratory at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD an “express interest in fire risk assessment to judge performance against the code’s explicit objectives” formed the basis for developing performance-based fire codes in most countries. Insurance companies, once again, are at the forefront of the effort to improve building codes, and this time they play a pivotal role because lower risk of fire damage is at the heart of what performance codes are. Many countries in northern Europe, Japan, Australia, and New Zealand have already adopted performance-based codes, or at least signaled their intent to adopt them in the near future, not only because of the incentives promised by insurance companies to low-risk designs, but because low risk and better
performance really means better engineering. Of all of the countries who’ve at least thought about performance-based codes, New Zealand’s probably provides the best argument for doing so. (Bukowski).

The Building Act of 1991 ushered wide sweeping changes into the legislative framework for building controls in New Zealand, introducing a national building code, the first of its kind in the tiny republic’s history, and ultimately paving the way for the development of a new performance-based code which became mandatory in 1993. The new performance-based building code represented an about-face from the traditional prescriptive building codes. The new performance-based code, at least in theory, allowed the use of any innovative or revolutionary design, provided that performance or safety was not compromised. It also came replete with a new set of prescriptive documents, known as “acceptable solutions,” which could be used in lieu of a comprehensive performance-based design. The professed goal of the new code was to allow for the better use of space, building materials, and funds. In theory, at least, it could be used to produce a more cost-effective design. (Buchanan 377).

The Building Act of 1991 and the Building Code are the principal fire protection documents in New Zealand, regulating fire safety for all 3.5 million people on the two islands. The main performance requirements of the new code, as described by A. H. Buchanan in the Fire Safety Journal, (Buchanan 378), are: “Provision of safe egress for occupants; Provision for safety of fire-fighters; Prevention of fire-spread to neighboring properties; and Safeguarding the environment from the adverse effects of fire.” A noteworthy observation is the evident failure of the new code to address the prevention of fire damage to the material contents of the building, which is treated as the sole responsibility of the building owner. Another deviation from the norm is the new code’s obvious promotion of safe egress for building occupants to a main performance requirement. (Buchanan 378). Whereas a few casualties were viewed as inevitable consequences of fire under past building codes, the primacy of life safety is loaded in every nuance of the language used to describe the performance requirements of the new building code. In the atrocity that unfolded on 9/11, egress capacity was clearly not sufficient to accommodate the throngs of people that flooded the exits to escape the fiery inferno inside the twin towers. It has been estimated that at least five hours would have been needed to evacuate buildings of that size. (“Why the Towers Fell”). Both towers collapsed well under the time needed to fully evacuate them, burying thousands of people stranded inside under the falling debris. Under the new code, safe egress for building occupants is a requirement. The traditional practices are expected to give way to significant increases in egress capacity and procedures for full evacuation of buildings.

The new building code leaves open the possibility of achieving said performance requirements in three different ways: An approved “Verification Method,” an “Acceptable Solution” from the aforementioned prescriptive documents of the new code, or an “Alternative Solution” relying on specific fire protection engineering design. At the writing of A.H. Buchanan’s article in the Fire Safety Journal, 32nd Edition (1999), there had not yet been an approved “Verification Method” for fire design, or rather an approved calculation method that would make possible the use of an approved
“Verification Method.” Moreover, since the new code was adopted in 1993, few buildings have been designed with “Alternative Solutions” using specific fire protection engineering designs, making the “Acceptable Solutions” published in the prescriptive documents of the new code the preferred method of building design by a wide margin. (Buchanan 378). To be sure, even the prescriptive documents of the new code represent a tremendous improvement over former building codes and standards, but they still fall short of a comprehensive performance-based fire protection engineering design, which is the cornerstone of the new building code and the critical distinction between performance-based codes and outdated and outmoded prescriptive building codes.

The “Alternative Solutions” using specific fire protection engineering designs represent a significant departure from the traditional reliance on prescriptive methods for fire design, especially since they form the basis for most “Alternative Solutions.” These designs must be justified by specific engineering calculations based on fire-scenario analyses. Designs are carried out and subsequently reviewed by qualified fire protection engineers. However, laments A. H. Buchanan, “numerical calculations are available for individual components of the process, but the final assessment of safety is by opinion, not calculation, because the performance requirements of the code are not quantified.” The inevitable result is a surfeit of possible design strategies and equally justifiable solutions, “without a quantifiable level of safety.” (Buchanan 378).

2.3.1 A.H. Buchanan’s Reporting on a Survey Conducted Five Years after New Zealand’s adoption of the Performance-based Fire Code

A.H. Buchanan, writing for The Fire Safety Journal, 32nd Edition (1999), reported on a survey conducted of the nine largest city councils in New Zealand five years after the adoption of country’s performance-based fire code. The following sections discuss the results of the survey.

The survey found that although the performance-based code was adopted in 1993, three-quarters of all building designs still used the new prescriptive “Acceptable Solutions,” with only 15% encompassing minor changes to the acceptable solutions, and only 8% including any significant fire engineering content. The majority of the designs are still performed by the main building designer, the architect or structural engineer in most cases, but the survey also reported that an increasing number are being referred to specialists. Lack of appropriate fire protection engineering education precludes the use of an “alternative solution” using specific fire protection engineering in most cases, which explains the tendency to rely on “Acceptable Solutions” from the prescriptive documents published in the performance-based code. (Buchanan 379).

The survey has also showed that close to 80% of submitted designs were checked in-house by city council staff, with most cities processing an even larger percentage. A few cities preferred to sub-contract most of their designs to consultants. A common complaint was that the new performance-based code has meant an increase in the amount of work required to process an application. The process followed for most major designs was to
send the design to an independent consultant for peer review prior to issuing a building consent or building permit, but city council staffs have had to be re-educated to process even the most routine jobs because of the major changes brought on by the new performance-based code. (Buchanan 379).

Originally the switch to a performance-based code was accompanied by fear in some quarters that buildings would be made less safe under the requirements of the new code. However the survey revealed that, five years later, the opposite was true. The general consensus in 1999 was that buildings were just as safe, if not safer under the new code. Praiseworthy benefits of the new performance-based code included improved processes for periodic inspections and more stringent regulations for existing buildings undergoing alterations or a change of use. (Buchanan 379).

The new legislation puts the emphasis on life safety, taking it away from property protection. Consequently, owners have had to take a greater responsibility for protecting the material contents of their buildings from fire damage. According to the results of the survey, most approving authorities agreed with the conclusion that the significant increase in life safety brought on by the new code has been accompanied by a corresponding decrease in property protection for the owner. Property protection for owners of adjacent building has not changed, evidently. (Buchanan 379-80).

An inevitable consequence of the new code’s de-emphasis of property protection, reported the survey, was that most designers now had to discuss property protection in greater detail with their clients. Since under the new code the responsibility of protecting the material contents of the building from fire damage fell squarely on the building owner, insurance companies have also had to get more involved, thus indirectly leading to a corresponding increase in fire protection. There is more than a hint of irony in the fact that a code that has arguably reduced property protection requirements for the building owner has also indirectly contributed to an increase in the use of active fire protections systems such as sprinklers, which not only protect lives, but property from fire damage. Another interesting fact revealed by the survey was that insurance companies, despite having more discussions about fire protection with the building owners they represent, have taken a more passive role in fire protection than previously, since buildings are arguably safer under the requirements of the new code. (Buchanan 380).

The new code has also produced an environment that promotes the use of more active fire protection systems such as automatic sprinkler systems, and smoke and heat detectors, as opposed to building materials with higher fire resistance ratings. Smoke detectors, rarely used in New Zealand prior to the introduction of the new code, were almost ubiquitous at the time that the survey was conducted. It also should come as no surprise then that most approving authorities believed that the overall cost of fire protection has gone up slightly since the new code took effect in 1993. The new code also mandated regular inspections of buildings to check all fire protection systems and escape routes, which became the financial responsibility of the building owner. (Buchanan 380).
The new code has created a culture of fire protection, which has inevitably meant changes for the major players of building design and the traditional approach to fire safety. But the success of the new code can be attributed in large part to a greater degree of cooperation between all of the responsible parties, such as the designers, reviewers, enforcers, insurers, contractors, and fire service officials. To his credit, Buchanan anticipated conflicts of interest that could arise from the changes occurring in the new code and initiated the preparation of the so-called Fire Engineering Design Guide, which considered input from the concerned parties and helped ease the transition from the old code to the new code. (Buchanan 380).

The new culture has created a sudden demand for educated professionals in a position to design, review, and implement the new code. The survey showed that although efforts to educate professionals were already underway, they lagged far behind what was needed. Educational efforts had to move faster and be more comprehensive in order to keep with the demand of the new code-environment. An alarming trend identified by the survey was the growing number of engineers with inadequate fire protection engineering education attempting fire protection designs. In fact, the survey revealed that 30% of all designs had been prepared by fire protection engineering consultants lacking the specific engineering education required to perform such designs. (Buchanan 380).

The way the design process usually works, architects cannot complete their designs until all of the fire issues have been resolved and all of the fire designs have been approved by the responsible authorities. As a result, architects were beginning to turn to qualified fire protection engineering consultants, realizing that expert advice not only offers innovative solutions to common design problems but also great cost benefits. There were significant new opportunities for fire protection engineering consultants under the new code-environment. Although slow to react at first, educational institutions, such as the University of Canterbury in Christchurch, New Zealand, have begun offering courses in fire protection engineering, slowly filling in the vacuum created by the new demand for professional fire protection engineering consultants under the new code. (Buchanan 380).

The majority of fire protection engineering consultants in New Zealand have had experience as both designers and reviewers, leading to some sort of consensus developing throughout the country. There is no way to guarantee safety, but safety-minded reviewers, although few in number, certainly have the power to influence the overall level of national safety. To be sure, at the time of Buchanan’s survey there were still some differences in interpretation across the country, but there was an emphatic trend towards consensus developing as the gulf between designers and reviewers continued to decrease. National consensus would be harder to achieve in a much larger country such as Germany, for example. (Buchanan 380).

Although as a national organization the New Zealand Fire Service has lost its former sway on fire safety in building design, a small consolation has been its increased responsibility for evacuation planning, building management, and hazardous activities in buildings. The fire service accepted its diminished influence in building design rather graciously, offering in-house education programs, employment to fire engineers, and its
whole-hearted support to the fire protection engineering degree at the University of Canterbury. (Buchanan 380-1).

The fire protection industry, on the other hand, has found the transition more difficult because they used to be the recognized experts on fire safety and found it unconscionable that a “new breed of fire engineering consultants” (Buchanan 378) would dare to challenge their authority. At the time of the survey, there were no suitable programs available for re-education. (Buchanan 381).

The new code has meant a change in the culture of fire safety in New Zealand, particularly in the way in which fire safety problems are addressed. Under the former prescriptive codes, most arguments had been about specific words in the code and how they applied to new buildings that did not exist when the codes were written. Now the arguments are about fire and life safety, and the biggest questions for designers are “where and when fires might occur, what would happen next, and who would be affected.” The new code was a prophetic event, since now designers had to seriously address the issue of fire, not just fire codes. The most optimistic fact revealed by the survey was a significant increase in knowledge about fire behavior and awareness of fire safety for both building officials and designers. (Buchanan 381).

2.3.2 How New Zealand’s Example Relates to Germany

New Zealand’s example provides a case-in-point for members of Germany’s fire protection community seeking to develop a similar performance-based code for Germany, and perhaps for the other European Union member-nations as well. New Zealand’s new code was greeted by the island nation’s fire protection engineering community with an equal measure of hope and skepticism. Although the code had been around for six years already by the time A. H. Buchanan had written his article, the survey he wrote about revealed that the prescriptive documents of the code (“Acceptable Solutions”) were still more widely used than the performance-based “Alternative Solutions.” This fact would suggest that the fire protection engineers of New Zealand had not yet developed the way of thinking required of a performance-based fire code that Professor Fitzgerald had talked about in his book. Germany, should it adopt a performance-based fire code of its own, would face the same challenge as New Zealand in trying to overcome its own fire protection engineering community’s fears and misconceptions about performance-based codes. But ultimately, as New Zealand’s example also demonstrates, education is the key to producing a successful performance-based fire code. Around the time the code was adopted, funds began flowing into the Department of Civil Engineering at University of Canterbury in Christchurch, New Zealand. The idea being that the code could benefit from a new generation of engineers trained in the way of thinking required of a performance-based fire code. The fire service in New Zealand gracefully accepted its diminished role in fire design, unlike the former fire safety experts who refused to relinquish their former status as the country’s only recognized experts in fire safety. Germany would doubtless be the stage of a similar power struggle should it decide to implement a performance-based fire code of its own. Some players would fight against the changes promised by the implementation of a
performance-based fire code; others would gracefully abdicate their positions and welcome the changes recognizing that they are meant for the common good.

2.4 *The German Educational System*

The following section briefly describes the German educational system from the first year a child enters school to post-graduate and doctoral education in Germany. This background is necessary for the reader to understand the information presented in the Results section of the report.

2.4.1 *Three Options for Secondary School*

German parents have to decide what kind of education they want for their children early on in their children’s lives. The decision is whether they want them to have a more theoretical education, like the kind of education offered by a typical American university; or a more practical, hands-on education, such as the kind of education one would expect from a vocational college here in the United States; a third option combines the theory of the universities with the practical education of the vocational schools. The parents’ decision either finds their children at a Hauptschule, a Realschule, or a Gymnasium. (Habetha 120). Children in the Federal Republic of Germany attend primary school for four years, between the ages of 6 and 10, after which they have three options for secondary school - Hauptschule, Realschule (Modern High School), and Gymnasium - each of which ultimately leads to different set of career paths. Thus begins the engineering education journey in the Federal Republic of Germany. (Habetha 120).

2.4.1.1 *Hauptschule*

In the Hauptschule children get an early introduction to engineering concepts. In addition to what would be considered a conventional high school curriculum, students at the Hauptschule receive instruction in a specific trade of their choice. In their tenth year of schooling, which normally occurs at the age of 16, they enter vocational training, during which they receive intensive instruction in their respective trades, preparing them for entry into vocational school, which occurs at the age of 17 and after which they'll begin their apprenticeships. The apprenticeship, which usually lasts a year or so, gives the young craftsmen the opportunity to hone their skills and to learn the tricks of the trade from master craftsmen. After the apprenticeship is over, they become journeymen, qualifying them to get a job working at a company involved in their trade. After three years or so (depending on locality) of working for a company, journeymen qualify to take the master’s exam. Master craftsmen are highly skilled workers, and are recognized experts in their respective trades. Master craftsmen’s title gives them the option of entering a Fachhochschule. (Habetha 120).

2.4.1.2 *The Realschule*

The Realschule, like the Hauptschule, has many aspects of a conventional high school. Students learn mathematics, science, literature, history, grammar, foreign languages, art, music, etc. Students attend the Realschule for 6 years, between the ages of 10 and 16. At the age of 16, they move onto the Fachoberschule (vocational high school), which they attend until the age of 18 and where they begin learning a trade. The graduates of a Fachoberschule have two options: they can begin their training in industry or they can
enter a Fachhochschule to pursue a higher degree in their respective trades. A degree from a Fachhochschule is the equivalent of the Anglo-American degree in engineering technology. The students at the Fachhochschule are extremely bright and capable students, but their engineering knowledge tends to be more practical and less theoretical. The graduates of Fachhochschule can go to work immediately upon graduation or they can attend a university. It is not uncommon to see graduates from a Fachhochschule with one or more higher degrees from a university. (Habetha 120).

2.4.1.3 The Gymnasium
The Gymnasium is the closest thing in Germany to a traditional American high school. Students enter the Gymnasium at the age of 10 and graduate at the age of 18 or 19. Students at the Gymnasium learn everything that a student at an American high school would learn, except that students graduate from the Gymnasium after 13 years of education, whereas their American counterparts graduate after only 12 years of education. In order to graduate from the Gymnasium and to be allowed to continue their studies at a university, students take an exam called the Abitur after 13 years of schooling. Students who choose to quit the Gymnasium after 12 years of education may enter a Fachhochschule. There are two phases at the university, the Vordiplom (pre-Diplom) phase, which concludes the Grundstudium (studies of the fundamentals), and the Diplom phase, which concludes the Hauptstudium (studies in one’s own major). It is important to note that the Vordiplom is not a degree like a Bachelor’s degree. Its only function is to signify that one has concluded his studies in the fundamentals and is qualified to begin studies in his major. Upon successfully completing his studies in his major, one receives a Diplom, which is like a combined Master’s and Bachelor’s Degree. This is currently the system at most universities in Germany, although many universities are already adopting the Master’s and Bachelor’s scheme, which may replace the Diplom system in the future. Students studying at the university are Germany’s best and brightest. They have a solid grasp of the theoretical aspects of their respective fields of engineering. And although they are required to do an internship before graduation, they lag far behind their peers in the Hauptschule and Realschule in the practical aspects of their fields. (Habetha 120).

2.4.2 The German System of Higher Education
According to the Constitution of the Federal Republic of Germany, the federal government is confined to a coordinating function in educational affairs. The individual states of the Federal Republic of Germany, in effect, have self-determination in nearly every aspect of education. They are responsible - not the federal government – for developing and implementing educational policies, as well as for supervising the higher education institutions in their respective states to make sure that they are abiding by those educational policies. The state of Nordrhein-Westfalen (NRW) has the largest number and the greatest variety of higher education institutions in all of Germany. Even though engineering education in Germany varies greatly from state to state, a close examination of the engineering education system in Nordrhein-Westfalen can still reveal a great deal of information about what makes engineering education in Germany unique. Therefore, the following discussion about engineering education in the Federal Republic of Germany is limited only to the Higher Education institutions in NRW. (Habetha 118).
The educational system in the Federal Republic of Germany is broken down into three levels: primary, secondary, and tertiary. The third level refers to higher education; or "Hochschulstudium" as it's known in Germany, literally "high school education." Unlike in the Anglo-Saxon world, high school in Germany refers to the institutions of higher education. In fact, the Technical University of Darmstadt (Technische Universität Darmstadt) was previously known as the Technical High School of Darmstadt (Technische Hochschule Darmstadt). German high school students who choose to begin their higher education after only 12 consecutive years of primary and secondary school may enter the Fachhochschulen; the entrance requirement for the universities, however, is 13 consecutive years of primary and secondary school as well as a graduation certificate known as the Abitur. Although Anglo-Saxon and American terms for higher education institutions will be often used throughout the course of this chapter for the purposes of comparison to explain the German terms, it is important to keep in mind that they are not direct equivalents. The fundamental differences between higher education in Germany and higher education in the United States are that: German students traditionally enter the university at the age of 19 after 13 years of primary and secondary school; and degree studies at universities and university-equivalent institutions cover a range which combines what is known in the Anglo-Saxon world as under-graduate and post-undergraduate education. (Habetha 118).

2.4.3 Engineering Education Institutions

In the Federal Republic of Germany there are the following institutions of higher education for engineers. The universities (including the Technische Universität (TU) and the Technische Hochschule (TH)) provide a scientific education, enabling the engineer to expand technological and scientific discoveries, make new scientific discoveries and technological innovations, and put them into practice. According to the university laws of the states, the primary function of the universities is to promote the development of technology and science, conduct research, and provide a well-rounded education to future generations of engineers. The majority of university applicants come from the Gymnasium. The graduation certificate of the Gymnasium, known as the Hochschulreife or the Abitur, entitles the holder to study at a university or equivalent institution. Some universities require their students to undergo a period of practical training (sometimes lasting up to half a year) as a requisite for enrollment. A course of studies in engineering at a university usually lasts for 5 or 6 years. Upon graduation, the student receives the academic degree of Diplom-Ingenieur.

The Gesamthochschulen (Comprehensive Institutes of Higher Education) combine the scientific education of the universities with the industry-oriented education of the Fachhochschulen. The Gesamthochschulen give students a choice of two course systems: one leading to the degree of Diplom-Ingenieur (Dipl.-Ing.) after 3 ½ years, equivalent to the degree from a Fachhochschule; the other leading to the degree of Diplom-Ingenieur after 5 or 6 years, equivalent to the degree from a university.

The Fachhochschulen (FH) developed from the former Colleges of Engineering. They provide a special industry-oriented education; the course of studies at the
Fachhochschulen have a strong practical orientation, and many require periods of practical training of up to one year prior to enrollment. But the Fachhochschulen are not to be confused with the vocational schools, which have an entirely different mission. In addition to teaching their students practical applications of engineering, according to the state law of Nordrhein-Westfalen, the Fachhochschulen are also required to conduct research and development and make new findings in science and technology, like the university. The entrance requirement of the Fachhochschulen is the Hochschulreife, which is attained after 12 years of primary and secondary school. The Anglo-Saxon equivalent of a course of studies at a Fachhochschule is an undergraduate degree with a duration of 3 – 3 ½ years. A course of studies at the FH leads to the degree of Diplom-Ingenieur. Although students from the TU and the FH get the same title upon graduation, prospective employers do make a distinction between TU graduates and FH graduates. (Habetha 118).

2.4.4 Paths Leading to Engineering Degrees

2.4.4.1 Undergraduate Education

As previously mentioned, engineering studies in Germany are not divided up in the same way that they are divided up in the United States. Instead of a separate under-graduate degree and post-graduate degree, university graduates receive the degree of Diplom-Ingenieur - which represents a combined under-graduate and post-graduate degree. Degrees from Fachhochschulen and Fachhochschule programs at Gesamthochschulen can be thought of as the equivalent to the Anglo-American Bachelor’s degree. (Habetha 118-119).

The first degree courses at universities (including the Technische Universitäten/Technische Hochschulen and the university programs at the Gesamthochschulen) are divided into two groups, basic studies and advanced studies, in much the same way as they are in the United States. Basic studies include scientific subjects, subjects of specialization, and intermediate examinations called Vorexamen. Advanced studies include specialized scientific subjects, higher theoretical education by participation in research, and a final examination called the Diplom-Hauptprüfung to conclude the university studies. Upon completion of the basic studies one may receive a Schein (a certificate); but the Schein would not represent a professional qualification in the sense of a Bachelor’s degree. It just signifies that one has completed the basic courses in his major and is prepared to move on to the advanced courses in his major. (Habetha 118-119).

2.4.4.2 Post-graduate Education

Some German institutions offer second degree courses (Zusatzstudiengaenge). Second degree courses at universities require proof of a first degree or final exam from a German universities or an equivalent foreign institution. As a general rule, second degree courses are open to holders of a Bachelor’s degree or another equivalent degree. In Germany, this is equivalent to the Fachhochschul-Diplom. Second degree courses are offered for a wide variety of majors including engineering (i.e., Safety Technology, Wuppertag U/GH, or
Energy Engineering, Köln FH) and science and economics (i.e., Operations Research and Management Studies, Aachen TH). (Habetha 119).

Only universities and the university-equivalent faculties at the Gesamthochschulen can confer the title Dr.-Ing., the German doctorate in engineering. The Fachhochschulen and the Fachhochschul departments of the Gesamthochschulen do not have the authority to confer this academic degree. Studying for a doctorate generally doesn't involve participating in any courses, but working on a research project under the academic supervision of a professor. Before arriving at a German university, foreign students are therefore required to show proof to the admissions department of that university that a professor or a faculty at the university have approved their proposal to do a research project using the facilities of the university and will provide the required academic supervision, and that they have fulfilled the formal requirements for admission to a doctorate program at a German university. In the case that they haven't satisfied the formal requirements of admission to a doctorate program at a German university, they should be prepared to clarify what additional requirements they must fulfill prior to admission. (Habetha 119).

2.4.5 Practical Training and Practical Semesters

Applicants to engineering education institutions should be aware of the regulations concerning practical training before and during their studies. The Fachhochschulen have stricter requirements regarding practical training than the universities. Many Fachhochschulen require practical training of up to one year prior to admission into their engineering programs. Some Fachhochschulen offer practical semesters during the academic year as an alternative to practical training. The practical semesters are organized differently in each of the states, and from one Fachhochschule to the next. (Habetha 119).

The universities (including the Technische Universität/Technische Hochschulen and the Gesamthochschulen) have less stringent requirements for practical training than the Fachhochschulen. As a general rule, the universities require practical training of up to a half a year as a prerequisite of enrollment for most engineering majors. Practical semesters are also offered at universities, and again the general regulations, the content, and the duration of the practical semesters vary from state to state and from university to university. (Habetha 119).

2.4.6 Professional Recognition of Engineering Degrees

The degrees Diplom-Ingenieur (Dipl.-Ing.) in engineering conferred by the universities (including the Technische Universität/Technische Hochschulen and the university-equivalent faculties of the Gesamthochschulen) of the Federal Republic of Germany entitle the holders to pursue their careers in engineering without any additional authorization. Diplom-Ingenieure in Architecture, however, must become members of the Architektenkammer (Chamber of Architects), which they are first allowed to do after a certain period of industry experience, before they can use the title of Architekt. Diplom-Ingenieure in the engineering subjects can become members of professional organizations if they want to, but it is not a requirement. Some professional organizations in
engineering today are Verein Deutscher Ingenieure (VDI), Verband Deutscher Elektrotechniker (VDE), and Verein Deutscher Eisenhüttenleute (VDEh). (Habetha 119).

2.5 Brief Overview of Fire Protection Education in the U.S.

2.5.1 WPI’s Fire Protection Engineering Degree
The Fire Protection Engineering Program was created at WPI in 1979, offering the first fire protection engineering master's degree program in the United States. The program sought to prepare men and women for careers in fire protection engineering, advanced levels of specialization, research, and teaching. WPI broke new ground again when, in 1993, it offered the first-of-its-kind fire protection engineering PhD. The Department of Fire Protection Engineering at WPI has been a crossroads for talents from many disciplines on campus such as mechanical, chemical, civil, and electrical engineering as well as computer science, physics, management and mathematics, not to mention students and professors from other campuses across the United States. (http://www.wpi.edu/Academics/Depts/Fire/).

2.5.2 The Second Conference on Fire Safety Design in the 21st Century
The Second Conference on Fire Safety Design in the 21st Century was held at Worcester Polytechnic Institute (WPI) in Worcester, MA on June 9-11, 1999. The conference brought together leaders from all facets of the industry – academicians, design professionals, and regulatory officials - to discuss the shift in fire safety design from "meeting the code" toward establishing "explicit building safety performance goals." (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 1). According to the former head of the WPI Fire Protection Engineering Department and editor of Proceedings of the Second Conference on Fire Safety Design in the 21st Century, Professor Lucht, this transition towards a performance-based approach to fire protection required "an entirely new way of thinking for fire designers and regulatory officials" in addition to research and development of new and improved design methods. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 1).

The First Conference on Fire Safety Design in the 21st Century (1991) had brought together 112 leaders in fire safety design to consider the dramatic changes taking place in the industry, and to identify barriers to progress as well as strategies for overcoming those barriers. The conference attendees in 1991 had also recognized that the industry was transitioning from a prescriptive "meet the code" approach to fire safety design towards a bona fide performance-based approach. The conference’s counsel didn’t go unheeded. One of the conference’s recommendations, a "first generation performance-based building code," had been realized by the time the Second Conference on Fire Safety Design in the 21st Century convened in Worcester. The 1999 conference brought together 120 industry leaders to review the progress made since the 1991 progress, identify the challenges still facing the industry and formulate strategies to overcome those challenges. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 1).
2.5.3 The First Conference on Fire Safety Design in the 21st Century establishes Roadmap for Progress: Education factors highly


Supported by funding from the NSF, the United Kingdom and Australia strengthened their research programs subsequent to the conference. In addition, Professor David Lucht interviewed over 60 practitioners in all facets of the industry, from design people to regulatory officials. The findings of Professor Lucht’s interviews, along with the results of the 1991 conference, laid the foundation for the road map for the future (show below). (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 9).
2.5.4 Progress since the 1991 Conference

Over the past ten years, the world has witnessed a "paradigm shift" in fire safety design and regulatory practices. A few countries have already adopted and implemented performance-based practices in fire safety design. Even the U.S. industry has witnessed some institutional changes, the most dramatic of which being the formation of the International Code Council (ICC) in 1994. This merged the three non-profit model building code organizations (Building Officials and Code Administrators International
Of particular interest to the conference report is the development of the *ICC Performance Building Code*. One of the 1991-conference’s recommendations was the development of a “straw-man” performance-based building code by the year 2000. Few conference attendees probably had faith this would happen. But the ICC *Performance Building Code* was released in 1999, a year shy of the deadline. The goal-oriented document is 40 pages long, compared to the ICC prescriptive *International Building Code*. All of the requirements of the ICC *Performance Building Code* are stated in performance terms. The following passage is an example of a requirement of the ICC *Performance Building Code*:

> “Section 4.2.2. Buildings shall be designed with safeguards against the spread of the fire so that... occupants have sufficient time to escape without being overcome with fire and smoke.”

The performance-based code offers no specific details. It just states the performance objectives of the code. It is up to the designer to meet those objectives. The designers in each state have the choice between the two ICC building codes. This represents a major paradigm shift. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 10).

Other national and international organizations have also made progress since the 1991 conference. For example, the Society of Fire Protection Engineers (SFPE) recently hired its first technical staff personnel (technical director and research director), a signal of its determination to give top priority to addressing the issues raised during the 1991 conference including filling voids in performance-based design and regulatory practice. Using a committee-based consensus process, it published a performance-based fire protection engineering design textbook, the first engineering tool titled “Engineering Guide to Assessing Flame Radiation to External Targets from Liquid Pool Fires,” and developed the first formal draft of a performance-based engineering design guide. Another group was tasked with documenting third-party evaluations of fire models. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 11).

The National Fire Protection Association (NFPA) has also sought to implement performance-based practices in its codes and standards. A notable example is the NFPA *Life Safety Code* which includes the performance-based option. In addition to the *Life Safety Code*, the NFPA has also published several primers on performance-based design. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 11).

In sum, since the 1991 conference, a paradigm shift has occurred in the industry. However, the United States is still a long ways away from developing a true performance-based design and regulatory system. Despite the development of the ICC
Performance Building Code, significant fears of liability and lawsuits, as well as other barriers to progress and doubts prevented the performance-based system from taking hold by the 1999 conference. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 11).

2.5.5 The U.S. lags behind Others, Conference Concludes

The 1999 conference concluded that a number of other countries have made significant progress towards developing and implementing performance-based fire safety design, and realizing a culture of fire safety that goes beyond “meeting the code” towards recognizing explicit building fire safety performance goals. In particular, Australia, the United Kingdom, New Zealand, Canada, Japan, and the Scandinavian countries have made significant progress in adopting performance-based practices. Performance-based practices were adopted throughout England and Wales in 1985, New Zealand in 1992, and Australia in 1997. These countries have also made progress in developing the necessary infrastructure to support a new culture of fire safety. Government coordination and leadership were crucial components in the success of these countries. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 3).

In stark contrast to the other countries just mentioned, the United States lacks a government policy for building fire safety and a coordinated national effort to implement performance-based practices which handicapped progress in adopting performance-based practices. The federal government is given no jurisdiction over the regulation of building fire safety; such matters are deferred to state and local governments. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 3).

2.5.6 Factors still handicapping Progress

The Second Conference on Fire Safety Design in the 21st Century found that a number of factors were still handicapping progress towards implementing performance-based practices in the United States and the other countries of the industrialized world. The conference cited a lack of validated engineering tools and a lack of specific fire protection education as handicapping progress. Despite some progress in the development of performance-based fire protection engineering tools since 1991, the conference attendees still cited “inadequate technology, lack of consistent and valid design tools,” and the inability of authorities having jurisdiction (AHJ) to distinguish between valid and invalid information as specific examples illustrating the lack of validated engineering tools (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 29). Education also factored highly in the conference’s findings, echoing calls in the first conference for specific fire protection engineering education. The conference underscored the need for “new and improved skills” in all facets of fire safety design. Education seemed to be a common theme in both conferences. The failure to develop an adequate educational foundation, an “inadequate number of decision makers,” a “lack of a comprehensive understanding of fire phenomena,” and a lack of qualified fire professionals in all facets of the industry (designers, owners, AHJ’s) all handicapped progress. Some members of the conference were bold enough to declare that AHJ’s were afraid of the unknown, and this skepticism hasn’t helped progress. (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 29).
2.6 Background Summary

As the examples in the background illustrate, education is absolutely key to successful adoption and implementation of performance-based practices. It was crucial to the success of New Zealand’s performance-based code. Both the first and second Conference on Fire Safety Design in the 21st Century mentioned education as a crucial component in making the transition from a prescriptive “meet the code” system to a system that establishes explicit performance goals for fire safety design. Designing and evaluating a building to meet fire safety performance objectives requires a specific fire protection engineering education. As Professor Fitzgerald explained in his book, performance-based fire protection engineering requires a different way of thinking than what prevailed under the prescriptive code system. It requires a new kind of education, a fire protection engineering education. Given this knowledge and the fact that most of the industrialized world is experiencing a “paradigm shift” in the way codes treat fire protection (Proceedings of the Second Conference on Fire Safety Design in the 21st Century 2), the goal of this IQP was to show the necessity of developing a fire protection degree at one or more of Germany’s major technical universities if Germany decides to implement a performance-based code.
3 Methodology

The purpose of the Methodology section of the IQP is to describe how the necessary research for writing the IQP was performed. It provides a brief overview of the role of the methodology in social science research, and explains the reasons behind choosing the particular type of methodology used. It describes the methodology for conducting the research as well as working with the information collected through the research. In order to meet the goal of this particular IQP, research had to be done about the German educational system, and its strengths and weaknesses had to be identified in order to state whether a more specific fire protection engineering education would be required to make the transition from a more prescriptive “meet the code” approach towards a performance-oriented system that establishes explicit performance requirements for building fire safety design. The author had to find a way to get right at the source of the information, to the people who were most knowledgeable about fire protection education in Germany.

3.1 The Significance of the Methodology in Social Science Research

The methodology determines the kind of information collected, and of that information collected, which will be accepted and which rejected. (Brown and Brown 6). The quality of the research can never be better than the quality of the data collected (Van Kammen and Stouthamer-Loeber 376), and, by extension, the data never better than the means by which it was collected. Some errors in data collection are unavoidable, but a flawed methodology can seriously handicap research.

Despite all of the guidance offered by books, however, there’s no easy way to start a social science research project (Van Kammen and Stouthamer-Loeber 375). Management of a social science research project requires skills which are not usually learned at universities, and the scientific journals to which social scientists often turn for information in their respective fields are no help to someone conducting a social science research project for the first time since they seldom provide information on how to start a social science research project. Often conducting social science research for the first time entails a painful process of trial and error, and with any luck, advice from mentors or more experienced researchers helps ease the pain. (Van Kammen and Stouthamer-Loeber 375).

3.2 The Interview as a Tool for Social Science Research

One of the most common ways of conducting social science research is the interview. “Increasingly, the social scientist has turned from books to social phenomena to build the foundations of science,” write Goode and Hatt (Goode and Hatt 185). It is possible that speech further complicates research by adding yet another dimension, but as Max Weber once noted, “This dimension is also a source of information” (Goode and Hatt 185). The social science interview taps into that information, allowing the researcher to uncover something that might have gone unnoticed otherwise. (Goode and Hatt 185).
The interview represents, in the words of William J. Goode and Paul K. Hatt, coauthors of *Methods in Social Research*, what amounts to the development in “complexity and precision far beyond common-sense mental operations” of an everyday social activity - conversation. (Goode and Hatt 184). An interview is more than a casual inquiry because it has explicit objectives. Social scientists treat the interview as a valid research technique, and in the hands of a shrewd researcher it can be a powerful instrument for collecting information.

Almost everyone reading this knows what a job interview is like. In a job interview the interviewer asks a series of questions designed to find out “What can you do?” When parents question their children about “What really happened at school,” they are also conducting an interview, whether they realize it or not. If parents don’t believe their children are telling the truth at first, they “probe” deeper to see if they can get an answer that tells the whole story. (Goode and Hatt 184). In the classic “whodunit” films, homicide detectives interrogate suspects to find out where they were on the night of the crime. They might ask innocent questions at first, trying to get the suspects to relax their guard, and then strike them with really probing questions when they least expect it to see if their alibis still hold up. (Goode and Hatt 184).

Like any other social activity, interviewing has many facets. There are many different interviewing styles and techniques, depending on the purpose of the interview. The style and format of the interview, as well as the interview questions themselves should be carefully designed to reflect the goals of the research. For example, an interviewer might find that an informal, unstructured interview is more suited for the purposes of his work than a formal set of questions. Because an informal, unstructured interview resembles a casual conversation, the interviewee might be more comfortable sharing information than he/she otherwise would be in a more formal, structured interview. If the interviewer wants the interviewee to address a specific issue, he can use an informal and unstructured, yet probing conversation to funnel the reader towards the main points he/she would like to address in the research.

This type of interview is called a *qualitative interview*, and was a favorite among social scientists of the turn of the century who used it almost exclusively. Qualitative interviews are unstructured, and tend to look more like regular conversations (but they have the distinguishing feature of being very probing). Nevertheless, in the hands of a shrewd researcher, they can be very powerful instruments for obtaining information. The problem with the qualitative interview, however, is that it is not standardized, which makes it only suitable if the question of reliability is never raised and if one researcher isn’t required to check the work of another. (Goode and Hatt 185).

Some research, however, requires a more formally structured interview, an interview with a questionnaire prepared before hand. This kind of interview is more useful when the researcher has several items he/she would like to address in an interview, whereas qualitative interviews are more easily applied when one or a few items need to be addressed. In an interview with several different items on the agenda, the interviewer does not have the same luxury of funneling the interviewee towards the main items. In
fact, since there could be many items that need addressing, the interviewer is liable to get lost without a formal structure to the interview. Therefore, an interview which has several items on the agenda needs to have structure, even a specific set of questions.

The kind of interview chosen depends on the interviewer’s goals, but it is something he/she needs to be confident of before proceeding to the interview. The interviewer has to maintain control throughout, reacting to any unforeseen events. The questions should be kept fair and unbiased to make it more likely for the interviewee to consent to a second interview (in case some questions remain after the first interview). The interviewer has to direct the tempo of the interview, allowing sufficient time for each question, but making sure a few questions are not allowed to dominate. The interviewee should be provided with additional time at the end for reflection.

3.2.1 The Interview Made Modus Operandi for Collecting Data
The interview served as the modus operandi for collecting data for the IQP because the subject under research was dynamic and books did not always have the most current information. Generally, the author found that book- and internet-research was more valuable if it followed interview research and there were specific points that still needed clarifying. Thus, it was decided that the best way to learn what one needed to know was to get at the source of the information and to talk to the experts. The interviews supplied the bulk of the data needed to write this paper.

3.2.2 Developing a Systematic Framework for Planning and Conducting the Interviews
The research had to take into account the wide range of opinions shaping Germany’s fire protection community today, and couldn’t be biased towards one sector of industry. Each sector of the industry had to be given the same opportunity to suggest ideas and offer recommendations. A systematic framework was developed to carry out the research in an unbiased manner, subdividing Germany’s fire protection engineering community into three sectors – academia, industry, and the fire service. One person from each sector was interviewed, and was given an opportunity to weigh in on the issues and offer their prognosis for the future of fire protection engineering education in Germany.

3.3 The Interviews
3.3.1 Professor Lange
The choice for first interview was Professor Joerg Lange, a civil engineering professor at the Technical University of Darmstadt and the author’s professor for steel design and construction. Professor Lange is arguably one of the university’s most enthusiastic supporters of creating a separate fire protection engineering degree. At the time of the interview, Professor Lange was in fact engaged in his own fire protection research. Having worked many years in industry before accepting a professorship at TU Darmstadt, Professor Lange’s background gave him the necessary tools to discuss the strengths and weaknesses of fire protection engineering education in Germany.
Entering the interview, the author was interested in learning more about the performance-based Eurocodes and what impact they were having on fire protection engineering in Germany. One important issue raised during the interview was whether the Eurocodes and the harmonization process were downgrading fire safety in Germany (a matter discussed in greater detail in the Appendix A). In addition to questions about the Eurocodes, questions about the fire service, the possibility of standardizing fire fighting practices, and the influence of the fire service on fire protection engineering were raised.

The first interview with Professor Lange was an informal, qualitative-style interview, with no specific questions having been prepared beforehand. This interview yielded some surprising information about the Eurocodes. The new performance-based codes were seldom used in Germany; national and state prescriptive codes took precedence. The Eurocodes did not have the force of law and were not going to be the new performance based codes for Germany, but they were a signal of intent. Reacting to advice from Dr. Gerhardt Staerk, head of the Zentrale Institut für Technische Forschung (ZIT) and the author’s advisor in Germany, the author scheduled a second interview with Professor Lange. Dr. Staerk and the author both believed a second interview was necessary to find out more about fire protection education in Germany. The second interview was also a qualitative interview, but was significantly more focused than the first. The second interview focused on educational opportunities for fire protection engineering in Germany and the requirements for becoming a fire protection design professional. There is no fire protection engineering degree program in Germany.

3.3.2 Frau Wokan
The next interviewee, Frau Verena Wokan, is an architect whose firm operates out of a neighboring state, Rhineland-Pfalz. Speaking from many years of industry experience, she offered valuable insight into how the construction industry operated in Germany and where fire protection fit in. The interview with Frau Wokan, in stark contrast to the previous two interviews with Professor Lange, was very formal, with a questionnaire having been prepared beforehand. The questionnaire was basically divided into three sections, although some questions covered more than one area: 1.) Education and Degrees, 2.) Job Environment/Work Place, and 3.) Daily Responsibilities. Below is the questionnaire used in the interview with Frau Wokan. For the full transcript of the interview, see Appendix C.

Frau Wokan Questionnaire:

1.) Education and Degrees:
   1.1.) What is fire protection engineering? (Was ist Brandschutz?)
   1.1.1.) What differentiates a fire protection engineer from other engineers? (Was unterscheidet einen Brandschutzingenieur, oder eine Brandschutzingenieurin, von anderen Ingenieuren?)
   1.1.2.) How much importance tends to be placed on fire protection engineers and the study of fire protection engineering today? (Wie wichtig sind Brandschutzingenieure und Brandschutz heute?)
1.2) What sort of education qualifies one to pursue higher education and/or a successful career in fire protection? (Welche Voraussetzungen benötigt man für eine erfolgreiche Karriere im Bereich des Brandschutzes?)

1.2.1.) What is the recommended academic background for choosing fire protection engineering as a career path? (Welchen akademischen/uniaversitären Background benötigt man, wenn man eine Karriere im Bereich des Brandschutzes aufstrebt? Welche Kenntnisse halten Sie für besonders Wichtig?)

1.2.2.) What kind of courses do you think would best prepare one for a future in fire protection? Would you recommend more courses from architecture or civil engineering? (Welche Kurse/Seminare sind sinnvoll? Würden Sie mehr Kurse aus dem Fachbereich Architektur oder Kurse aus dem Fachbereich Bauingenieurwesen empfehlen?)

1.2.3.) What is the educational background of most fire protection engineers in Germany? Are most structural engineers, architects, or fire fighters? Or do many have educational backgrounds not mentioned here? (Welche Ausbildung haben die Brandschutzbeauftragter in Deutschland?)

1.3.) A hot-button issue at some universities today is whether fire protection should be part of a basic university curriculum or whether instead it should be based on a full disciplinary education, such as architecture or civil engineering? (Sollte Brandschutz auch in der Zukunft Teil anderer Studiengänge sein? Oder Sollte es ein eigener Studiengang sein?)

1.3.1.) What is the case at most German universities today? (Wie ist es im Moment in Deutschland?)

1.3.2.) What is the case at the TU Darmstadt? What about the University of Wuppertal? (Wie ist der Studiengang in TU Darmstadt und in der Universität Wuppertal aufgebaut?)

1.4.) Are German universities under any pressure or obligation to conform to any nationally recognized standard(s) as to what constitutes a fire protection engineering program, or are they, in fact, free to determine for themselves what constitutes a fire protection engineering program? (Nimmt der Staat Einfluss auf den Studiengang?)

1.5.) Are there any German universities particularly well-known for their devotion to studies in fire protection engineering? (Gibt es in Deutschland Ausbildungstatten, die auf Brandschutz spezialisiert sind?)

1.6.) What sort of state exams, if any, must one take in order be officially certified as a licensed practicing fire protection engineer? (Was ist erforderlich um eine Lizenz als Brandschutzingenieur zu erhalten?)

1.6.1) Are there annual or periodical examinations for fire protection engineers to renew their licenses? (Muss man seine Lisenz als Bauingenieur regelmässig erneuern?)

2.) Job Environment/the Work Place:
2.1) What about the job environment? Is there a hierarchy at the workplace? If so, where does the fire protection engineer fit in? (Wo ist der Brandschutzingenieur innerhalb des Teams angesiedelt?)

2.2) Where would a typical German fire protection engineer spend most of his day? In the office at his desk or at a construction site? (Wo verbringt ein Brandschutzingenieur die meiste Zeit? In seinem Büro- oder auf der Baustelle?)

2.3) Do most fire protection engineers work for large companies, small companies, or for themselves? (Wo sind die Brandschutzingenieure aufgestellt? Wo arbeiten die Brandschutzingenieure? Haben sie ihr eigens Büro- oder sind sie meistens bei einer Behörde ausgestellt?)

2.4) Are many of them also professors? (Sind viele auch Professoren?)

3.) Responsibility/Daily Activities:

3.1.) Who has the greatest authority over the design of a building's fire protection aspects? Is it the fire protection engineer, the local fire department, a combination of the two, or somebody else? In case of an accident, who would be held accountable? (Wer hat in einem Streitfall hinsichtlich des Designs das letzte Wort? Der Architecht, der Brandschutzingenieur, oder die Feuerwehr?)

3.1.1.) Do fire protection engineering firms work together with fire departments to design buildings, or do they do it alone, consulting the fire department only when the need arises? Is it possible that the fire department might not even be involved in the design process? (Wer kann bei einem Brand verantwortlich gemacht werden?)

3.2.) Certainly fire codes are very important for fire protection engineers. Does any in particular take precedence over the others? If not, how can he/she justify the use of one over another? (Welche Fire Codes sind für den Brandschutzingenieur maßgeblich? Eurocodes, DIN, HBO, ISO?)

3.3.3 Professor Ries

A similar questionnaire was prepared for the interview with Professor Reinhard Ries, who was contacted for an interview after an article about him appeared in a local newspaper. As Chief of the Frankfurt Fire Department and a professor at the FH Darmstadt, Professor Ries straddles the gulf between the worlds of academia and the fire services. Professor Ries was asked to elaborate on the fire service’s role in fire protection and offer his thoughts on initiating fire protection engineering education in Germany.
3.4 Supplemental Information from Books, Journals, and Internet Resources

The interviews yielded a wealth of information and supplied the bulk of the data for the research. If there were any points that still needed clarifying after the interviews, supplemental information from books, journals, and internet resources was obtained. For example, after the interview with Professor Ries there were some unanswered questions about the responsibilities of the fire services, the answers to which were found on the Frankfurt Fire Department’s website.

3.5 Working with the Interview Transcripts

After the interviews were performed, all of the salient information was pulled together. Different categories were established, and the data was separated according to category. The experts who were interviewed provided information about the current state of fire protection education in Germany, the role of the fire services, and offered their opinions on whether Germany’s technical universities should develop specific fire protection engineering education and what that specific education would look like. These issues emerged as the overriding conclusions of the Results section and ultimately formed the different categories by which the data was analyzed.
# 4 Results and Data Analysis

## 4.1 Germany has Know-how to successfully implement Performance-Based Fire Codes

### 4.1.1 Fire Protection a Crucial Component of Building Design – Nachweisberechtigtger and Sachverstaendiger

<table>
<thead>
<tr>
<th>Statement</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire protection is a crucial component of building design. Neither design nor construction can proceed without approval from a Nachweisberechtigtger or Sachverstaendiger.</td>
<td>Second Interview with Professor Lange, Interview with Frau Wokan</td>
</tr>
<tr>
<td>The title of Sachverstaendiger is awarded by the Chamber of Commerce after successful completion of a state examination and performing several Gutachten (design or expert’s report), very few people in each state have it (approximately 90 in the state of Hessen), and it allows the holder to design buildings of any size, type, or occupancy.</td>
<td>Second Interview with Professor Lange</td>
</tr>
<tr>
<td>The Nachweisberechtigtger, like the Sachverstaendiger, is awarded upon successful completion of a state examination.</td>
<td>Second with Professor Lange</td>
</tr>
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</table>

### 4.1.2 The 5 Building Classes

<table>
<thead>
<tr>
<th>Statement</th>
<th>Source</th>
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<tbody>
<tr>
<td>The Hessian Building Codes, die Hessische Bauordnung (HBO), specifies 5 building classes. No specialized education beyond a university degree in civil engineering or architecture is required for building classes 1 - 3. For building class 4, one must be a Nachweisberechtigtger. For building class 5 and higher, one must be a Sachverstaendiger. The Architecture Chamber or the Engineering Chamber, depending on one’s education, is the only institution that has the authority to award</td>
<td>Interview with Frau Wokan</td>
</tr>
</tbody>
</table>
the title of Nachweisberechtigter, and the Chamber of Commerce the title of Sachverstaendiger.

### 4.1.3 Structural and Prospective Fire Protecting Engineering

The responsibility for fire protection is shared between the civil engineers and the architects, both of whom can hold the title of Sachverstaendiger in fire protection. However, each profession is responsible for a different component of fire protection; the civil engineers handle the structural engineering component, and the architects the “prospective” engineering component, which involves choosing non-flammable building components (e.g., choosing windows, doors, carpets, etc. which do not react to fire).

Source: Interview with Frau Wokan

### 4.1.4 Frankfurt: The Origin of the Modern Skyscraper

Frankfurt is the origin of the concept of safety in a modern skyscraper. New Chinese skyscrapers are being modeled after the design of skyscrapers in Frankfurt.

Source: Interview with Professor Ries

### 4.1.5 The Brandschutzcenters (Fire Protection Centers)

The expertise to train fire protection engineers already exists today at the so-called Brandschutzcenters. As mentioned in the interview transcript with Frau Wokan in the Appendix C, the closest Brandschutzcenter to Hessen is in Rhineland-Pfalz. The Chamber of Commerce is the government agency responsible for designating Brandschutzcenters. The education offered at these Brandschutzcenters is very diverse, with a wide variety of courses and training seminars available for civil engineers.

Source: Interview with Frau Wokan
architects, fire fighters, and professionals in all facets of the fire protection industry. The expertise from the Brandschutzcenters could be transferred to the universities since many of the Professors who teach at the Brandschutzcenters come from local universities anyways. Not all states have Brandschutzcenters. The state of Hessen, for example, doesn’t have one; the closest fire protection center to Hessen is located in the neighboring state of Rhineland-Pfalz.

### 4.1.6 Fire Protection Education in Germany

<table>
<thead>
<tr>
<th>The closest thing to a degree in fire protection is a Sicherheitsingenieur (safety engineering degree) offered at the University of Wuppertal.</th>
<th>Source: Interview with Frau Wokan, Interview with Professor Lange</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are actually two degrees in safety engineering offered at Wuppertal: the Diplom 1, and the Diplom 2. The Diplom 1 is offered the Fachhochschule Wuppertal (FH Wuppertal), and the Diplom 2 at the Technical University of Wuppertal (TU Wuppertal). The Grundstudium (prerequisite classes) of these degrees is the same; the only difference is the Hauptstudium (major classes). The Grundstudium refers to the basic requirements of a degree. The Hauptstudium, on the other hand, refers to more advanced classes in a particular field of concentration. As one might expect, students at the TU Wuppertal get a more theoretical education in safety engineering. Students at the FH Wuppertal, however, get a more practical, hands-on education in safety engineering. The same concepts are covered, but the approach is different at each institution.</td>
<td>Source: Interview with Professor Ries</td>
</tr>
<tr>
<td>The University of Köln offers a program in rescue engineering.</td>
<td>Source: Interview with Professor Ries</td>
</tr>
</tbody>
</table>
The University of Magdeburg offers both a bachelor’s and master’s degree in safety engineering. In fact, the FH Magdeburg had the first fire protection engineering professor in Germany.

4.1.7 Data Reflection and Analysis:
The Nachweisberechtigter and Sachverstandiger are the recognized fire protection experts in Germany today. But these fire professionals come from backgrounds in civil engineering or architecture, and, moreover, courses and the training seminars they had to take to get their titles don’t have any specialized fire protection engineering education. This system is appropriate for a prescriptive code environment. Switching to a performance-base code would drastically change the rules of the game, and building fire design would call for a more specialized education in fire protection engineering. The fire protection expertise available at educational institutions across Germany, as well as its rigid licensure system, demonstrates that Germany has all of the elements to make a performance-based fire code and fire protection engineering degree work. However, like New Zealand, the current experts in the field could try to resist any change to the status quo.

The Brandschutzcenters have a tremendous amount of fire protection resources which could be channeled to the universities to create a fire protection engineering degree. The closest thing to a degree in fire protection is a Sicherheitsingenieur (safety engineering degree) offered at the University of Wuppertal. The degree in safety engineering at the University of Wuppertal already covers some fire protection concepts; a new fire protection engineering degree could be started by using some courses from the safety engineering program and some from the civil engineering program. There’s no shortage of possibilities. For example, in the United States there are about three universities that offer a fire protection engineering degree; WPI only offers a Master’s Degree in fire protection engineering. There’s no reason why Germany couldn’t adopt a similar approach. But the know-how is there. Between the Brandschutzcenters and the University of Wuppertal, there’s plenty of expertise on fire protection engineering.

Despite intense pressure from industry, the fire services, and distinguished academics from campuses all across Germany, fire protection engineering still isn’t offered as a separate engineering degree anywhere in the Federal Republic of Germany. “Das ist ein Trauriges Kapitel in Deutschland,” recalls Professor Ries, who’s tried for many years to convince his peers in industry, academia and the fire services of the necessity of integrating fire protection engineering into the civil engineering and architecture curricula of Germany’s technical universities, but to no avail. The performance-based Eurocodes are at the bottom of Germany’s hierarchy of building and fire codes, and although some universities have taken steps to introduce fire protection concepts into their engineering curricula, in each case, however, they fall just short of creating a bona fide fire protection engineering degree. Some universities, like the University of Wuppertal, offer degrees in things like safety engineering, not quite fire protection engineering, but certainly a step in
the right direction. Germany’s educational institutions and licensure system are designed for a prescriptive-code environment, and a switch to a performance-based code will necessitate some changes in structure, but the data collected from the interviews and books revealed that Germany is one nation that has the know-how to make a performance-based fire code work. Whether a fire protection engineering degree will happen all at once in little stages is a matter of conjecture, but that it will happen at all is almost a foregone conclusion. Although Germany’s technical universities do not yet offer a fire protection engineering degree, its educational system shows that Germany takes fire protection seriously. According to Dr. Staerk, engineering by and far is the most respected profession in Germany. After Germany had been destroyed by the Allies during World War II, it was the engineers that put it back together again. That period of reconstruction following World War II forged a bond between engineers and Germany, a bond that still exists today. Germany is a nation of engineers, engineers who are proud of their history and are looking ahead to putting their talents in fire protection to good use in the future.

4.2 The Fire Services, their Role in Building Design, and Speculation about how they would fare under a Performance-Based Code System

4.2.1 The Fire Services’ Influence on Building and Fire Codes

| DIN 18230, a law that allows for a reduction in the designed fire load of a building if the building is near an active fire fighting facility, is an example of the prominent role the fire services currently play in building fire design. | Source: First Interview with Professor Lange |

4.2.2 The Fire Services as Researchers

| Smoke management, particularly in tunnels, is a topic of particular concern to fire fighters whose line of work gives them a front row seat to the wicked nature of this deadly phenomenon. | Source: Interview with Professor Ries |

| The Frankfurt Fire Department recently closed a project evaluating tunnel safety in Germany. Germany’s fire services work with universities and the industry on research and development projects to improve fire fighting tactics and building fire design. | Source: Interview with Professor Ries |
As a result of research into smoke behavior in tunnels, the Frankfurt Fire Department developed trucks to be used especially during fires in tunnels.

### 4.2.3 Technical Advice

The German fire services are consultants in the building design process. With blueprints of every major building in their cities and experience gained from research, they can be a good source for technical advice.

The fire services are routinely consulted for technical advice during building fire design, but they are not designers. Professor Ries had only designed buildings during his years at the TH Darmstadt and the time he spent working as an architect. His design years ended when he joined the fire service.

Many fire service officers are engineers or architects by training and many of them have design experience, but none of them is a designer. It’s beyond the scope of their responsibility. The fire service’s influence on the building design process is limited to technical advice. They have the authority to reject design proposals if they fail to satisfy minimum fire protection requirements, or to suggest changes to proposals to make them acceptable, but that’s as far as their powers go.

### 4.2.4 Technical Expertise of the Fire Services

Every one of the senior engineers in the Frankfurt Fire Department is a Sachverstaendiger, although they don’t officially hold the title. They know the fire codes by heart, and are as familiar with fire protection concepts as their industry-
counterparts.

<table>
<thead>
<tr>
<th>Their familiarity with the fire codes and their knowledge of fire protection gets them many requests for technical advice from designers. The fire service officers from the Frankfurt Fire Department, in addition to participating in research projects, frequent international symposiums on fire protection.</th>
<th>Source: Interview with Professor Ries</th>
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<tr>
<td>The Frankfurt Fire Department has 8 officers in the gehobene Dienst who have a specialized education in fire fighting technology (Feurwehrtechnick), and 6 in rescue engineering. Jens Stiegel, an officer of the gehobene Dienst who was present for the author’s interview with Professor Ries, specializes in fire fighting technology.</td>
<td>Source: Interview with Professor Ries</td>
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### 4.2.5 The Concept of the Rescue Elevator

Germany is also home to the concept of the rescue elevator. On 9/11 fire fighters had to climb many flights of stairs to reach the fire, but fire fighters in Germany use an elevator connected to the side of the building to fight fires in skyscrapers. The elevator is connected to an independent power source, so it won’t be affected by a power shortage in the building. Air-pressure differentiation keeps smoke out of the elevator shaft.

The rescue elevator is also intended to be an escape route for the physically handicapped residents of the building, who can go there and wait to be rescued by fire fighters. It’s a fire code diktat that every skyscraper must be connected to one.

Source: Interview with Professor Ries
4.2.6 Data Reflection and Analysis:
The fire services are central players in Germany’s fire protection community. Their influence extends to the building and fire codes, e.g. DIN 18230, which allows for a reduction in the designed fire load of a building if the building is near an active fire fighting facility. They are involved in fire protection research and have been responsible for important innovations in fire fighting techniques, developing a specialized fire truck for fighting fires in tunnels. Some gehobene Dienst members attend international symposiums and have specialized educations in fire fighting technology and rescue engineering. Their promotion of the concept of the rescue elevator shows that the fire services recognize the importance of fire protection, and, like their counterparts in New Zealand, would readily stand behind a new program in fire protection engineering.

The fire services play a significant role in building fire design and have been at the forefront of the debate on whether to switch to a performance-based fire code since Professor Ries’ predecessor, Professor Achilles, was Frankfurt’s Fire Chief, suggesting that if Germany were to implement a performance-based fire code of its own and create a separate fire protection engineering degree, like the one offered at WPI and the equal of any other degree in engineering, they will somehow influence it. If the reader recalls, New Zealand’s fire services were important donors to the University of Canterbury’s Department of Fire Protection Engineering. If New Zealand’s example is any lesson, after a switch to a performance-based code the fire services would be given a less prominent role in building fire design. Professor Ries, like Professor Achilles before him, teaches fire protection courses at one of Germany’s leading educational institutions, suggesting that Germany’s fire services could offer more resistance to any change in the status quo. But Professor Ries is also a pragmatist. He’s been a champion of the cause ever since he ascended to office, having been taught the importance of fire protection from his one-time professor at the TH Darmstadt, Professor Achilles, and he knows what has to be done in order for a fire protection engineering degree to succeed in Germany, suggesting that Germany’s fire services, like New Zealand’s, would also be amenable to compromise.

Professor Ries understands that in a performance-based code environment, the fire services would have to yield to the fire protection engineers and the universities producing them on matters of building fire design. But that doesn’t mean that they should withdraw altogether from fire protection engineering. On the contrary, they have an important role to play in the future, as they do now, and although the creation of a fire protection engineering degree would mean the loss of their expert-status, they still have a lot to offer to the fire protection engineering industry.

4.3 What would a German Fire Protection Engineering Degree look like?

4.3.1 Frau Wokan and Professor Ries’ Recommendations

| One can pursue a career in fire protection with a background in architecture, but civil | Source: Interview with Frau Wokan |
Engineering provides a more solid engineering foundation, which is absolutely crucial to understanding fire protection engineering concepts.

A fire protection engineering degree should either be a separate engineering degree or a sub-discipline of civil engineering. In any event, it should overlap with civil engineering and the two should have common core classes since many concepts in fire protection engineering have applications in civil engineering.

Professor Ries, who is himself a professor at the FH Darmstadt, shares Frau Wokan’s belief that fire protection engineering should either be separate or linked to civil engineering.

### 4.3.2 The State’s Influence on Curriculum

A proposal for a new academic program requires state approval to go forward; the state gives its approval only after it is satisfied the program fulfills its academic requirements. But after the proposal has been approved, the professors are free and clear to decide how best to structure the new program. But the state can intervene at any time if it has reason to believe the new program doesn’t satisfy its minimum requirements. This would be a rare event. In general, professors are given a lot of flexibility.

### 4.3.3 Data Reflection and Analysis:

In the Federal Republic of Germany today, fire protection engineering is recognized as being composed of two parts: *structural* and *prospective*. In Germany fire protection is the shared responsibility of the architect and the civil engineer, with the civil engineer responsible more for the structural engineering component of fire protection design and the architect more for what’s commonly referred to in Germany as the “prospective” component of fire protection design, e.g. choosing non-flammable building elements,
such as windows, doors, carpet, etc. which do not react to fire. Given this arrangement, one tends to wonder what a German fire protection engineering degree would look like, whether it would be more of an extension of an architectural or civil engineering degree, or whether it be better off as a separate engineering degree altogether. Interviews with Frau Wokan and Professor Ries, both of whom are architects, reveal unanimity of opinion among the experts that a fire protection engineering degree would have to be closer to civil engineering than architecture, if not a totally separate engineering degree. Frau Wokan also recommended that students in Germany interested in becoming fire professionals get civil engineering degrees first, rather than architectural degrees. In order to understand fire protection one needs an engineering background, she believes.
5 Conclusion

The interviews revealed that although German universities do not yet offer a fire protection engineering degree like the one offered at WPI, Germany unquestionably has the technical know-how to develop one if it adopts a performance-based fire code. If the Germans were to adopt a performance-based fire code like New Zealand’s, a genuine fire protection engineering degree at one or more of its major technical universities wouldn’t be too far behind because of the demand for fire protection engineers that it would generate. The performance-based Eurocodes are at the bottom of the hierarchy of building and fire codes, and can only be used as an alternative to the prescriptive national and state building and fire codes if they specify more stringent requirements, but this rarely happens in practice. But as Bob Dylan would say, ‘the times they are a changing.’ Most of the industrialized world is already beginning to experiment with performance-based fire protection, and some countries like New Zealand have had a full-fledged performance-based fire code for a few years. A German performance-based fire code is bound to follow sooner or later. To wit, some universities are already offering fire protection engineering-like degrees, a notable example being the University of Wuppertal in northern Germany which offers a safety engineering degree. Professor Ries, an architect by training and chief fire fighter at the Frankfurt Fire Department, teaches fire protection courses at the FH Darmstadt which are open to students from both the FH and TU Darmstadt. Professor Ries’ predecessor, the former fire chief of Frankfurt, Professor Achilles, did the same thing. In fact, it was the late Professor Achilles who gave Professor Ries his first introduction to fire protection in one of his fire protection classes at the TU Darmstadt when Professor Ries was a student there and it was still known as the TH Darmstadt.

Professor Ries devoted his career to getting a complete fire protection engineering program started at the either FH or TU Darmstadt or both. During the interview he seemed really disappointed that neither one of those schools has one yet, or even appears close to getting one. Professor Ries might be a man ahead of his time; none of his peers seemed to share his sense of urgency. But his influential role in trying to get fire protection engineering recognized as a separate engineering discipline by Germany’s technical universities is an example of the important part the fire service can play in developing a fire protection engineering degree to meet the needs of a performance-based fire code. If the reader recalls, when New Zealand implemented its performance-based fire code, the fire services were important donors to the fire protection engineering program at the University of Canterbury. And in Germany, it is again the fire service, under the leadership of Professor Ries, which is leading the charge to get a fire protection engineering degree started in Darmstadt. If Germany were to adopt a performance-based code, just like in the case of New Zealand, the fire services would have an important role to play in starting a fire protection engineering degree at one or more of the major technical universities in Germany, even if it would mean a curtailment of their fire protection powers and the loss of their expert-status.

Since Germany allows universities a lot of independence in designing academic programs, after a proposal for a new academic program gets the required state approval
the professors are free to design it however they choose. When Germany finally gets a fire protection engineering degree, the experts all seemed to agree, it should be deeply rooted in science and engineering and share core classes with civil engineering since it has many applications to the construction industry. It should be considered equal to a degree in civil, mechanical, electrical, or chemical engineering. In contrast, the WPI Fire Protection Engineering Program, created in 1979 by Professor Fitzgerald, a civil engineering professor at WPI, is a far cry from what they are hoping to achieve in Germany. The Department of Fire Protection Engineering is located in Higgins Laboratories, the WPI Mechanical Engineering Department building at WPI; instead of being part of the WPI Civil Engineering Department, it serves as a cross-road for talented students with mechanical, civil, chemical, and electrical engineering backgrounds, as well as people with backgrounds in computer science, physics, management, and mathematics.

To summarize, Germany is a nation capable of developing a fire protection engineering degree to supply the fire professionals that would be required under a performance-based code system. Just like in New Zealand, once a performance-based fire code is put into effect, progress would occur gradually. It would take several generations of graduates from the new fire protection engineering programs to completely replace the former fire protection experts; recall in New Zealand the former fire professionals were reluctant to surrender their expert-status. The fire services were more cooperative, and, in fact, supported the new fire protection engineering programs through funding. It is also possible that, like in New Zealand, the performance-based codes would include prescriptive documents that could be used as an alternative to a performance-based design, perhaps as a compromise with the former fire professionals. At first, fire professionals might prefer to use the prescriptive documents until they get comfortable with performance-based design. The performance-based codes would require some time to be phased in, but eventually prescriptive fire codes would yield to performance-based fire protection engineering.

The IQP achieved its objectives because it provided sufficient evidence to support the proposition put forth at the beginning of the paper, that making the transition from a prescriptive “meet the code” approach to fire protection engineering towards a system that establishes explicit performance goals for fire safety design requires Germany’s technical universities to offer specific fire protection engineering education. The IQP does not conclusively prove this thesis statement. But the data from the Background and Results section corroborate the idea that education is crucial to the development of a bona fide performance-based fire safety design system. In that respect, its objectives were met.
6 Reflections

The IQP makes a modest, yet important contribution to the issue of performance-based fire codes and its implications on education. It also recognizes the link between fire protection engineering education to performance-base codes, and puts forth the proposition that the former must an inevitable consequence of the latter. Future research could be a possibility, such as researching whether Germany has adopted a performance-based fire code or started a fire protection engineering program and if either one has been successful. If research determines that either performance-based practices or fire protection engineering education failed to take hold in Germany for some reason, the obstacles to progress could be identified and the steps taken by the government and industry to overcome those obstacles documented and analyzed.

The IQP was limited in scope. The author’s limited knowledge of the subject and limited preparation before beginning the IQP handicapped the field research. A plan of action was never established before the author went to Germany, and it was unclear who would be the primary advisor to the project. In retrospect, the author should have prepared a more detailed plan of action before heading to Germany and better coordinated research with his advisor in Worcester as well as the advisor to the project in Darmstadt, Dr. Staerk.

The author experienced difficulty adjusting to life in Germany, especially at a time of heightened anti-American sentiment following the 2003 invasion of Iraq. The experience was made more difficult by the unexpected death of his uncle, just three years after three years after the death of his mother. All of these events combined to further frustrate progress on the IQP. But he was determined not to give up. Buoyed by the support of Dr. Staerk and his friends in Darmstadt, the author resisted the temptation to return home and continued carrying out the research until his last day in Germany.

With the research phase of the IQP behind him, the author returned home to Worcester to begin writing the report. Difficulty readjusting to WPI also impeded progress of the IQP because the author had his MQP, as well as other academic requirements to take care of. The IQP was put on hold until B-term of 2006. Revisiting the IQP after a year proved to be challenging work for the author. Analyzing the data was difficult enough - the report still had to be written. But it was done, in part thanks to Professor Albano’s unwavering support.

In retrospect, many things could have been done differently. More diverse methods of collecting data could have been employed for the research, or more interviews could have been performed. Hindsight is always 20/20. But the IQP is what it is, and, though some things could have been done differently, overall the IQP was a valuable learning experience for the author. It was his first time conducting a large-scale research project, and he did it alone and in a foreign country (conducting some of the interviews in a foreign language). It was a difficult undertaking, but it was something he did with minimum fuss and in spite of all of the hardships he has had to face. It is an experience he will carry with him for the rest of his life.
Appendix A: First Interview with Professor Lange

On Thursday, December 9, 2004 I met with Professor Lange, Professor of Structural Engineering at TU Darmstadt, who is currently conducting research into fire protection engineering and structural fire protection, in order to learn the current situation of fire protection engineering in Germany. During the interview, I also asked him about the so-called “Hot Eurocodes” and what effect, if any, the harmonization process was having on fire protection engineering in Germany. In other words, was harmonization lowering the quality of the fire codes? There were also questions about the role of the fire service in fire protection engineering, and if fire fighting could be standardized in much the same way as fire protection engineering. The interview was an informal, qualitative-style interview that didn’t look for answer to specific questions, per se, but rather looked instead to paint a picture of the current situation of fire protection engineering in Germany under the harmonization process.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>Is there a common set of building and fire codes for all EU member-nations?</td>
<td>Yes. Fire requirements are discussed in section 1.2 of each section of the Eurocodes (EC). These are the so-called &quot;Hot Eurocodes.&quot; EC 1 deals with fire loading cases, EC 2 with concrete, EC 3 with steel, and EC 4 with composite concrete.</td>
</tr>
<tr>
<td>Do the “Hot Eurocodes” take precedence over state and national fire codes?</td>
<td>No. Building and fire protection requirements and regulations are still determined at the state level. In Darmstadt, for example, the appropriate documents would be the Hessian Building codes, die Hessische Bauordnung (HBO), since Darmstadt is located in the state of Hessen. To be sure, the state codes themselves are modeled on the national building code, die Deutsche Bauordnung, but there are still differences between the states. One can’t expect the state codes are not going to be perfect replicas of the national code because every state has its own unique traditions, culture, population and demographics, and level of industrialization. To a certain extent, the EU member-nations also try to replicate the Eurocodes, but differences between them are inevitable for the same reasons that there are differences between the states.</td>
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<td>Question</td>
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<tr>
<td>Is there a danger that harmonization could lower fire protection standards in Europe?</td>
<td>Not according to Professor Lange, who believes fire protection in Europe is as strong ever. To his knowledge, the harmonization process hasn't had any negative effect on fire protection in Europe.</td>
</tr>
<tr>
<td>Could fire fighting be standardized?</td>
<td>No. Building and fire codes lend themselves more easily to harmonization, than does fire fighting. Fire fighting is something altogether different. Fire fighting in the cities is more rational, fire fighting is a paid profession. In Germany’s small towns and villages, however, fire fighting is more emotional. There are no professional fire brigades, the fire fighters are volunteers. And everybody in the town knows a fire fighter. Many people have a neighbor, a friend, or a relative who's a fire fighter. Volunteer fire fighters hold normal jobs in addition being a fire fighter, but nevertheless are prepared to respond to a fire alarm anywhere in their jurisdiction at a moment’s notice.</td>
</tr>
<tr>
<td>How fast can fire fighters respond to a fire?</td>
<td>In Germany, fire fighters are said to reach the scene in less than 6 minutes (Corroborated by Dr. Stärk).</td>
</tr>
<tr>
<td>What influence, if any, do the fire services have on fire protection engineering?</td>
<td>There's a law, DIN 18230, that allows for a reduction in the designed fire load of a building if the building is near an active fire fighting facility. Columns are designed for dead load and the live load that would be expected in 50 years. If the dead load had a safety factor of 1.35m and the live load of 1.5, then the safety factor of the fire load could be reduced to 1.0, according to EC 1.</td>
</tr>
<tr>
<td>What is the process for designing a building for fire protection?</td>
<td>Design of a building requires a Sonderbau which contains the project's fire designer’s recommendations for the building. The Sonderbau is certified by a Gutachter (legal witness), and then presented to the state.</td>
</tr>
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</table>
authorities, who then determine whether the Sonderbau meets state code. If it does, it is used for construction.
Appendix B: Second Interview with Professor Lange

The second interview with Professor Lange focused on the qualifications of becoming an officially licensed fire professional in Germany.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>From what professions do most fire professionals come from?</td>
<td>Most people involved in fire protection come from structural engineering or architecture backgrounds.</td>
</tr>
<tr>
<td>Is a fire protection engineering degree offered anywhere in Germany?</td>
<td>There is no such thing as a fire protection degree.</td>
</tr>
<tr>
<td></td>
<td>The closest thing to a degree in fire protection is a Sicherheitsingenieur (safety engineering degree) offered at the University of Wuppertal.</td>
</tr>
<tr>
<td>Does one need something beyond a university education in structural</td>
<td>In order to produce fire protection designs for buildings up to a certain size, one must be a Nachweisberechtigter (from the HBO), which roughly means proof permit.</td>
</tr>
<tr>
<td>engineering or architecture to produce fire protection engineering</td>
<td>One becomes a Nachweisberechtigter after taking a state examination. Brief 4-day-long review courses are offered before the exam. The Nachweisberechtigter could be considered the equivalent of the structural engineering Dipl.-Ing.</td>
</tr>
<tr>
<td>designs?</td>
<td>The title of Sachverstaendiger allows one to design buildings of any size or type.</td>
</tr>
<tr>
<td>What is beyond Nachweisberechtigter?</td>
<td>The title of Sachverstaendiger allows one to design buildings of any size, type, or occupancy.</td>
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<tr>
<td></td>
<td>In order to become a Sachverstaendiger one is also required to take a state examination. Again, a brief review course lasting around one to two weeks usually precedes the exam. In addition, one has to perform between five or six Gutachten. A Gutachten is more than a design; it can be thought of as an expert’s report. Like a design, it contains input data, improvement advice and recommendations, calculations, but it’s more forceful. There are no more</td>
</tr>
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</table>
than 90 practicing Sachverstaendigers in Hessen.
The ultimate goal of my IQP will be to determine what qualifies (education, certification, experience) one as a fire protection engineer in Germany, and what are the responsibilities/daily activities of a German fire protection engineer, and, time permitting, what are the similarities/differences to those of an American fire protection engineer. In other words, what is a German fire protection engineer’s job like on a daily basis? What sorts of problems is he confronted with and how does he resolve those problems?

<table>
<thead>
<tr>
<th>What is fire protection engineering? (Was ist Brandschutz?)</th>
<th>There are two types. She deals with prospective.</th>
</tr>
</thead>
<tbody>
<tr>
<td>What differentiates a fire protection engineer from other engineers? (Was unterscheidet einen Brandschutzingenieur, oder eine Brandschutzingenieurin, von anderen Ingenieuren?)</td>
<td>Fire protection engineering as a separate discipline doesn't exist yet in Germany; that will come in the future perhaps. But nevertheless fire protection is always a major concern during design and construction. Designing a building for fire protection is the shared responsibility of the architect and civil engineer. Structural engineers handle fire protection issues that arise during the design of the structure, and architects are responsible for the “prospective” part of fire protection engineering, such as specifying windows, doors, carpets, etc. that won't react to fire. Master craftsmen who have a degree from a Fachhochschule can also make contributions to fire protection designs.</td>
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<td></td>
<td>There are 5 building classes. No specialized education beyond a university degree in civil engineering or architecture is required for building classes 1 - 3. For building class 4, one must be a Nachweisberechtigter. For building class 5 and higher, one must be a Sachverstaendiger. The Architecture Chamber or the Engineering Chamber, depending on one's education, is the only institution that has the authority to award the title of Nachweisberechtigter, and the</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
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<tr>
<td>Chamber of Commerce the title of Sachverstaendiger.</td>
<td>Brandschutzbeauftragters are people hired by companies to ensure that all of their fire protection equipment is operating smoothly and to disseminate information to company employees about how to use them and how to properly react during a fire. The Brandschutzbeauftragters are not responsible for fire protection designs.</td>
</tr>
<tr>
<td>How much importance tends to be placed on fire protection engineers and</td>
<td>Construction requires approval from a Sachverstaendiger in order to go on. That is a state requirement in Hessen, a Landgesetz. The same law exists in each of Germany’s states. There are also very few Sachverstaendigers in each state. In order to be become a Sachverstaendiger, one has to have spent many years in industry in fire protection engineering design, probably as an apprentice to another Sachverstaendiger. Professor Lange is a Sachverstaendiger.</td>
</tr>
<tr>
<td>the study of fire protection engineering today? (Wie wichtig sind</td>
<td></td>
</tr>
<tr>
<td>Brandschutzingenieure und Brandschutz heute?)</td>
<td></td>
</tr>
<tr>
<td>What sort of education qualifies one to pursue higher education and/or</td>
<td>A background in civil engineering would do it. One can still lead a successful career in fire protection with a background in architecture, but civil engineering provides a more solid engineering foundation.</td>
</tr>
<tr>
<td>a successful career in fire protection? (Welche Voraussetzungen</td>
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<tr>
<td>benötigt man für eine erfolgreiche Karriere im Bereich des Brandschutzes?)</td>
<td></td>
</tr>
<tr>
<td>What is the recommended academic background for choosing fire protection</td>
<td>Civil engineering or architecture.</td>
</tr>
<tr>
<td>engineering as a career path? (Welchen akademischen/universitären</td>
<td></td>
</tr>
<tr>
<td>Background benötigt man, wenn man eine Karriere im Bereich des Brandschutzes aufstreb? Welche Kenntnisse halten Sie für besonders Wichtig?)</td>
<td></td>
</tr>
<tr>
<td>What kind of courses do you think would best prepare one for a future in</td>
<td>Refer to previous two questions.</td>
</tr>
<tr>
<td>fire protection? Would you recommend more courses from architecture or</td>
<td></td>
</tr>
<tr>
<td>civil engineering? (Welche Kurse/Seminare sind sinnvoll? Würden Sie mehr Kurse aus dem</td>
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<tr>
<td>Fachbereich Architektur oder Kurse aus dem Fachbereich Bauingenieurwesen empfehlen?)</td>
<td>Refer to previous two questions.</td>
</tr>
<tr>
<td>What is the educational background of most fire protection engineers in Germany? Are most structural engineers, architects, or fire fighters? Or do many have educational backgrounds not mentioned here? (Welche Ausbildung haben die Brandschutzingenieure in Deutschland?)</td>
<td>(Eigenes Studium mit Grundstudium in Bauingenieurwesen.) A separate engineering degree with core classes in civil engineering.</td>
</tr>
<tr>
<td>A hot-button issue at some universities today is whether fire protection should be part of a basic university curriculum or whether instead it should be based on a full disciplinary education, such as architecture or civil engineering? (Sollte Brandschutz auch in der Zukunft Teil anderer Studiengänge sein? Oder Sollte es ein eigener Studiengang sein?)</td>
<td>It's not a separate engineering degree.</td>
</tr>
<tr>
<td>What is the current situation in Germany? (Wie ist es im Moment in Deutschland?)</td>
<td>It's not a separate engineering degree.</td>
</tr>
<tr>
<td>What is the case at the TU Darmstadt? What about the University of Wuppertal? (Wie ist der Studiengang in TU Darmstadt und in der Universität Wuppertal aufgebaut?)</td>
<td>It's not a separate engineering degree.</td>
</tr>
<tr>
<td>Are German universities under any pressure or obligation to conform to any nationally recognized standard(s) as to what constitutes a fire protection engineering program, or are they, in fact, free to determine for themselves what constitutes a fire protection engineering program? (Nimmt der Staat Einfluss auf den Studiengang?)</td>
<td>A university interested in starting a new academic program would first have to seek acceptance from the state. If it meets all of the minimum requirements and gets state approval, then the professors would then have the authority to determine the curriculum however they see fit.</td>
</tr>
<tr>
<td>Are there any German universities particularly well-known for their devotion to studies in fire protection engineering? (Gibt es in Deutschland Ausbildungstaten, die auf Brandschutz spezialisiert)</td>
<td>The closest Brandschutzcenter to Hessen is in Rhineland-Pfalz. States usually have no more than two Brandschutzcenters which have been approved by the Chamber of Commerce. The Chamber of Commerce is</td>
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<td>Question</td>
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<tr>
<td>Sind?</td>
<td>(Was ist erforderlich um eine Lizenz als Brandschutzingenieur zu erhalten?)</td>
</tr>
<tr>
<td>What sort of state exams, if any, must one take in order be officially</td>
<td>Nachweisberechtigter/Sachverstaendiger.</td>
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<tr>
<td>certified as a licensed practicing fire protection engineer?</td>
<td></td>
</tr>
<tr>
<td>Are there annual or periodical examinations for fire protection</td>
<td>Renewal of a Nachweisberechtigter or Sachverstaendiger license requires payment of an annual fee to the appropriate state agency which issued the license, either the Chamber of Engineering/Chamber of Architecture or the Chamber of Commerce.</td>
</tr>
<tr>
<td>engineers to renew their licenses? (Muss man seine Lisenz als Bauingenieur</td>
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<td>regelmaessig erneuern?)</td>
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<tr>
<td>What about the job environment? Is there a hierarchy at the work place?</td>
<td>Typically, the architect is the lead designer.</td>
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<tr>
<td>If so, where does the fire protection engineer fit in? (Wo ist der</td>
<td></td>
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<tr>
<td>Brandschutzingenieur innerhalb des Teams angesiedelt?)</td>
<td></td>
</tr>
<tr>
<td>Where would a typical German fire protection engineer spend most of his</td>
<td>The Bauleiter (Project Manager) is usually at the construction site, because his job is to inspect the work of the other people to make sure they haven't overlooked anything. A structural engineer specializing in fire protection would probably spend most of his time in the office.</td>
</tr>
<tr>
<td>day? In the office at his desk or at a construction site? (Wo verbringt</td>
<td></td>
</tr>
<tr>
<td>ein Brandschutzingenieur die meiste Zeit? In seinem Büro- oder auf der</td>
<td></td>
</tr>
<tr>
<td>Baustelle?)</td>
<td></td>
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<tr>
<td>Do most fire protection engineers work for large companies, small</td>
<td>(Ganz unterschiedlich.)</td>
</tr>
<tr>
<td>companies, or for themselves? (Wo sind die Brandschutzingenieure aufgestellt? Wo arbeiten die Brandschutzingenieure? Haben sie ihr eigens Buero oder sind sie meistens</td>
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<tr>
<td>It varies. Some work for large companies, some for small companies. Some</td>
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<td>have their own offices, like Frau Wokan.</td>
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<tr>
<td>Are many of them also professors? (Sind viele auch Professoren?)</td>
<td>She didn’t know.</td>
</tr>
<tr>
<td>Who has the greatest authority over the design of a building's fire protection aspects? Is it the fire protection engineer, the local fire department, a combination of the two, or somebody else? In case of an accident, who would be held accountable? (Wer hat in einem Streitfall hinsichtlich des Designs das letzte Wort? Der Architekt, der Brandschutzingenieur, oder die Feuerwehr?)</td>
<td>For building classes 1-3, the Bauleiter (project manager) has the greatest authority over the fire protection components of a building. All of the decisions must go through him; he has the last word. The courts will hold him/her responsible if something happens and an investigation determines he/she ignored minimum code requirements. For building class 4, either the Brandschutznachweisberechtigter or the Brandschutzsachverständiger have the last word; for building class 5, the Brandschutzsachverständiger.</td>
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<tr>
<td>Do fire protection engineering firms work together with fire departments to design buildings, or do they do it alone, consulting the fire department only when the need arises? Is it possible that the fire department might not even be involved in the design process? (Wer kann bei einem Brand verantwortlich gemacht werden?)</td>
<td>If there is a mistake in a design, the designer is responsible. The Bauleiter would usually be held accountable because he has to inspect the design and construction and sign off at the end. If he overlooks a serious mistake either in the design or construction of the building, he can be held accountable. All orders on the construction site emanate from him. If he gives an order, but doesn’t check on the worker(s) to see if the order is being carried out correctly, he could get into trouble. As a result, most Bauleiters or the companies they work for carry insurance.</td>
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<tr>
<td>Certainly fire codes are very important for fire protection engineers. Does any in particular take precedence over the others? If not, how can he/she justify the use of one over another? (Welche Fire Codes sind für den Brandschutzingenieur maßgeblich? Eurocodes, DIN, HBO, ISO?)</td>
<td>Building codes in the Federal Republic of Germany can be arranged in a pyramid (See Figure Below). The Gesetze (law), crown the pyramid at the top and take precedence over the Regeln (rules and regulations). The fundamental difference between Gesetze and Regeln is that Gesetze, emanating from the federal or state (Bundesland) government, are more forceful. The distinction is important. The penalties are harsher for breaking Gesetze than for breaking Regeln because Gesetze</td>
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enjoy the full sponsorship of the federal or state government. The Gesetze regulating construction industry practices go through the same basic processes as any other laws, becoming Gesetze only when they receive the backing of the federal or state government which deems them necessary for the common good, which explains why there are harsher penalties for breaking Gesetze. Gesetze always take precedence over Regeln, except in the rare circumstances where Regeln are more stringent.

At the very top of the pyramid are the Bundgesetze, laws that have been enacted by the highest courts in the federal government of Germany. Representing the highest law of the land, it goes without saying that Bundgesetze take precedence over all other laws. Some examples of Bundgesetze are:
The Arbeitsstattenverordnung, which specifies how many rest rooms for men and women each type of building should have; The Garagenverordnung; And the Energiesparverordnung, which limits the consumption of energy to 50 Kilowatts / m² per occupancy (Frau Wokan).

Germany, like the United States, is a federal republic consisting different states, each of which has the power to enact its own laws. State laws are not as binding as federal laws. Occupying the next stage of the pyramid, after the Bundgesetze, are the Hessian Building Codes, known in German as die Hessische Bauordnung (HBO). These are laws enacted by the state government of Hessen and are only valid in the state of Hessen, although the other states of Germany, to be sure, have similar laws. The HBO, renewed every 5 years, applies at all times, unless, however, it happens to contradict the Bundgesetze, in
which case the Bundgesetze takes precedence, as previously mentioned. (Frau Wokan).

Occupying the third stage of the pyramid is the "allgemeine anerkannte Regeln der Technik," or in English “the generally accepted rules of technology.” These are sensible engineering practices that are not written into any law, but passed down from one generation to another. Some of these have even reached the status of law. (Frau Wokan).

At the lowest stage of the pyramid are the Regeln, such as the VOB (the VOB contains the HOAI, DIN, or the Euro codes). These apply only in instances where they do not conflict with any of the aforementioned Gesetze. As a general rule, they are used only when their specifications are stricter than those of the Gesetze. Some Regeln that have to do with Standsicherheit (structural stability) have been recognized as Gesetze (laws). (Frau Wokan).

*For a graphic representation, refer to figure below.*
The Hessische Bauordnung (State Laws) includes the VOB, which contains the HOAI, DIN, and the Eurocodes.

Figure 3: Hierarchy of Building Codes
Appendix D: Interview with Professor Ries


Ich möchte Ihnen danken für die gute Zusammenarbeit, und dass Sie Zeit von Ihrem Tag genommen haben um ein Paar Fragen zu beantworten. Das Interview würde vielleicht eine Stunde lang dauern. Und ich wollte auch fragen, ob wir nach dem Interview vielleicht 10-Minuten Zeit haben würden um umzusehen in Ihrer Brandwache?


| Wo haben Sie studiert und was haben Sie studiert? Wo war Ihr Curriculum Vitae/Ihre Lebenslauf? | Professor Ries studied architecture at the TU Darmstadt, which at the time was known as die Technische Hochschule (TH) Darmstadt. The term Hochschule was later dropped because of its association with secondary school in the Anglo-Saxon world. Professor Ries discovered he had an interest in fire protection late in his academic career. When he was a student at the TH Darmstadt some of the professors in the architecture and engineering departments started offering courses and workshops in fire protection. One of them was the now late Professor Achilles, a distinguished former professor at the TH Darmstadt and Ries’ predecessor at the Frankfurt City Fire Department. |
| Where did you study and what had you majored in? What is your Curriculum Vitae? | Professor Ries’ had majored in architecture at the TH Darmstadt. As a student at the TH Darmstadt, he attended lectures in Bauphysik (building physics). He also took courses in construction project management. Courses in... |
| Was sind die Hauptaufgaben von Ihnen? | In Germany, the emergency services not under the jurisdiction of the police department are the lumped together with the fire department. Therefore, as Chief of the Frankfurt Fire Department, Professor Ries not only heads the fire service but oversees all operations of the other emergency services under his command as well. This is a big job which requires a lot of managerial skills, which Professor Ries learned while a student at the TH Darmstadt.

The fire service is an active participant of the building design process, usually in the form of technical advice. With blueprints of every major building in Frankfurt in their possession and research experience, the Frankfurt Fire Department is a good source for advice on fire protection.

Like their counterparts in the United States, German fire fighters take an oath to protect and serve the public. To meet those ends, they are constantly drilling, honing their skills to prepare for a real fire. Professor Ries’ description of the thorough training his fire fighters go through was reminiscent of the historian Josephus writings on the Roman army: the drills of the Roman army resembled bloodless battles, and their battles bloody drills. Professor Ries believes his fire fighters are ready for anything.

But a fire fighter’s job is never done. Any time a natural or man-made disaster happens to occur anywhere in the world, such as the terrorism attacks that struck the twin towers of the World Trade Center in Manhattan and the Pentagon in |
| What are your main responsibilities? | management were very popular electives among the architecture students since architects were expected to be good managers too. |
Washington, D.C. on September 11th or those that struck the London mass transit system on the 21st of June, there’s sure to be throngs of reporters waiting for Professor Ries to arrive to work with questions about how well the Frankfurt Fire Department is prepared to deal with such an event.

The media attention helps to keep the Frankfurt Fire Department on its toes, but the ultimate test of its preparedness is how quickly it responds to a fire. The maximum emergency response time of the Frankfurt City Fire Department is 10 minutes, a time they hope to reduce to 5 or 6 minutes in the near future. Other fire departments in other municipalities have different emergency response times. Dr. Staerk’s hometown of Gunter’s Bloom in the state of Rhineland-Pfalz has a maximum emergency response time of 8 minutes, slightly less than Frankfurt’s. But it’s a lot smaller and more sparsely populated than Frankfurt, which has a population approximately the size of Boston’s.

The Frankfurt Fire Department’s facility is currently undergoing construction to add a new testing ground and a repair station behind the main building. With the addition of the new testing ground, the fire crews would be able to simulate fires in trains and buses and perform mock-rescue operations, enhancing the realness of their training simulations. The advantage of having a repair station located directly on the grounds is that it rather than sending their vehicles somewhere else to be repaired or upgraded, their engineers and mechanics can do that work themselves and thus increasing their familiarity with the vehicles they have to work with everyday.

In a conversation Dr. Staerk and I had with Dipl.-Ing. Jens Stiegel, one of Professor
<table>
<thead>
<tr>
<th>Ries’ co-workers at the department, during a tour of the grounds, he mentioned that the department was planning to upgrade all of its fire engines for newer ones. All of the fire departments in Germany were doing the same thing, so the new fire engines are the same ones that are going to be used throughout all of Germany.</th>
</tr>
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<tbody>
<tr>
<td>Smoke management is a topic of particular concern to fire fighters. Most of the people, who die in fires, don’t die from burns but from smoke inhalation. Therefore smoke has a strong influence on fire fighting tactics. The issue of tunnel safety is closely intertwined with the issue of smoke, since a tunnel can easily become filled with smoke. Professor Ries’ department just recently closed a project evaluating safety in tunnels in Germany. The department also has trucks specially designed to be used during emergencies in tunnels.</td>
</tr>
<tr>
<td>Fire rescue operations are drilled constantly, and every fire fighter of the gehobene Dienst is an expert in fire protection engineering design and fire rescue operations. In addition, each fireman and firewoman has been trained in CPR and is a state certified paramedic. Professor Ries expressed a high degree of confidence in his fire department’s ability to mount large fire rescue operations.</td>
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<tr>
<td>Frankfurt is actually the origin of the concept of safety in a modern sky scraper. The design of Chinese sky scrapers are modeled after the design of the sky scrapers in Frankfurt.</td>
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<tr>
<td>The fire department also conducts experiments, testing old fire rescue methods or equipment and developing new ones.</td>
</tr>
<tr>
<td>Sind Sie Sachverständiger? Für welche Art Each engineer in Professor Ries’</td>
</tr>
<tr>
<td>Question</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>Are you a Sachverstaendiger? What type of fire protection do you deal with? Do you cover both types?</td>
</tr>
<tr>
<td>Sind sie involviert im Design Prozess? Was machen Sie im Design Prozess (Was ist Ihre Rolle im Design Prozess)? Are you involved in the design process? (What is your role in the design process?)</td>
</tr>
<tr>
<td>Haben Sie selbst Gebäude entworfen? Wo für? Für Hochhäuser oder Industrieanlagern? Have you design buildings? What, for example? Skyscrapers or factories?</td>
</tr>
<tr>
<td>Waren Sie auch ein Feuerwehrmann? Sind Sie Designer oder Feuerwehrmann oder machen Sie beide? Were you also a fireman? Are you a designer or a fireman, or both?</td>
</tr>
<tr>
<td>Was passiert wenn irgendwo ein Feuer brennt? Wie ist die Alarmkette? Gibt's eine automatische Alarmkette/Brandkette? What happens where there is a fire</td>
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</table>
Somewhere? How does the alarm chain function? Is there an automatic alarm chain?

Most sky scrapers, however, are equipped with an automatic alarm which, once triggered, alerts central headquarters, which then dispatches one or more fire crews. The alarm is usually a small red button located in the wall behind a glass panel, which must be broken before one can trigger the alarm. The unusual feature about Germany alarm system is that all emergency calls go directly to central headquarters. Professor Ries recalled speaking to a Chinese colleague who found it odd that the alarms went straight to central headquarters. In China, only the local fire department would be alerted. He seemed to suggest that a routine fire alarm was somehow beneath the dignity of central headquarters. But Professor Ries argued that any fire in the city of Frankfurt, however great or small, was the responsibility of central headquarters, and could not be left to the smaller local fire departments to handle by themselves. The resources of the entire city must be brought to bear, if necessary. Only central headquarters has the authority to decide how much of the city’s resources to use against a fire.

Wie werden die Menschen informiert wenn irgendwas passiert im Hochhaus?

How are people in a skyscraper informed of a fire in their building?

In some countries, if there’s a fire anywhere in a sky scraper, the people would go to the housemaster to report it, whose responsibility it would then be to alarm the rest of the people in the building. In Germany, as mentioned earlier, there’s an automatic alarm that directly alerts central headquarters in the case of a fire. This system is not peculiar to Germany. The system is also present in the United States and presumably in every industrialized nation as well. I am not certain if the central headquarters would be directly alerted in the in the United States, as in Germany. But Professor Ries seemed to suggest that this was unique to Germany.

Unlike the United States, where fire
fighters have to climb many flights of stairs to reach a burning fire somewhere in a sky scraper, fire fighters in Germany often rely on an elevator connected to the side of the building to reach the scene of a burning fire in a sky scraper. The elevator is connected to an independent power source, so it could not be affected by a power shortage in the building. It is also surrounded by high air pressure to prevent the entry of smoke. Many of the inhabitants, especially those who are physically handicapped, can enter the elevator during a fire and wait to be rescued by fire fighters. The fire codes also specify that every sky scraper must have such a device.

Once the fire alarm has sounded, there are usually some people responsible for evacuating everyone from the building. There may several such people in different wings or levels of the building. The order of evacuation is often announced over the loudspeaker. This is called integrative fire protection. The fire alarm is sounded in reaction to a fire alarm somewhere in the building, and the people are evacuated from the building in an orderly fashion to prevent panic and to make sure that nobody is inside when the fire fighters reach the scene. However, if some people are left behind, the fire fighters can rescue them.

Sind Sie auch mit Vorbeugenden Brandschutz beschäftigt? Was machen Sie im vorbeugenden Brandschutz?

Are you also involved in preventive fire protection? What do you do in preventive fire protection?

Machen Sie Übungen/Fire Drills im Hochhäusern?

Do you also perform fire drills in skyscrapers?

Professor Ries' department is always performing fire drills. Since September 11th, everyone wants to perform fire drills as regularly as possible.

According to Professor Ries, the department is always performing fire drills. Especially since September 11th, everybody wants to make sure that their homes and places of work are safe. The administration
Office of every skyscraper and major building in the city of Frankfurt requests a fire drill at least once a year, and some more than once. Airports, train stations, and the like are also scenes of fire drills. Nobody wants a repeat of the Düsseldorf tragedy. With that in mind, fire drills are performed at major airports every three years.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>Haben Sie einen Gefahrverhütungsschau (GVS)? Wie oft machen Sie das? In welchen Zeit Intervallen?</td>
<td>There wasn’t time for this question during the interview, refer to Appendix E for information on Gefahrverhütungsschau (GVS)/Hazard Prevention Examination.</td>
</tr>
<tr>
<td>Do you also perform Hazard Prevention Examinations? How often do you do them? In what time intervals?</td>
<td></td>
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<tr>
<td>Was ist die Beziehung zwischen die Freiwillige Feuerwehr und die Berufsfeuerwehr?</td>
<td>The volunteers are as well trained as their professional counterparts, and often are the first to respond to the scene of a fire. The professionals, however, have more specialized training. For example, a crew of volunteers would probably not be trained or equipped to deal with an industrial accident or a fire in a tunnel. That would be a job for the professionals.</td>
</tr>
<tr>
<td>What ist he relationship between the volunteer fire fighters and the professionals?</td>
<td>There are about 36 people a year who undergo training at the department. The total number of employees at the department is around 1000, 860 of whom are fire fighters.</td>
</tr>
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<td>The relationship between the volunteer fire fighters and the professionals is very important in the fire fighting world. Not every town has a professional fire department. Dr. Staerk’s hometown of Gunthersblum, for example, a small farming and wining community in Rhineland-Pfalz, has a fire fighting force composed of volunteers from the community. Gunthersblum’s fire department can usually take care of most of the community’s needs, but if there were...</td>
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<td>Question</td>
<td>Answer</td>
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<tr>
<td>Sind Sie auch Professor? Wo sind Sie Professor? Was machen Sie in der akademischen Lehre? Was Unterrichten Sie?</td>
<td>Are you also a professor? Where are you a professor? What do you teach?</td>
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<tr>
<td>Professor Ries is also a professor. He offers fire protection lectures at the FH Darmstadt (which are open to students from both the FH and TU Darmstadt), and the FH Frankfurt. His lectures are a combination of practice and theory. He expects his students to learn the codes and specifications religiously. He also offers them the opportunity to participate in excursions to see how fire protection works in practice.</td>
<td></td>
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<tr>
<td>Welchen akademischen/universitaeren Background benoetigt man, wenn man eine Karriere im Bereich des Brandschutzes austrebt? Welche Kenntnisse halten Sie fuer besonders Wichtig?</td>
<td>What kind of academic/university background does one require in order to pursue a career in fire protection engineering? What knowledge do you hold particularly valuable to you?</td>
</tr>
<tr>
<td>There are three types of fire service officers:</td>
<td>There are three types of fire service officers:</td>
</tr>
<tr>
<td>2. Höhere Dienst</td>
<td>2. Höhere Dienst</td>
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<tr>
<td>Gehobene Dienst:</td>
<td>Gehobene Dienst:</td>
</tr>
<tr>
<td>At the highest level of the pecking order of the fire services of the Federal Republic of Germany is the gehobene Dienst. The Gehobene Dienst commands the rank-and-file fire fighters of the höhere Dienst.</td>
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</tr>
<tr>
<td>The gehobene Dienst is also actively involved in the building process in the form of technical advice to engineers and architects. Very often they have the final word in approving designs affecting fire safety. The officers of the gehobene Dienst traditionally have architecture or civil engineering degrees from major universities (Professor Ries has a degree in architecture from the Technical University of Darmstadt). Their role in the design process is to make sure that buildings possess the minimum fire safety requirements.</td>
<td>The gehobene Dienst is also actively involved in the building process in the form of technical advice to engineers and architects. Very often they have the final word in approving designs affecting fire safety. The officers of the gehobene Dienst traditionally have architecture or civil engineering degrees from major universities (Professor Ries has a degree in architecture from the Technical University of Darmstadt). Their role in the design process is to make sure that buildings possess the minimum fire safety requirements.</td>
</tr>
</tbody>
</table>
The gehobene Dienst recruits graduates of engineering or architecture programs. There is no equivalent of a degree in fire protection engineering at any German university, however, there is something similar offered at a few German universities. For example, the University of Wuppertal offers a degree in Sicherheitsingenieurwesen (safety engineering). Some of the officers of the gehobene Dienst have degrees in safety engineering from Wuppertal, and some have other similar degrees from other German universities. However, recruitment is not limited to people with degrees in engineering or architecture, but technical degrees are preferred to other types of degrees. In order to become officers of the gehobene Dienst, candidates are required to go through a period of training which includes seminars designed to expose them to various topics of fire protection and fire fighting tactics. The seminars, however, are by no means a substitute for a real degree in fire protection engineering. But they do provide them with an appropriate background for their line of work.

Höhere Dienst:

Fire fighters belong to this branch of the fire service. Fire fighters in the Federal Republic of Germany aren't much different than their counterparts in the United States, and their training is probably very similar to the training undergone by fire fighters here in the United States. Perhaps the only difference is the education of the fire fighters. German fire fighters are recruited from the Fachhochschule. The best Anglo-Saxon equivalent for a degree from a Fachhochschule is a degree in engineering technology. An education from a Fachhochschule is less theoretical than an education from a university. Students of
Engineering at a Fachhochschule learn many of the same engineering concepts as their university counterparts, but at the Fachhochschule the theory of the material is watered down and more practical.

Mittlere Dienst:

The mittlere Dienst refers to the dispatchers who respond to emergency calls from the fire service's headquarters. They undergo in-house training before starting their work, which provides them with a valuable set of skills. During their training they learn how to prioritize calls, to determine which calls require more urgent attention than others.

Sollte Brandschutz auch in der Zukunft Teil anderer Studiengänge sein? Oder Sollte es ein eigener Studiengang sein?

Should fire protection engineering be its own engineering discipline in the engineering or part of another engineering discipline?

"Das ist ein trauriges Kapitel in Deutschland." That is a sad chapter in Germany, explained Professor Ries. He's been trying for at least the past ten years to have a fire protection engineering program created at either the TU Darmstadt or the FH Darmstadt, or perhaps as a joint effort between the two institutions. Professor Ries has taken the battle to the highest levels of government, presenting his argument before politicians and university officials. But his cries for the creation of a separate fire protection engineering degree at universities have fallen on deaf ears.

To be sure, there are currently no German universities which offer a degree in fire protection engineering. But some universities offer similar degrees. The Technical University of Wuppertal, for example, offers a degree in Sicherheitsingenieurwesen (safety engineering), which covers some topics in fire protection engineering. There are actually two degrees in safety engineering offered at Wuppertal: the Diplom 1, and the Diplom 2. The Diplom 1 is offered the Fachhochschule Wuppertal (FH Wuppertal), and the Diplom 2 at the
Dispatchers respond to emergency calls. Firefighters battle fire.

Technical University of Wuppertal (TU Wuppertal). The Grundstudium of these degrees is the same; the only difference is the Hauptstudium. The Grundstudium refers to the basic requirements of a degree. The Hauptstudium, on the other hand, refers to more advanced classes in a particular field of concentration. As one might expect, students at the TU Wuppertal get a more theoretical education in safety engineering. Students at the FH Wuppertal, however, get a more practical, hands-on education in safety engineering. The same concepts are covered, but the approach is different at each institution. The University of Köln offers a program in rescue engineering. The University of Magdeburg offers both a bachelor’s and master’s degree in safety engineering. In fact, the FH Magdeburg had the first fire protection engineering professor in Germany. The Frankfurt Fire Department has 8 officers in the gehobene Dienst who have a specialized education in fire fighting technology (Feurwehrtechnick), and 6 in rescue engineering. Jens Stiegel, an officer of the gehobene Dienst who was present for the author’s interview with Professor Ries, specializes in fire fighting technology.

Figure 4: Personnel Structure of the Fire Services in Germany
Mitgliederzuwachs

Palmengarten erfreut sich neuer Förderer


Zum Vorsitzenden gewählt wurde in der jüngsten Mitgliederversammlung Georg Zicka. Stellvertreterin und Schatzmeisterin ist Herta Menk, als Schriftführer fungiert Herbert Billensteiner.

Die Geschäftsstelle im Palmengarten, Siegmayerstr. 63, Montag und Donnerstag von 12 bis 17 Uhr geöffnet. Die Vorstand ist dann telefonisch erreichbar unter 745839. www.palmengarten-frankfurt.de

Hauptbahnhof

Grüne fordern Sanierung der Rolltreppen


Frankfurts Hochhäuser

Feuerwehrchef Ries zieht positive Bilanz einer Großübung

„Frankfurts Hochhäuser“

Dichter Rausch, Schreie der Menschen und ein schwer zu lokalisierender Brandherd:

Im Hochhaus Skyper an der Taunusanlage probierte die Feuerwehr den Ernstfall. Feuerwehrchef Heidrun Ries lobte dabei den Brandschutz in den Hochhäusern.


Um genau 18:50 Uhr, die gespielte Einsatzsirene, ist im 26. Stock des Skyper bei Baustellenarbeiten ein Feuer ausgebrochen. Die Baustellenarbeiter rufen zunächst ein Stockwerk tiefer, kommen dort Alarm aus. Was für die Feuerwehr, die genau sechs Minuten später
Figure 5: Fire Fighters in Frankfurt performing a Fire Drill in a Skyscraper (Source: Frankfurter Rundschau, Saturday, April 30, 2005)

Figure 6: Diagram of the Rescue Elevator described in the Transcript of the Interview with Professor Ries (Source: www.Stadt-Frankfurt.de/Feuerwehr)
Figure 7: A Page from the HBO describing who is responsible for Fire Protection for each Building Class (Source: Frau Wokan).
E.1 Vorbeugender Brandschutz (Fire Prevention)

Fire prevention and emissions control (VB) is something altogether different from fire fighting and general assistance to civilians during a fire. The Hessian fire protection laws assigns “Die Allgemeine Hilfe und dem Katastrophenschutz” (HBKG) (“the General Assistance and Disaster Control wing of the Frankfurt Fire Department”) of the fire-brigade the task of fire prevention for the city of Frankfurt/Main.

VB participates in licensing procedures for different jurisdictions:
- Construction licensing procedure
- Licensing procedure according to the Federal Emissions Control Law and its administrative regulations
- Licensing procedures according to the Radiation Protection Law
- Licensing procedure according to the Genetic Engineering Law
- Licensing procedure according to the General Railway Law
- Licensing procedure according to the Work Liability Regulation

For all of the licensing procedures specified above “Der Vorbeugende Brand- und Immissionsschutz” (VB) (Fire Prevention and Emissions Control) are consulted for advice by the responsible Federal agencies. The demands placed thereby are transferred as collateral clauses to the appropriate notice of approval. Before start-up of the construction, the plant examinations should accomplished in order to control the conformity of the execution with the demands posed. (www.Stadt-Frankfurt.de/Feurwehr).
1. Nachweis des vorbeugenden Brandschutzes gem. § 59(1) St HKO und
2. Überwachung der Bauausführung gem. § 73(2) St HKO, i. V. m. § 78(1) S. 1 Nr. 2 HKO

Auftraggeber

Standort:

Herrn, Straße:

Fax: PLZ/Ort:

Hiermit beantragen wir bei der Stadt Frankfurt am Main - Branddirektion, Anstellung vorbeugender Brandschutz

, für das Objekt in Frankfurt am Main


Figure 8: Application to the Frankfurt Fire Department for vorbeugenden Brandschutz (a Preventive Fire Protection Drill) (Source: Professor Ries)
E.2 Gefahrenverhütungsschau (GVS)

Every object posing a serious fire hazard (e.g. increased fire risk, large number of occupants) is subject to an examination known as Gefahrenverhütungsschau. This Gefahrenverhütungsschau is accomplished in legally given time intervals as well as after firmly defined basic conditions. The problems with the associated object identified by the Gefahrenverhütungsschau are communicated to the responsible person and must be corrected within an agreed upon time period. The correction must be proven in writing or with an on-site inspection. These examinations are liable to cost money. (www.Stadt­Frankfurt.de/Feuerwehr).

E.3 Bebauungspläne/Building Layout Plan
In the context of the list of development plans the VB examines the sufficient fire-fighting water supply as well as the accessibility for the area concerned, so that in case of application effective deletion and rescue measures are possible. (www.Stadt-Frankfurt.de/Feurwehr).

**E.4 Brandschutzerziehung/Fire Protection Education**

An important task of the fire prevention is the fire protection education in kindertagesstaetten (day-care facilities) and the schools. The fire department explains the most important rules for behaving in fires, such as how to escape from a building that is on fire and what to do when one is caught on fire. The fire department also educates the children about the fire brigade, such as their daily responsibilities and the dangers they face on the job. (www.Stadt-Frankfurt.de/Feurwehr).

**E.5 Brandschutzunterweisung/Fire Protection Instruction**

All private enterprises are required to offer fire protection instruction to their employees; it is a state requirement. The fire protection instruction, is organized by request of the private enterprise, is handled the VB and paid for by the private enterprise. (www.Stadt-Frankfurt.de/Feurwehr).

**E.5 Löschwasserversorgung/Fire Fighting Water Management**

It is the responsibility of every municipality in the Federal Republic of Germany to provide a sufficient fire-fighting water supply to its fire fighters. In the context of licensing procedures, it is examined whether the existing fire-fighting water supply is sufficient or whether additional measures have to be taken to procure the necessary amount of water the city would need to fight a fire. The fire-hydrant net is examined in regular time intervals by the fire-brigade and the fire-hydrants are marked. (www.Stadt-Frankfurt.de/Feurwehr).

**E.6 Brandsicherheitsdienst/Fire Safety Service**

Various legislation requires the presence of a fire security service at meetings in assembly places (e.g. theatre, fair) or special meetings in other premises. A danger analysis of the meeting is accomplished and specified by the VB to assess the risk to the visitors. The VB risk assessment will also determine whether local security forces can handle the risk or whether additional measures have to be taken. (www.Stadt-Frankfurt.de/Feurwehr).

**E.7 Beratung und Prüfung/Advice and Inspections**

The buildings of today – particularly Sonderbau (special buildings) - have ever more complex and larger dimensions. Deviations from the material requirements of the building code and/or other legally binding sets of rules occur more frequently and must
be plausibly justified in order to be allowed to occur. Fire protection-technical measures of the relevant sets of regulations are usually not applicable for these cases, thereby making it easier to make a mistake and jeopardize the lives of the building’s occupants. For a reasonable fee, the VB offers its consultation on matters of fire safety to designers of Sonderbau. After a building permit for the project is procured, the VB can envision fire protection concepts for the building and try to provide the building with the best fire safety defenses. Eliciting the help of the VB can certainly pay off later as the building will be less thoroughly scrutinized by the building officials, since they know the VB participated in the design and hence the building has a higher-than-average fire safety. (www.Stadt-Frankfurt.de/Feurwehr).
Appendix F: The University of Wuppertal’s Program in Safety Engineering

To my knowledge, there isn't a single university in the whole of Germany which offers a degree in fire protection engineering. There is, however, one university which offers something slightly similar. At the University of Wuppertal in northern Germany, one can earn a bachelor's or a master's in the field of safety engineering, which concerns the risks that people and environments can become exposed to on a daily basis but with a particular focus on those risks associated with the use of technology. The objective of the program is to provide students with the ability to foresee the development of risks and to derive ways of handling those risks. The university offers a unique high level instruction, often in cooperation with industry. Interdisciplinary education (team projects) is also part of the curriculum.

In the bachelor's program, courses in the following subjects are offered:
- Fundamentals of mathematics, sciences, and engineering
- Fundamentals of safety engineering regarding methodological aspects, areas of occupational safety, and problems of organization and management in safety engineering
- Applications in occupational safety, fire and explosion protection, and environmental protection
- Labs, interdisciplinary (team) projects, bachelor's thesis.

The compulsory courses of the Master's program are the following:
- Fundamentals of safety engineering such as methods of safety engineering and work sciences
- Extended fundamental sciences such as mathematics, reliability, control engineering, hazardous substances, psychology, work regulations
- Safety and risk management with various applications in industrial safety, environmental protection, fire safety
- Interdisciplinary (team) project, master's thesis

Additionally one of the following three modules must be taken as an elective:
- Occupational safety: Occupational safety, occupational medicine, ergonomics, personal protective equipment, fire and explosion protection, environmental protection
- Environmental safety: Environmental chemistry with respect to air, soil, and water pollution problems
- Transportation and traffic safety: Safety of transportation systems and processes, safety of road traffic, safety of air traffic, psychology, metrology, car control systems
Appendix G: A Discussion of the Practice of Subcontracting and how it has meant a Downgrade in the Quality of Construction

After the oil crisis of 1973 and the recession that immediately followed, there was a significant drop in construction demand throughout Western Europe, and contractors were forced to lay off much of their workforce. But as the demand later picked up, according to the International Labor Organization (ILO), contractors tended not to rehire their old workforce, but tended instead to hire subcontractors. (ILO 2).

The practice of subcontracting was most pronounced in the Federal Republic of Germany, which accounts for approximately 26 percent of the construction output of the member states of the European Union. (ILO 3). Germany is also the prime destination for migrant workers from Eastern Europe, and has recently been attracting large numbers of construction workers from lower-wage EU-member states such as Ireland, Portugal, and the United Kingdom. (ILO 3).

Most of the construction workers from Eastern Europe entered Germany in the early 1990's as “project bound contractees,” usually working for foreign enterprises (most of them Polish), active in the German construction market as subcontractors. (ILO 3). According to the German construction trade union, there were an estimated 500,000 workers from Eastern Europe in Germany in 1992, with 150,000 in Berlin alone, raising concerns that foreigners were being illegally employed on job sites. The German government has since taken steps to regulate the practice of subcontracting, substantially reducing the employment of workers from Eastern Europe and the illegal employment of them on the job site, according to sources of the International Labor Organization. (ILO 3).

Although many countries already have legislation in place that could be used to protect the rights of migrant workers, most of it is often too generally worded and seldom enforced. The International Labor Organization has always championed the cause of the migrant workers, arguing that more specific legislation and more efficient labor inspection services would provide the country receiving the migrant workers with a whole host of economic benefits, while at the same time protecting the rights of the migrant workers themselves. But without legal recognition by host governments, the status of migrant workers remains in limbo, thus increasing the chances of illegal employment and abuse of the rights of the migrant workers. In its report, the International Labor Office warns that unless countries legalize and devise methods to regulate the flow of migrant workers, illegal employment and abuse will only get worse. Even while labor shortages exist, countries are still reluctant to acknowledge the need for migrant workers. (ILO 3).

The practice of subcontracting has had serious consequences for Germany's construction industry. The migrant workers from Eastern Europe, who are often illegally employed on
job sites, don’t have the same education or training as their German counterparts. When a Polish migrant worker in Germany builds a house, he builds it the way he would in Poland. He doesn’t think about any building codes or standards, he just builds the way he always did. But what would be satisfactory in Poland, is too often unacceptable in Germany. To put it plainly, the employment of migrant workers has meant a downgrade in the quality of construction, and, as a result, construction firms are required to pay more each year for their insurance. Frau Wokan’s firm, for example, has to pay 4,000 € each year, although it only consists of three people and has never had an accident. Very often the migrant workers can only speak poor German, if any at all. So they don’t understand the instructions they’re given on the job site, which is why their work tends to be shoddy, or at least not up to par with their German counterparts. But legal recognition of migrant workers could, in addition to protecting their rights, set basic standards required of migrant workers seeking work in Germany, such as a certain level of training/education and/or a certain level of German.
Appendix H: The 5 Phases of Construction

There are four phases of construction in Germany: the building permit application phase, during which the contractor applies for a building permit in order to be allowed to begin construction; the phase before the start of construction, during which designs and calculations are done, anticipating the start of construction; a phase before the carrying out of certain stages of construction, such as the analysis and confirmation of the stability of the structure, or the analysis to determine whether there is adequate insulation against loss of heat or penetration of sound; and finally the stage of construction completion, during which the newly erected structure must undergo various inspection processes in order to certify that construction conditions met the approval of certain state and federal agencies responsible for verifying whether or not building codes and standards were followed during construction. (Source: Sheet provided by Frau Wokan).
### Wissenswertes zur Bauausführung

Nach Erteilung der Baugenehmigung bzw. nach Ablauf der Frist bei Verfahren nach § 58 sind im Zuge des Baufortschritts noch Unterlagen nachzureichen.

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<td>Zu diesem Zeitpunkt können je nach Projekt noch weitere Unterlagen wie z. B. Betäubungsnachweise, Abnahmeverfahren, technische Gebäudeausstattung, Feuerlöscherbescheinigungen etc. erforderlich werden.</td>
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X = zu diesem Zeitpunkt einzureichen

1. Aktenexemplar der Nachweise kann auch erst bei Rohbaustellung geliefert werden
2. einschließlich Aktenexemplar der Nachweise
3. einschließlich Nachweis der Eintragung des Nachweises bei der Bauphase im Archiv der Ingenieurbüros
4. BA = bereits mit dem Bauantrag einzureichen
5. o.B. = ohne Bestätigung (bautaugliche Prüfung)
6. m.P. = mit Prüfausweis (Prüfauftrag durch die Bauaufsicht)

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**Figure 10: The Four Phases of Construction (Source: Frau Wokan)**
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