SICK BUILDING SYNDROME: CHALLENGES AND OPPORTUNITIES

BY

ROSS D. DORN

B.A. ENGLISH
UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON, 1990

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE
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Signature of Author: _____

Ross D. Dorn
Department of Architecture
July 31, 1998

Certified by: _____

Lawrence S. Bacow
Martin Professor of Environmental Studies
Thesis Advisor

Accepted by: _____

William C. Wheaton
Chairman, Interdepartmental Degree
Program in Real Estate Development

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ABSTRACT

Case studies of three office buildings were undertaken in order to determine whether the phenomenon known as 'sick building syndrome' (SBS) creates a lasting economic stigma after a proven or alleged SBS problem is corrected, and whether undertaking preventive measures against factors known to cause SBS at the development stage is a prudent investment of additional resources.

Thesis Supervisor: Lawrence S. Bacow
Title: Martin Professor of Environmental Studies

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Chapter 1: Introduction

I. Description of the problem

The U.S. Environmental Protection Agency (EPA), in a 1981 report to Congress, cited indoor air pollution as one of the top five environmental risks to public health.[1] Other phenomenon such as Sick Building Syndrome (SBS), Building Related Illness (BRI) and a host of other building-related health problems including factors other than air quality have been the subject of much scientific and medical study and debate over the past decade.

While most studies to date have focused on the identification of sources and possible solutions to indoor environmental quality, few have touched on whether there is economic benefit to be gained from incurring the additional cost of having a 'clean' building.

Fisk and Rosenfeld (1997) wrote a general paper discussing the linkage between worker productivity and overall building health. They estimated that a 1% increase in worker productivity should be sufficient to justify an expenditure equivalent to a doubling of energy or maintenance costs or large increases in construction costs or rents.[2]

A 1989 EPA Report to Congress concluded that improved indoor air quality can result in higher productivity and fewer lost work days. EPA estimates that poor indoor air may cost the nation tens of billions of dollars each year in lost productivity and medical care costs.[3] While this is a very difficult cost to quantify, a 1989 EPA survey in New England concluded that the average self-reported productivity loss due to poor indoor air quality (only one of the many causes) was 3%.[4]

It is on the central issues of economics and risk management that this thesis is based. Few, if any, building developers would commit to the additional costs of engaging in an unproven program of constructing 'healthy' buildings if they could not realize an economic benefit. However, when owners and developers look at the costs stemming from 'sick building syndrome' (litigation, repairs, re-leasing at below-market rates because of 'stigma'), engaging in the construction of 'clean' buildings may make sense purely from a risk management perspective.

II. Research Questions

1) Does a lingering negative economic effect remain even after a known SBS problem is corrected? In other words, do indoor environmental problems create economic stigma?
2) In consideration of the legal and time costs of SBS, is it economical to spend more money on the design and construction of a 'clean' building as a means of risk management?
3) A third question (which cannot be answered by this thesis) is whether tenants, in recognition of the productivity and other benefits of 'clean' space, will pay more for it.

III. Why hasn't more been done to prevent indoor environmental problems?

At the present time, there are numerous articles, books and handbooks from industry organizations, health experts and the government speaking to the subject of indoor environmental issues. The most common subject is that of indoor air quality. While history shows that energy efficiency comes at the expense of indoor environmental quality–and vice-versa, sufficient information now exists from many sources that indicates both can be achieved in an economically viable manner.[5,6,7]

However, this information is not in the form necessary for commercial real estate practitioners to make a financially supportable decision to engage in what will be termed here as 'clean building practices'. A 'practitioner' of real estate is defined here as one who engages in the construction, ownership, leasing, acquisition/disposition, maintenance, redevelopment, renovation, financing, insuring, taxation or occupancy of commercial real estate.

In name, these practitioners would include general and sub-contractors, materials suppliers, architects, engineers, developers, owners (public and private), existing and prospective tenants, facilities managers, brokers, property managers, consultants, assessors, attorneys, property casualty insurance agents, loan officers, appraisers, title insurance agents, and even Wall Street analysts.

When one considers how a new building is built, it is not surprising that construction cost is a major consideration. The ability to pay debt service is a major consideration. The time required to build the building is a major consideration. With all these 'major' items, how does engaging in 'clean building practices' fit in?

Arguments against clean building practices

Developer:	Banks won't finance the extra cost, which hurts my margin, which is already pretty thin.
Architect:	That's the engineer's problem. I'm dealing with the design of the building. Besides, the building code doesn't require that we do that.
Engineer:	The architect hasn't left me with enough room to execute an adequate HVAC system like that. Besides, the building code doesn't require that we do that.

General Contractor:	Our subs (sub-contractors) aren't familiar with those materials. That will cost a lot more to do and will be disruptive to the construction schedule.
Sub-Contractor:	I'm not familiar with that material or process. That will take extra time and will cost more money.
Bank Loan Officer:	The appraised value doesn't support this extra expense.
Private Owner:	If I invest money in these improvements, will I see a return on it? Will the market pay for this?
Public Owner:	If we invest money on these improvements, we'll be restricting our FFO too much. Besides, will the market pay for this?
Existing Tenant:	Are you going to charge me for this?
Prospective Tenant:	Will I have to pay for that?
Facility Manger:	Am I going to have to get all new training to run this new equipment? There's nothing wrong with the stuff that's there now.
Broker:	The market won't pay for this.
Property Manager:	I have to keep my costs down and my rents competitive. I can't get my tenants to pay for this.
Assessor:	I'll charge you for it.
Attorney:	You should definitely do all this to protect yourself, but my firm won't pay more rent for it.
Casualty Insurance Agent:	There's no evidence to show that you'll lower your risk, so we can't lower your rates.
Title Insurance Agent:	Are there any liens on the property?
Appraiser:	There's no market data that justifies this expense.
Wall Street analyst:	Intuitively it makes sense, but the market isn't that sophisticated, and therefore the market isn't likely to recognize value there.

IV. The purpose of this thesis

With all these arguments against engaging in clean building practices, why do it? This thesis attempts to serve as a rebuttal to each of the preceding arguments. It will do so by utilizing three case studies that show the costs and benefits of engaging in a proactive clean building program, as well as the costs and risks of engaging in the status quo.

There are a variety of reasons for a variety of parties to read and utilize this thesis. Whether developers believe they could actually reap higher rents for more expensive 'clean' space (a question that cannot be answered by this thesis), they would probably agree that, in consideration of the first two case studies, the outlays might be justified for risk management (read litigation management) reasons alone.

V. Methodology

Case Studies

This thesis will explore three case studies highlighting buildings that have dealt with SBS issues. Preliminary research yielded a pool of potential case buildings, which was narrowed to three prior to writing this thesis. The objective of the search for case studies was to find at least two cases that dealt with SBS issues reactively, and at least one case that dealt with SBS issues proactively.

The two 'reactive' cases needed to show the following spectrum of events:

1) Identification of SBS problems (more than 20% of occupants having SBS symptoms).
2) Steps taken to correct the problem (renovation/replacement, temporary relocation of tenant).
3) Re-occupancy of building by original or other tenant.

Financial impact would be measured as accurately as possible using known rental data, expenditures associated with curing the problem, litigation and other costs.

The one 'proactive' case would need to show the following spectrum of events:

1) Identification of a need to avoid SBS.
2) Motivation for engaging in the extra cost of creating a 'clean' building environment.
3) Financial analysis undertaken which led to the decision to be proactive.

4) Project description.
5) Measured variations between 'clean' and 'standard' construction.
6) Measured impact of 'clean' space.

Once each of the case studies was identified based on the respective foregoing criteria, the cases were then written utilizing data gathered during an extensive research phase. A variety of information sources such as trade journals, newspaper articles, documents from the EDGAR database (Securities and Exchange Commission), court documents, web site information, personal interviews, videotaped television investigations, historical real estate rental data, and guidance from knowledgeable professionals were used in the case study research phase.

Cost/Benefit Analyses

Cost/benefit analyses relied on cost data provided by the parties where possible, or from published materials found through research. Where no published information was available, court documents stemming from past litigation or other sources were used. Income/benefit data was similarly researched, but relied more heavily on disclosure by the affected firms.

Sources of Information

In addition to printed and electronic media, information was obtained through conversations with practitioners including persons in the following fields:

Construction
Brokerage/Services
Law
Architecture
Engineering
Corporate Real Estate
Development
Property Management
Financial Institutions
Acquisitions personnel for REITs
Wall Street Finance/Stock Brokerage

VI. Summary

Information is the key to making good decisions. There is a disconnect between the medical approach to the literature on SBS and the financial realities at the core of nearly every commercial real estate project. The information exists, but not in a form that allows for implementation into the decision making process of the commercial real estate practitioner.

Risk Management

From a risk standpoint, any company in the market for office space that has an opportunity to improve worker safety, health and welfare merely by leasing 'clean' space would do so immediately. The primary reason this is not industry practice at the present time relates to a lack of appropriate information on which to base these decisions.

Economic Risks

From an economic standpoint, development companies cognizant not only of the litigation risks stemming from SBS issues, but also of the economic risks of market stigma lingering after an SBS problem has been cured, would benefit greatly in their construction and acquisition decisions by having better information.

Economic Opportunities

From an economic standpoint, companies that are cognizant of the cost of lost worker productivity should, in theory, realize that this cost far overshadows the amount of money paid in rent. A well-informed company, therefore, should be willing to pay higher rent for 'clean' space as a means of avoiding these productivity losses. This amount of increased rental payment should, in theory, more than adequately reward developers and owners for building space that is 'clean'.

Conclusion

This thesis will shed light on the economic risks of a reactionary approach to dealing with indoor environmental issues as well as the economic opportunities of a proactive approach to indoor environmental quality. Ultimately, information plays a key role in whether builders, owners and users of space will find it in their collective best interest to build that space proactively as 'healthy' or 'clean', or whether they will continue in the status quo.

With adequate information, prospective tenants can create value through informed leasing of 'clean' space, and owners can create value through providing space that has more value to the user. This thesis should be part of that information.

Footnotes

[1] Environmental Protection Agency (1981)

[2] Indoor Air V7 (1997) pp. 158-172. *Estimates of Improved Productivity and Health from Better Indoor Environments.* Fisk, William J.; Rosenfeld, Arthur H.

[3] An Office Building Occupant's Guide to Indoor Air Quality [www.epa.gov/iaq/occupgd.html], p. 3

[4] Indoor Air. V7 (1997) p. *163 Estimates of Improved Productivity and Health from Better Indoor Environments.* Fisk and Rosenfeld.

[5] Rocky Mountain Institute website {www.rmi.org}

[6] United States Green Building Council website {www.usgbc.org}

[7] United States Department of Energy - IPMVP (1997)

Chapter 2: Background

I. What is Sick Building Syndrome?

Sick building syndrome is a combination of physical and psychosocial elements that result from the condition of the indoor environment. SBS is really a combination of three illnesses found within buildings as defined by Rollins and Swift[1]. Each of these is described below:

Building-Related Illness (BRI)

This term is defined as an illness caused by exposure known irritants (such as dust, mold, and other allergens) that are generated from within a building. These pathogens are identifiable and measurable, and uniform diagnosis of the causal agent can be made with lab work. Examples of Building-Related Illnesses are humidifier fever and legionnaire's disease. Building-related asthma and allergic rhinitis may also be considered in this category. The symptoms tend to be physical and not psychosocial.

Neurotoxic Disorder (NTD)

Like BRI, Neurotoxic Disorder (NTD) has a known aetiology; however, the sources are toxic agents found within materials used either in the construction of the building or in the materials brought into the building, such as furniture. Common sources include heavy metals and mixtures of organic solvents such as formaldehyde, ozone and hydrocarbons. The symptoms include mood changes, motor and mental slowing, memory problems and problems with concentration. As opposed to Building-Related Illness, NTD has identifiable physical causal agents but a mixture of physical and psychosocial effects.

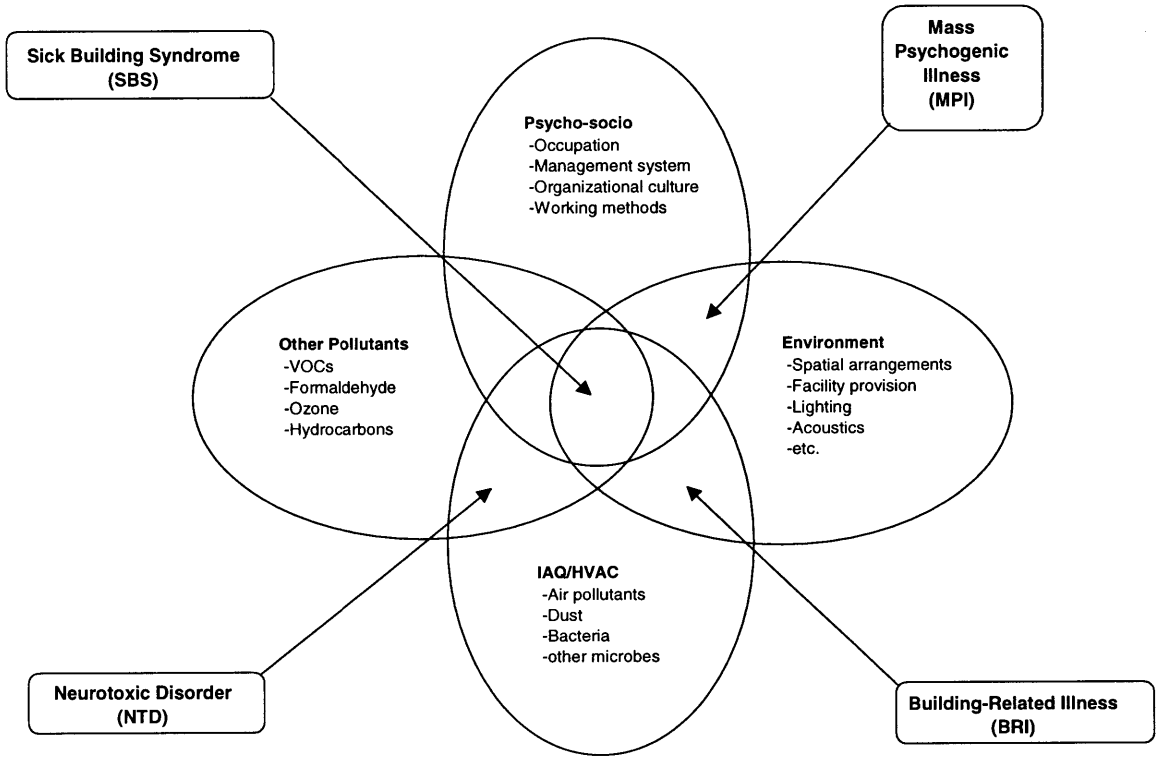
Mass Psychogenic Illness (MPI)

In 1982, Colligan and Murphy defined Mass Psychogenic Illness as "the collective occurrence of a set of physical symptoms and related beliefs, in the absence of, an identifiable pathogen."[2] Five predictors were identified as accounting for more than a third of the variables of an outbreak of MPI. These are, in order of importance:

1) Work Intensity
2) Mental Strain
3) Work/Home Problems
4) Education
5) Gender

Unlike BRI or NTD, the causal agents of Mass Psychogenic Illness cannot be identified in a lab. The factors above are psychological issues and vary widely from person to person. Since the symptoms are not caused by any physical characteristic of the building or the contents therein, the problem will usually not disappear when the person leaves the building. Interestingly, the symptoms do tend to spread through social networks rather than through workgroups or departments. Thus, this illness is phychosocially-based as opposed to the more physical attributes of NTD and BRI.

Rollins and Swift (1997) utilized the preceding three main types of workplace illness in the following model which helps to define SBS, called the Workplace-Related Illness Model:



The Workplace-Related Illness Model

Source: Rollins and Swift[3]

Sick Building Syndrome (SBS)

Unlike BRI or NTD, Sick Building Syndrome (SBS) cannot be traced to a specific source or combination of specific sources. This results from the psychosocial component found within Mass Psychogenic Illness. As the diagram above shows, SBS is really some mixture of BRI, NTD and MPI. The combination of factors comprising SBS is different for each sick building.

Because SBS is caused by a combination of physical and psychosocial factors, uniform detection and assessment is very difficult. SBS is characterized by a distinct pattern of people becoming symptomatic when entering the building and becoming asymptomatic when away from the building. A 1986 World Health Organization (WHO) panel described the symptoms identifiable with SBS as follows[4]:

1) Mucous membrane irritation of the eyes, nose, and throat should be one of the most frequent symptom expressions;
2) Other symptoms involving the lower respiratory airways and internal organs should be infrequent;
3) No evident causality should be identified in relation to occupant sensitivity or to excessive exposures;
4) Symptoms should appear especially frequently in one building or part of it; and
5) A majority of occupants should report symptoms.

The WHO also identified five features that are common to sick buildings:[5]

1) They often have forced ventilation (the WHO does not specifically refer to air conditioning, even though it falls into this category).
2) They are often of light construction.
3) Indoor surfaces are often covered in textiles.
4) They are energy efficient, kept relatively warm and have a homogeneous thermal environment.
5) They are airtight, i.e. windows cannot be opened.

Further, the WHO panel suggested that a 'sick' building should be distinguishable from a normal one by the prevalence of symptoms; that is, a large percentage (greater than 20%) of the occupants report symptoms.

Rollins and Swift indicated that, while physical sources may be the initial cause of SBS symptoms, the psychosocial structure of the organization may have an effect on the continuing occurrence and perceived relief of symptoms. Therefore, the extent to which a physical cause is

identified and promptly solved or eradicated, the less chance of the onset of psychosocial factors such as feelings of helplessness, contempt toward building and firm management, and distrust. Once these building-induced psychosocial factors arise, they may never truly subside.[6]

Primary to their argument of the psychosocial aspect was the issue of 'locus of control' Rollins and Swift state that "when freedom or control are threatened people tend to react by reasserting their freedom, i.e. exhibiting SBS type symptoms; this is called psychological reactance, or 'learned helplessness'.[7]

Most office building occupants have little say in what an 'appropriate' work environment should be. This includes decisions on levels of lighting, temperature, ambient light, desk height, and so on. Should a concern arise and this request is delayed or ignored, the locus of control will ultimately manifest itself in heightened or exaggerated SBS symptoms, with the result being increased absenteeism and loss in productivity to the firm.

II. Sources of SBS

As stated earlier, there are two primary sources of indoor environmental pollution. These are physical and psychosocial sources. Whereas in the earlier section the sources were broken down into named symptoms, here the sources are listed by the actual pathogen.

Physical Sources of SBS

Indoor Air Pollution is the preeminent physical source of indoor environmental problems. Poor indoor air quality is often cited as the source of illness within buildings by occupants. Indoor air quality (IAQ) problems factor significantly into the health problems identified as SBS. The EPA's 1981 finding from Chapter 1 (top five risks to public health) is believed to be an indirect result of the energy crisis of the early 1970's, when federal policy mandated energy efficient buildings though the use of sealed buildings and high levels of recirculated indoor air.

Sources of indoor air pollution:

1) Poor outside air quality.
2) Low fresh air introduction rates (due to outdated systems or poor design).
3) In new buildings, off-gassing of volatile organic compounds (VOCs) such as urea-formaldehyde from foam insulation, benzene from polystyrene insulation, latex from adhesives, and dust from construction.
4) In existing buildings with recently renovated office space, off-gassing of VOCs from new carpet, paint and furniture. Also, HVAC systems may not be upgraded for cost or feasibility considerations.
5) Inadequate particle filtration in an otherwise adequate air handling system.
6) Organic contamination due to inadequate cleaning or maintenance practices, or to flaws in building or air systems design. (dust, dust mites, insect infestation, bacteria, molds and fungi).
7) Human sources. For example - smoking, use of perfumes, aerosol sprays.
8) Equipment. For example - copiers, laser printers, blueprinting machines, plotters.
9) Toxic construction materials (asbestos).
10) Toxic but naturally occurring gases (Radon).
11) Aerosol transmission of the common cold or flu.

Other physical sources not linked to indoor air pollution:

1) Technology (repetitive stress injury to eyes and hands due to computer use).
2) Lighting (natural and artificial).
3) Thermal comfort (temperature, humidity).
4) Noise (ambient, direct).
5) Ergonomics (chairs, desks, computer screen height, keyboard height).

Psychosocial Sources of SBS

These are largely untreatable within the context of the design or systems in an office, but physical problems with a building can initiate psychosocial pathogens, or can exacerbate psychosocial problems that already exist.

III. Background on SBS

Of the factors cited as contributing to SBS, the most common is Indoor Air Pollution. This topic is by far the most studied and researched by a variety of environmental health professionals, government agencies and international health organizations.

Interestingly, to date there is no federal indoor air quality statute. In 1993, U.S. Representative Joseph Kennedy III introduced a bill to the House (H.R. 2919)[8] entitled "The Indoor Air Act of 1993." The purpose of the H.R. 2919 was "to amend the Public Health Service Act to authorize a national program to reduce the threat to human health posed by exposure to contaminants in the air indoors." The bill set forth timelines for creating a list identifying common indoor air hazards, a program for accreditation and certification of 'indoor air contractors', a national campaign for public awareness concerning public health risks and preventive measures, and a variety of programs for implementing and assuring continued focus in IAQ issues.

This bill garnered widespread approval but failed to make it into law by the end of the 103rd Congress. The Senate passed a similar "The Indoor Air Quality Act of 1993" (S. 656) on October 29, 1993. An amended version of H.R. 2919, "The Indoor Air Act of 1994" (H.R. 2919 RH) was reintroduced in early 1994, but was tabled in favor of the Senate Bill. No single bill has been passed by both the House and Senate as yet.

Despite this legislative difficulty, there is an overwhelming interest in SBS, particularly on the part of several international and government agencies, trade and professional organizations, and other groups promoting clean indoor environments. A list of these follows, with a description of each:

International Organizations

World Health Organization (WHO)

Cited as 'An International Cooperation in Public Health,' the World Health Organization (WHO) was founded in 1948 and is part of the United Nations. The WHO is charged with the 'attainment by all peoples of the highest possible level of health.'

The WHO is a world-wide organization as a specialized agency of the United Nations with 6 regional offices and 191 member states. WHO promotes technical cooperation for health among nations, carries out programs to control and eradicate disease and strives to improve the quality of human life.

The WHO is involved with Sick Building Syndrome because SBS has become a major concern in many of its member countries where there are many energy-efficient office buildings, and thus many reported cases of SBS.

Government Agencies

A partial listing of United States government agencies is listed here. There are equivalent agencies in many other countries, including Canada, the United Kingdom, and Sweden.

Environmental Protection Agency (EPA)

The EPA is the lead agency with regard to indoor air quality, sick building syndrome and other indoor environmental issues.

The mission of the EPA is "to protect human health and to safeguard the natural environment — air, water, and land — upon which life depends." The purpose of the agency is to ensure that:[9]

1) Americans are protected from environmental risks;
2) national efforts are made to reduce these risks;
3) federal laws intended to protect people from these risks are enforced fairly and effectively;
4) environmental protection is an integral consideration in U.S. policies and legislation;
5) all Americans have access to accurate information sufficient to participate in managing human health and environmental risks;
6) environmental protection contributes to making communities and ecosystems diverse, sustainable and economically productive; and
7) the United States plays a leadership role in working with other nations to protect the global environment.

In 1970, the Clean Air Act was signed into law. This gave broad powers to the EPA to enforce airborne pollution levels. The EPA essentially focused on six primary pollutants: lead, ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, and particulate matter. Sizable reductions in levels of lead and carbon monoxide have been made through reductions automobile pollution, despite significant growth in automobile use since 1970.[10]

Indoor air quality (IAQ) is a more recent development. The Clean Air Act does not cover IAQ and, as stated earlier, there is no law governing IAQ at the present time. Today, the EPA has an Office of Air and Radiation, and one of the divisions within this office is the Indoor Environments Division.[11] This division has produced much of the recent data on indoor air quality in the U.S, and has several publications which are used throughout this thesis.

EPA has done a substantial amount of research on SBS, and this agency has produced several publications on the subject. EPA has acknowledged SBS issues since the early 1980's, and is the lead government agency on most SBS research. EPA also produces most of the statistical data referenced by experts in their separate works pertaining to SBS.

United States Department of Energy (DOE)

The United States Department of Energy was officially formed on October 1, 1977, with the merger of the Federal Energy Administration, Energy Research and Development Administration, Federal Power Commission, and parts and programs of several other agencies.

The purpose of the DOE is "to provide the framework for a comprehensive and balanced national energy plan by coordinating and administering the energy functions of the federal government. The Department undertook responsibility for long-term, high-risk research and development of energy technology, federal power marketing, energy conservation, the nuclear weapons program, energy regulatory programs, and a central energy data collection and analysis program."[12]

The directives of DOE have changed with the changing needs of the country. During the late 1970's, DOE emphasized energy development and regulation, much of this in the form of promoting the use of nuclear and hydroelectric generation of electricity over fossil fuel consumption. During the Reagan and Bush administrations and the Cold War era of the 1980's, nuclear weapons research, development, and production took priority. Since the end of the Cold War, DOE has focused on environmental clean-up of the nuclear weapons complex, nonproliferation and stewardship of the nuclear stockpile, energy efficiency and conservation, and technology transfer and industrial competitiveness.[13]

Today, the Department of Energy contributes by ensuring energy security, maintaining the safety and reliability of nuclear stockpiles, cleaning up the environment from the legacy of the Cold War, and developing innovations in science and technology.

The most recent focus of DOE has been in the area of resource conservation through technological advancements. In 1997, DOE published the International Performance Measurement and Verification Protocol (IPMVP). The purpose of this protocol is to enable investors and financial institutions to measure and ensure savings from investments in efficiency, thereby promoting more such investment in the future.

This relates to SBS because, in many ways, SBS is the result of efforts made in the 1970's by DOE to make office buildings more efficient without measuring the human impact of such a program. Learning from this, the IPMVP aims to execute a measurement and verification protocol that does not compromise the indoor environment.

Reference is made here to following base-line performance levels established by DOE in the form of an ENERGY STAR® building label, and has endorsed a similar concept, which is a building efficiency and environmental quality rating system devised by the U.S. Green Building Council, called LEED™ (Leadership in Energy and Environmental Design).[14]

National Institute of Occupational Safety and Health (NIOSH)

NIOSH was established in 1970 by the Occupational Safety and Health Act, which concurrently created the Occupational Safety and Health Administration. NIOSH is part of the Centers for Disease Control and Prevention (CDC). NIOSH is a research agency, while OSHA is under the Labor Department and is more of an enforcement agency.[15]

NIOSH is charged with researching and identifying the causes of work-related diseases and injuries and the potential hazards of new work technologies and practices. NIOSH works primarily in the area of prevention. Responsibilities of NIOSH include:[16]

1) Investigating potentially hazardous working conditions as requested by employers and employees.
2) Evaluating hazards in the workplace, ranging from chemicals to machinery.
3) Creating and disseminating methods for preventing disease, injury, and disability.
4) Conducting research and providing scientifically valid recommendations for protecting workers.
5) Providing education and training to individuals preparing for or actively working in the field of occupational safety and health.

It was largely on NIOSH's findings that AHSRAE (described later) invoked Standard 62-1989. This changed the required air flow rate for fresh outside air introduction from 5 cubic feet per minute per person to 20 cubic feet per minute per person. This is an industry benchmark specified by the preeminent organization for the building air handling systems industry. ASHRAE Standard 62-1989 is not a federal law.

The link to SBS is fairly clear. NIOSH is the organization that would research the causes of SBS cases and would be the agency most likely to make recommendations on prevention of SBS. NIOSH has several publications covering topics such as indoor air quality, chemical safety, noise, organic solvents, and stress.

Occupational Safety and Health Administration (OSHA)

A government agency located within the United States Department of Labor, OSHA was created under the Occupational Safety and Health Act of 1970. OSHA's mission is "to save lives, prevent injuries and protect the health of America's workers. To accomplish this, federal and state governments must work in partnership with the more than 100 million working men and women and their six and a half million employers who are covered by the Occupational Safety and Health Act of 1970."[17]

At the federal level, OSHA has a staff of 2,209 including 1,113 inspectors and a budget of $336.5 million. OSHA's regulations and programs cover more than 100 million Americans at more than 6 million workplaces. Sharing that responsibility are 25 states that run their own OSHA programs with more than 2,625 employees, including 1,216 inspectors. There are 200 OSHA offices throughout the country. OSHA establishes protective standards, enforces those

standards, and reaches out to employers and employees through technical assistance and consultation programs.[18]

In 1994, OSHA proposed standards for indoor air quality in work environments.[19] However, this standard was never ratified due to intense industry opposition and lobbying. At the present time, there is no OSHA standard covering indoor air quality, while OSHA does have standards for some other SBS causal factors such as noise, illumination, and ventilation.

Trade/Industry Organizations

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

Mentioned earlier, ASHRAE is "organized for the sole purpose of advancing the arts and sciences of heating, ventilation, air conditioning and refrigeration for the public's benefit through research, standards writing, continuing education and publications." ASHRAE has 50,000 members and was founded in 1894.[20]

ASHRAE writes standards that set uniform methods of testing and rating equipment and establish accepted practices for the Heating, Ventilating, Air Conditioning and Refrigeration (HVAC&R) industry worldwide, such as the design of energy efficient buildings. The Society's research program which currently includes more than 100 research projects worth nearly $8 million, investigates numerous issues, such as identifying new refrigerants that are environmentally safe.[21]

With regard to SBS, ASHRAE is most well known for its Standard 62-1989, which specifies minimum ventilation rates and indoor air quality levels that will be acceptable to human occupants. Standard 62-1989 was intended to minimize the potential for adverse health effects. Standard 62-1989 applies to all indoor or enclosed spaces that people may occupy except where other applicable standards and requirements dictate larger amounts of ventilation (for instance, where smoking is allowed).

A proposed addendum to Standard 62-1989 was made in 1998. The most significant proposed change is lowering the maximum allowable carbon dioxide (CO_2) level from 1000 ppm (parts per million) indoor reading to a 650 ppm indoor-to-outdoor differential measurement.[22]

In the absence of legislation or other government standards, most municipal building codes rely on the ASHRAE standard. ASHRAE's current standard for indoor air flow is 20 cubic feet per minute (cfm) per person. In the early 1970's, government-mandated energy efficiency resulted in and ASHRAE standard for indoor air flow of 5 cfm per person. This resulted in high levels of carbon dioxide in buildings and caused many building-induced illnesses. This standard was changed largely as the result of research and recommendations made by NIOSH.

American Society for Testing and Materials (ASTM)

ASTM was founded in 1898 for the purpose of setting consensus standards in industry. ASTM's mission statement is "to be the foremost developer and provider of voluntary consensus standards, related technical information, and services having internationally recognized quality and applicability that promote public health and safety, and the overall quality of life; contribute to the reliability of materials, products, systems and services; and facilitate national, regional, and international commerce."[23]

The purpose of ASTM is to serve as an independent authority on the methods of testing materials. Many construction materials are tested by ASTM to ascertain their properties under a variety of situations. Based on their initial findings, ASTM develops model testing procedures for testing materials in place to ascertain product performance and quality relative to intended function. Other organizations serve the same function. One of these is the American National Standards Institute (ANSI), which also serves as a consensus standard organization in the United States. The International Standards Organization (ISO), is an international consensus standard organization based in Europe.

ASTM relates to SBS in that one of the identified pathogens in two of the three case studies was sprayed-on insulation. ASTM has a defined testing procedure to determine whether this type of insulation meets its intended function. This procedure was used to test whether insulation in the case buildings was losing its adhesive properties and being inducted into the interior air of the buildings.

Building Owners and Managers Association International (BOMA)

BOMA was founded in 1907 and has more than 16,500 members internationally. The primary mission of BOMA is "to actively and responsibly represent and promote the interests of the commercial real estate industry through effective leadership and advocacy, through the collection, analysis, and dissemination of information, and through professional development."[24]

BOMA is also a standard-setting organization. Its first standard created a standardized measurement method for office space. Another BOMA standard was setting forth a standardized chart of accounts for office income and expenses. Today, BOMA has an annual Experience Exchange Report that publishes income and expense data throughout the country, as well as numerous books and guides. BOMA has courses and a professional designation entitled "Real Property Administrator," or RPA.

BOMA is also a formidable lobbying organization on behalf of its membership. BOMA opposed and continues to oppose the proposed OSHA Indoor Air Quality regulations, which have remained on the table since their inception by OSHA in 1994. The primary concerns of BOMA relate to addressing source pollutants with 'reliable evidence' as opposed to 'supposition.'[25] BOMA claims that the new regulation, if enacted, would increase reporting measures and burdens on management staff. BOMA had an independent research firm conduct a nationwide survey in 1995 to determine air quality in office buildings and had 80% of the respondents state air quality as 'okay' or 'good' or 'excellent'.

Institute of Real Estate Management (IREM)

IREM is a national organization of commercial and residential property management professionals. IREM is part of the National Association of Realtors. Its focus is broader than that of BOMA, because it covers both residential and commercial property management. Founded in 1934, IREM has approximately 9,200 members with a Certified Property Manager (CPM) designation, 3,879 members with an Accredited Residential Manager (ARM) designation, and 618 firms with the Accredited Management Organization (AMO) designation.[26]

Like BOMA, IREM is a formidable lobbying organization and opposes the proposed OSHA regulation, citing paperwork and cost considerations as unacceptable portions of the regulation. IREM is in support of HR 1622, the Indoor Air Quality Act of 1993, which has languished in Congress, and is also in support of the similar Senate bill (S. 656). Both HR 1622 and the House and Senate bills differ from the proposed OSHA regulations in that they would allow more flexibility and thus opportunities for cost savings to building owners and managers without the paperwork typically associated with OSHA regulations.

American Institute of Architects (AIA)

The AIA is the professional association of architects. Founded in 1857, the AIA "promotes a public environment that is responsive to the people it serves while representing the professional interests of America's architects. In close concert with other members of the design and construction team, the AIA also works to fulfill its commitment to help coordinate the building industry. The AIA accomplishes this through education, government advocacy, community redevelopment, and public outreach activities."[27]

The AIA is involved with both the design and construction of nearly all commercial office space in the United States. As a result, this organization would be involved with any SBS issues, from reactive to proactive measures. The AIA has published several articles pertaining to Indoor Air Quality as well as SBS. The AIA has professional interest areas (PIAs) which cover topics like environmentally healthy design in more detail, one of these being the Committee On The Environment (COTE).

Illuminating Engineering Society (IES)

The IES is the trade association for lighting contractors. The IES was organized in 1906 and has a current membership of approximately 10,000 individuals from a variety of backgrounds. The purpose of this association is "to research and promote the advancement of technology in the lighting industry. This organization also makes recommendations through its research findings of appropriate levels and types of lighting for different applications."[28]

IES is involved with SBS because lighting levels are thought to be integral in the overall indoor environmental quality of buildings. The IES publishes several documents that allow contractors, designers and architects to select appropriate lighting applications for building interiors.[29]

Proponents of Clean Building Practices

U.S. Green Building Council (USGBC)

The USGBC is a consortium of more than 104 leading international organizations including manufacturers, general contractors, research institutes, public and private industry, and government agencies. Formed in 1993, the USGBC also works in strategic partnerships with many of the professional and trade organizations outlined above. The organization is committee-based

and focuses on promoting 'green' building development through market-based solutions and programs for existing buildings and new construction.[30]

The purpose of the USGBC is "to promote energy conservation in concert with healthier building environments". The primary manifestation of this effort is the LEED™ (Leadership in Energy and Environmental Design), a rating system for the compliance of buildings to energy efficiency and indoor environmental quality. The LEED™ system essentially pulls together numerous industry standards into one rating system and allows for an objective measurement of environmental quality for any given building.[31]

Rocky Mountain Institute (RMI)

RMI, founded in 1982, was one of the original proponents of 'green' technology in building design and construction, focusing on inexhaustible resources such as solar and wind technology. RMI deals with many issues on a national and international level, including resource conservation, energy, transportation, green development, climate change, water, economic renewal, corporate sustainability, forests and safety.[32]

RMI's Green Development Services (GDS), promotes building technologies that are energy efficient and more cost effective over the long-run. One of GDS's most influential projects is a research project looking into 'performance based fees' that reward rather than penalize designers, engineers and architects for creating more energy efficient commercial buildings.[33]

RMI has consulted on many national and international projects and has several publications on the topic of healthy environmental design, including a recent book entitled Green Development

- Integrating Ecology and Real Estate (1997).

Footnotes

[1] *Psychological issues: a multifaceted problem, a multidimensional approach* Vyla Robbins and Gill-Helen Swift. As published in Sick Building Syndrome - concepts issues and practice (1997). pp 70-71

[2] Colligan and Murphy(1982), excerpted from Sick Building Syndrome - concepts, issues and practice, p. 72

[3] *Psychological issues: a multifaceted problem, a multidimensional approach* Vyla Robbins and Gill-Helen Swift. As published in Sick Building Syndrome - concepts issues and practice (1997). Figure 5.1, Page 70

[4] Sick Buildings: Definitions, Diagnosis and Mitigation. Godish, Thad (1995)

[5] Sick Building Syndrome - concepts issues and practice. *Overview.* Rayner, Alison J. (1997) p. 6

[6] Sick Building Syndrome - concepts issues and practice (1997). pp. 74-75

[7] Rollins and Swift, p. 75

[8] Congressional Record. V195 No. 4, P. 26

[9] EPA website {www.epa.gov/epahome/epa.html}

[10] EPA website {www.epa.gov/25year/air.html}

[11] EPA website {www.epa.gov/iaq/}

[12] DOE website {www.doe.gov/glance/mission.htm}

[13] DOE website {www.doe.gov/glance/doehist.htm}

[14] U.S. Department of Energy *IPMVP* (1997). DOE Document No. DOE/EE-0157

[15] NIOSH website {www.cdc.gov/niosh/about.html}

[16] NIOSH website {www.cdc.gov/niosh/about.html}

[17] OSHA website {www.osha.gov/oshinfo/mission.html}

[18] OSHA website {www.osha-slc.gov/OshDoc/OSHFacts/OSHAFacts.html}

[19] OSHA website {www.osha-slc.gov/FedReg_osha_data/FED19940405.html}

[20] ASHRAE website {www.ashrae.org/}

[21] ASHRAE website {www.ashrae.org/}

[22] ASHRAE website {www.ashrae.org}

[23] ASTM website {www.astm.org/NEWS/Mission2.html}

[24] BOMA website {www.boma.org}

[25] BOMA website {www.boma.org}

[26] IREM website {www.irem.org} and IREM staff assistance.

[27] AIA website {www.aia.org}

[28] IES website {www.iesna.org}

[29] IES website {www.iesna.org}

[30] USGBC website {www.usgbc.org}

[31] USGBC website {www.usgbc.org}

[32] RMI website {www.rmi.org}

[33] RMI website {www.rmi.org/a_report/gds.html}

Chapter 3: Case Studies

I. Introduction

Case Study 1: Clark Building

This case study subject is disguised as a condition of the agreement to disclose information by the parties involved. The subject of this case, the "Fred" building, is a multi-tenant biotech and office building that is part of a larger mixed-use development. The case study looks at the costs incurred as the result of an alleged indoor environmental problem. Costs included the evacuation of a major tenant, a protracted court battle, substantial repairs, and re-leasing.

Case Study 2: Ruggles Center

The Ruggles Center is a well-known example of SBS in Boston, Massachusetts. This is a single-tenant, 9 story office building built specifically for use by the Commonwealth of Massachusetts Registry of Motor Vehicles. This building was part of a larger five acre, four lot development that was to include hotel and other uses. The development team was a consortium of local minority business leaders and a development firm based in Chicago.

This case study examines the costs incurred by the Commonwealth of Massachusetts as a result of its evacuation of the building, the costs incurred by the developer in an attempt to solve the problems, the ultimate foreclosure of the building and diminution of property value, the ultimate sale price of the building and its current lease rates with a new owner and a clean building. There is litigation in progress for this case, so certain costs remain unknown until this legal matter is settled.

Case Study 3: Ernst & Young regional office, Atlanta

The 55 story NationsBank Plaza was opened in midtown Atlanta, Georgia, in April 1992. Ernst & Young (E & Y) was one of the building's larger initial tenants, taking eight floors during pre-leasing in approximately 1990. Ernst & Young wanted to build out their new regional headquarters in a way that would minimize or eliminate unnecessary environmental risks or exposures.

This case study looks at the additional costs incurred by E & Y to build this space. It also looks at the use of an environmental consultant and the steps taken toward executing a clean building program for the E & Y space. Lastly, this study attempts to quantify whether the costs incurred have resulted in a measurable benefit to Ernst & Young.

II. Case Study One - Suburban Biotech/Office Building

At the request of the parties involved, the location, dates, and names of parties are disguised; however, important ratios remain accurate.

I. Building Information

Opened:	May 1991
Developer:	Bedrock Development (a subsidiary of Flintstone LLP)
Management:	Bedrock Management (a subsidiary of Flintstone LLP)
Development Type:	Part of Master-Planned Mixed-Use Development
Ownership:	Flintstone LLP
Construction Type:	Steel frame, brick curtain wall exterior.
Use:	Multi-tenant biotech and office space
Size:	146,000 SF
Stories:	6

II. Background

In 1985, Bedrock Development was selected by a large public university to develop a university-owned 20-acre tract of land with a mixed use urban project including retail, hotel, office and residential units. The first phase was begun in 1989 and consisted of three multi-tenant office/ R&D buildings. The first building completed was a biotech building in late 1989, which was a renovated industrial building. The first two new buildings were completed in 1991, and were called the Fred and Barney buildings. The Fred building contains 146,000 square feet in six floors and is the subject of this case. The uses in the Fred building included a mix of office and biotech tenants.

Wheel Incorporated (Wheel), an up-and-coming biotech company with many products under development, leased the fourth and fifth floors of the Fred building and began occupancy in May 1991. Wheel had options to expand into space on the other floors of the building as well. Wheel exercised its option on one of these spaces, and amended its lease in July of 1994 to include an additional 5,000 square feet on the third floor of the building, for a total leased area of 60,000 square feet. In August of 1996, Wheel was paying base rent of $21.00 per square foot per year, triple-net, or approximately $105,000 per month for 60,000 square feet of space in the Fred building.

III. Events

First Sign of SBS

On August 20, 1996, just past the fifth anniversary of their lease commencement in the Fred building, Wheel informed Bedrock Management for the first time of its concerns pertaining to the building's indoor air quality, this coming after several months of employee complaints and medical absences for such. The complaints were generally of skin rashes and respiratory problems. According to Wheel, these symptoms would commonly dissipate upon leaving the office and would return again upon entering the office. There had been some problems with a leaking roof which primarily affected the top (sixth) floor of the building, but it was not known whether this was contributory.[1]

Initial response by Bedrock Management

In response to this, Bedrock Management advised Wheel that Bedrock Management would commission qualified 'neutral' experts to conduct several tests to investigate the building's indoor air quality. The investigation included both 'passive' and 'aggressive' air sampling tests, which

are explained later. The experts brought in were Plate Tectonics Engineering (PTE) and Breath Technology Ventilation (BTV).[2]

Wheel's decision to break it's lease, claiming 'constructive eviction'

On August 23, 1998, Wheel disclosed to Bedrock Management its intent to vacate the premises, citing anxieties on the part of management and employees about air quality. Altogether, approximately 50 of Wheel's 150 employees were said to be affected by the air quality problems in the premises. Wheel delivered to Bedrock Management a formal notice alleging constructive eviction due to poor air quality. Constructive eviction is covered in the local state statutes.

The intent of both parties at this point was that Wheel would relocate temporarily until the problems were fixed. Wheel would then move back upon completion of the repairs, estimated to be January 1997. In the time following Wheel's 'temporary' relocation, Bedrock undertook an investigation of the Wheel space and began remediation work. However, as the repairs were nearing completion, Wheel advised Bedrock that it would not be returning to its space, citing the same constructive eviction statute and the health concerns of its employees. Wheel filed suit against Bedrock Management, et al. in February of 1997 seeking damages said to have resulted from the purported 'constructive eviction'.[3]

Counterclaim by Bedrock Management

In February of 1997, Bedrock Management counterclaimed for damages flowing from the alleged breach of contract (lease). The building's other tenants, of which there were several, did not move out of the building as the result of the alleged problems and the building retained its occupancy permit. Wheel evacuated the Fred building during the last week of August and the

first week of September 1996. Most of the investigative work took place subsequent to their departure.[4]

Investigation of air quality in the Wheel premises

Bedrock began its investigation into the Wheel space after Wheel's 'temporary' relocation in late summer of 1996. These tests continued into the fall and included passive and aggressive air sampling tests, a comprehensive evaluation of the materials and systems, and chemical testing. The cost of these tests was approximately $425,000.

In the passive air sampling test, the investigators placed collecting plates at various points in the spaces formerly occupied by Wheel, thus allowing the ambient air to deposit samples of whatever particles might be present. The plates remained in the space for three weeks before being removed for testing. In the aggressive air sampling test, a leaf blower agitated dust in the Wheel spaces so that the air sampled would include material otherwise lying on flat surfaces in rooms and hallways. Altogether, the experts took a total of at least 175 dust samples from the Wheel spaces.[5]

Broken pipe found

In the course of conducting the tests for Bedrock Management, PTE revealed a broken polyvinyl chloride (PVC) pipe connected to one of the labs installed by Wheel. This pipe had failed several times, and it had been repaired by Wheel several times. As a result of the frequent repairs, the walls were left open for easy regular access to the pipe. The dampness from the leakage resulted in a substantial bloom of fungal growth, which in turn was introduced into the occupied areas by the unsealed openings in the wall, according to a report by PTE.[6] This pipe

was repaired properly during the testing and repair period and the cost of the necessary repairs was paid by Wheel.

Wheel refutes broken pipe as cause of problems

Wheel became suspicious of the 'neutral' inspection when it sensed Bedrock's inspectors were focusing in on laboratory practices rather than ambient air quality. Only at this time did Wheel decide to conduct its own inspection and investigation of the building, and this inspection is detailed below. After receiving the report from PTE, Wheel took a very defensive stance in the legal proceedings.[7]

Separate investigation ordered by Wheel

While the initial investigation was being conducted, Bedrock allowed Wheel to have a representative monitor Bedrock's testing. Wheel did not commission its own testing until the matter was in litigation in the fall of 1997. Wheel's investigation was done as part of the discovery process for the trial.

Sticky Tech Incorporated (STI) conducted the primary testing for Wheel with an "adhesion/ cohesion" test. This test found that sprayed-on fireproofing material had lost its adhesive and cohesive properties due to excess humidity in the plena[8] of the building. STI cited sources of the humidity as improperly installed synthetic stucco exterior (which allowed water intrusion) and the lack of dehumidification of outside air before introduction into the plena of the building.[9]

Bedrock conducted a similar and independent investigation regarding the adhesion/cohesion properties of the insulation, also as part of discovery. However, its findings were at odds with those of Wheel's, and this became a major issue in the trial.

Trial Events

A non-jury trial was held in the fall of 1997 in superior court. At trial, Wheel argued 1) that the fireproofing material had badly degraded and that 2) the fireproofing dust had infiltrated and contaminated its occupied space. Wheel's primary evidence was its adhesion/cohesion test, and the finding of this test were supported by testimony of several other of Wheel's experts. One of Wheel's experts had been instrumental in proving that insulation degradation was at the heart of the problems in another building in the same region, and of approximately the same age and construction as the Fred building.[10]

Flawed testing procedures hurt Wheel's case

While STI's test showed that much of the sprayed-on insulation had degraded, this evidence was set aside by the judge because STI's expert admitted that the adhesion/cohesion testing had not followed applicable ASTM (American Society of Testing and Materials) requirements. Bedrock's consultants had followed ASTM procedures. Many of the other experts brought in by Wheel relied on STI's test; their testimony was undermined as a result.[11]

Decision

On April 17, 1998, the judge ruled in favor of the defendant, Bedrock. The judge determined that a) Wheel did not prove conclusively that the fireproofing had degraded, b) Wheel did not prove conclusively that any fireproofing materials had entered their space, and c) Wheel was in breach of contract for abandoning its premises and lease.

Settlement Agreement

Subsequent to the court decision, Wheel and Bedrock entered into a settlement on June 16, 1998. The settlement required total consideration from Wheel to Bedrock of $7,985,000 as follows:[12]

Cash Payable January 19, 1999	$1,500,000
Cash Payable January 18, 2000	$1,000,000
Cash Payable January 17, 2001	$1,000,000
Wheel Stock	$4,485,000[13]
Total Consideration	$7,985,000

IV. Financial Summary

The damages awarded to Bedrock roughly approximated Bedrock's calculated losses due to the vacation/breach of contract by Wheel which were submitted at trial. The following is an accounting of the losses incurred by each party due to the alleged problems within the Fred building:

Wheel's Alleged Damages[14]

		Total Damage ($)
(1)	**Loss on Sale of Equity**	5,967,000
(2)	**Lost Product Sales**	2,262,089
(3)	**Lost Employee Productivity**	1,642,589
(4)	**Facility Replacement Cost**	1,267,219
(5)	**TCD Buildout Costs Incurred**	1,213,156
(6)	**Lost Collaborative Research Revenue**	943,257
(7)	**Expense Incurred**	864,314
(8)	**Lost R & D Time**	804,675
(9)	**Evacuation and Relocation Expense**	751,058
(10)	**Restructuring Costs**	358,295
	Subtotal - Expenses Incurred	16,073,652
(11)	**Projected Lost R & D and Employee Productivity**	621,148
	Total	16,694,800

It is necessary to note here that Wheel specified the above losses in the midst of a trial, and included any and all business losses. Specifically, items (1) and (2) will be excluded from consideration, even though some entity loss did occur. Utilizing the remaining costs, Wheel incurred a loss of approximately $8.5 million. Wheel specifically stated lost employee productivity as a cost, which represents almost 20% of the total losses.

		Total Damage ($)	% Of Total (%)
(3)	**Lost Employee Productivity**	1,642,589	19.40
(4)	**Facility Replacement Cost**	1,267,219	14.97
(5)	**TCD Buildout Costs Incurred**	1,213,156	14.33
(6)	**Lost Collaborative Research Revenue**	943,257	11.14
(7)	**Expense Incurred**	864,314	10.21
(8)	**Lost R & D Time**	804,675	9.51
(9)	**Evacuation and Relocation Expense**	751,058	8.87
(10)	**Restructuring Costs**	358,295	4.23
	Subtotal - Expenses Incurred	7,844,563	
(11)	**Projected Lost R & D and Employee Productivity**	621,148	7.34
	Total	8,465,711	100.00

Of the losses stated by Wheel, items (3) and (7) were caused implicitly by the alleged SBS-type illness in the Fred building. Item (3) reflects lost employee productivity due to SBS symptoms, and item (7) reflects expenses incurred for testing and legal action. The remainder of the costs would in large measure have occurred under a normal relocation situation.

In total, therefore, Wheel suffered losses directly attributable to the alleged problems in the Fred building of $2.5 million, or 30% of their $8.5 million in non-entity losses. On top of this, Wheel lost the court case and agreed on a settlement amount to Bedrock of $7,985,000. This figure corresponds with Bedrock's calculation of losses attributable to Wheel's breach of contract in the Fred building, as well as attorney's fees, testing costs, much of the cost to cure the problem, and indirect opportunity costs stemming from the events at the Fred building. Bedrock's costs are outlined below:

Bedrock's Losses[15]

	Total Damage ($)
Wheel Incorporated Rent 9/1/96 - 3/31/98	
Minimum Rent	$ 1,995,000
Tenant Reimbursement	$ 855,000
Total Rent	$ 2,850,000
Expenses	
Air Quality Investigation	$ 480,000
Legal Expenses	$ 215,000
Total Expenses	$ 695,000
Expenditures	
Est. Tenant Improvements	$ 1,260,000
Structural T.I.'s	$ 745,000
Painting & Carpet	$ 90,000
Upgrade Air Handling System	$ 425,000
Leasing Commissions	$ 320,000
Total Expenditures	$ 2,840,000
Opportunity Cost/Collateral Damage	$ 1,600,000
Total Make Whole Damages at March 31, 1998	$ 7,985,000

Bedrock included much of the cost to cure the problems in its counterclaim, so remediation/ renovation costs are inclusive. The total cost of the SBS problem, without respect to the future income stream of the Fred building, amounts to $7,985,000. Legal fees account for approximately $215,000 of that total.

Remediation of Wheel Space

In the time after Wheel's departure, Bedrock incurred costs of approximately $1,260,000 to renovate the Wheel space in order to modify the Wheel space and its systems in response to concerns raised by Bedrock's consultants during the investigation of the space. This was also necessary to re-lease the space. Several brokers had advised Bedrock that the space was 'unleasable' until the problem was fixed. In addition, these repairs were necessary to placate the building's other tenants, some of whom had become anxious over their own health and safety.

Two of the building's other tenants had requested rent reductions, which were ultimately avoided. The HVAC repairs cost approximately $515,000 and included hard-ducting of the return air for the office portion of the Wheel space rather than using the open plena as a return air channel. Other changes including an upgrade of the air handling and air conditioning units servicing the Wheel office space.

Re-Leasing of the Wheel Space

The fifth and sixth floors were re-leased in June of 1998 to Spoke, Incorporated. The space comprised 55,000 square feet and leased for $21.00 per square foot. Spoke was the only 55,000 square foot biotech user in the market at the time, and the market for biotech space was soft. Nonetheless, typical market conditions at the time were $26.00 - $28.00 rents and a minimum term of 10 years for such a user. Due to the situation at the Fred building, Spoke was able to obtain a lease at $21.00 base rent, a term of 5 years, and a generous tenant improvement package. Bedrock accepted the deal because the building was experiencing negative cash flow and this tenant was seen as the only option to remedy the situation.

Subsequent Events

Bedrock Development is in the progress of constructing two other buildings within the project and has others planned. The market has improved significantly and leases are now being signed in the $34.00 - $36.00 range, triple-net. The market has shifted from a tenant's market to a landlord's market. While the Fred building had both market conditions and stigma of an alleged SBS problem going against it in mid-1998, the current conditions are such that the stigma no longer exists.

With regard to construction on Bedrock's new projects, the company utilizes different fireproofing materials and air handling systems, though the company says this is due to changes in construction practices and prudence, and not as a response to the prior events in the Fred building.

Footnotes

[1] Wheel v. Bedrock

[2] Wheel v. Bedrock

[3] Wheel v. Bedrock

[4] Wheel v. Bedrock

[5] Wheel v. Bedrock

[6] Wheel v. Bedrock

[7] Wheel v. Bedrock

[8] Plena is the plural of plenum. A plenum is the space above the ceiling tiles in an office where air handling machinery and ductwork are located.

[9] Wheel v. Bedrock

[10] Wheel v. Bedrock

[11] Wheel v. Bedrock

[12] SEC Edgar Database website {www.sec.gov/Archives/edgar/}

[13] Based on Wheel's closing stock price 6/31/98 and 1.2 million shares issued.

[14] Wheel v. Bedrock

[15] Wheel v. Bedrock

Ruggles Center
1135 Tremont Street
Boston, Massachusetts

III. Case Study Two - The Ruggles Center

1135 Tremont Street
Boston, Massachusetts

I. Building Information (at construction)

Year Built:	1992-1994
Opened:	April 1994
Developer:	Metropolitan Structures/Columbia Plaza Ventures
Development Type:	Build-To-Suit for State Agency
Ownership:	Metropolitan Structures/Columbia Plaza Ventures
Construction Type:	Steel Frame, Brick Curtain Wall
Use:	Primarily Single-Tenant Occupancy
Size:	165,000 SF
Stories:	9

II. Background

The Roxbury neighborhood is located in Southeast Boston, and is one of the city's poorest neighborhoods. City and state agencies had tried since the late 1970's to improve neighborhood conditions. One of the largest infrastructure investments in the area was construction of a sub-way station for the Massachusetts Bay Transportation Authority (MBTA) Orange Line. The new Ruggles Station was completed in 1986 as part of a larger $792 transportation project.[1] Crime had long been a concern in the area, but this issue was largely solved with relocation of the Boston Police headquarters to a new building across from Ruggles Station. Despite these municipal investments, most developers avoided the area in favor of sites in downtown Boston and the suburbs.

The development of Ruggles Center happened as a result of a process called 'linkage'. This was devised by then City of Boston Mayor Raymond Flynn. The City would 'link' a development parcel in a neglected community with a more attractive and viable parcel downtown. Then the City would select a single development entity, typically with significant minority investment required, to develop both sites. [2]

In this case the 'good' site was a tract of land in Chinatown and the 'neglected' site was the Ruggles Center site, a five acre development tract consisting of four separate parcels of land located approximately one quarter mile from Ruggles Station. This project began in 1986 when the City of Boston selected a development group consisting of several business leaders from the Roxbury and Chinatown communities along with a development company based in Chicago called Metropolitan Structures.

Mayor Flynn had hoped to use the 'good' downtown parcel as a carrot to leverage investment in Roxbury, but it didn't happen that way. The real estate market crashed. The Chinatown parcel, known at the time as the "One Lincoln Street" development[3], was postponed, while the development group went ahead with the Roxbury project, which was permissible under the 'linkage' structure.

Revitalizing the Roxbury neighborhood was a high priority for both state and city of Boston officials. The reason the development group proceeded on the Ruggles Center site had a significant amount to do with the fact that these officials were willing to do what was necessary to get a government tenant in the building under a long-term lease. This was something these officials were unwilling to for the more favorable Chinatown parcel. As will be shown later, this project got built specifically because of a favorable long-term lease with a government tenant.

The original plan called for a $250 million, three office building and hotel development on four separate parcels of land. The overall Roxbury project was commonly referred to as Parcel 18, and as stated earlier, was a top priority for both state and city officials[4]. The development group, called Metropolitan/Columbia, encountered difficulty in finding a private tenant willing to anchor the office project. As the economy worsened, this became increasingly difficult.

Then Governor Michael Dukakis, finishing his last term in office, signed legislation that allowed state agencies (such as the Registry) to lease office space on a long-term basis, without having to conform to normal bidding practices for leasing. The sole purpose of this legislation was to establish a lease term with a credit government tenant that would be sufficient to get the Parcel 18 project financed. Dukakis' successor, Governor William Weld, was criticized in the media for signing 'a remarkably generous lease' with the development group in 1992.[5]

In a June 25, 1990, article in *The Boston Globe*, the bill is described as one that "...directs public agencies to enter no-bid leases for all of the space in Parcel 18 — one hundred percent of the four-building development. The bill mandates 15-year leases, but effectively allows 25-year no-bid leases. And it sets no cap on the rent the state would pay."[6]

Specifically, Governor Weld had committed the state to pay $106 million over 15 years, or approximately $4 million per year.[7] This equated to $26.25 per square foot per year on a triple-net basis. Comparable market rents at that time were difficult to measure, as there were no like-kind buildings in Roxbury or anywhere near Roxbury.

However, better-located downtown Class A space was leasing at $28.00 per square foot per year, with rates falling and concessions rising by the month. By this measure, the Ruggles Center lease was above market. In consideration of the location of the building and the high credit quality of the tenant, this lease was substantially above market.

With lease in hand, Metropolitan/Columbia obtained construction financing from then Bank of Boston in the amount of $26 million. It was the largest private investment in Roxbury history, and the largest real estate project with 50% minority ownership in American history.[8] Total development cost for the building was stated as $31 million. Construction commenced in mid-1992, and the building was finished and occupied in early 1994.

III. Events

Onset of Symptoms

Employees began to complain of the air quality in the building almost immediately following occupancy. The number of sick employees became significant within the first two months of occupancy. Ailments included "irritated skin, eyes and lungs along with headaches, fatigue and malaise," according to Dr. William B. Patterson, a consulting physician.[9]

Investigation

As the weather warmed into early summer 1994, the problem seemed to get worse. The Registry hired environmental consultant Joseph W. Lstiburek to investigate the building. Lstiburek concluded in a May 1995 report that the fireproofing material, when used in open plena as in the Ruggles Center, should be 'encapsulated' or 'seal-coated' to prevent the moisture-induced degradation that was evident in all floors of the building. Lstiburek concluded that "Omission of this encapsulant is believed to be responsible for the health complaints."[10]

Lstiburek also estimated that the cost of including the encapsulant would have been approximately $15,000 to $25,000. Other consultants found that the HVAC units were improperly installed, causing water to leak onto ceiling tiles. This produced a release of Butyric acid, a putrid-smelling organic toxin that causes people to become nauseous.

Experts concluded that high humidity coupled with air conditioning induced condensation within the plena. This condensation caused the sprayed-on fireproofing material to degrade. The particles caused by the degradation of the fireproofing were easily carried into the building because of the design of the air handling system, which used the plena as an air chamber for the building.

The number of complainants and absences attributable to building conditions grew with every passing month over the next thirteen months, until most of the 640 Registry employees were suffering some reaction to the building environment at Ruggles Center. From mid-summer 1994 to mid-summer 1995, nearly 60 workers transferred out of the building because of building-related health problems.[11]

In the 15 months the Ruggles Center was occupied, 517 of the 640 employees complained the air in the building made them sick.[12] A review of Ruggles Center by the National Institute of Occupational Safety and Health found a higher percentage of Registry employees were becoming ill than employees at 80 other 'sick' buildings in a national survey.[13]

Evacuation

In early July 1995, Public Health Commissioner David Mulligan urged top Registry official Jerold Gnazzo to evacuate the building by July 31, 1995. This recommendation came as a result of a Department of Public Health investigation that found loose insulation particles in the building air.[14]

The July 31, 1995 move-out was seen as temporary by Registry officials. Their understanding was that repairs would be made to the building and then the Registry would move back in. The Registry moved its employees to a variety of locations, including offices at 100 Nashua Street (its former offices) and Copley Plaza. The initial cost of the relocations was $10 million, with the Weld administration requesting an additional $7.75 million to move the Registry back into Ruggles Center when the repairs were completed. The $10 million cost would later rise to $14.2 million.

Repairs

In the intervening time between the Registry's move-out at the end of July, 1995 and the following July, Metropolitan/Columbia spent approximately $6 million completing renovations and improvements necessary for the Registry to return to the Ruggles Center.

Lease Cancellation

At the conclusion of the Metropolitan/Columbia renovations, Department of Public Health officials inspected the building for occupancy. They were "shocked" by the condition of the building, warning that any return to the building would be very difficult. A certificate of occupancy was denied. As a result, the Registry canceled its lease as of right, and this cancellation took effect at the end of July 1996.[15]

Last-Minute Work-Out Efforts

After last-ditch efforts at a work-out in August and September of 1996, Bank of Boston (which had become BankBoston) initiated foreclosure proceedings against Metropolitan/Columbia in early October 1996.[16]

Auction

BankBoston repurchased its own notes at auction on November 7, 1996. BankBoston paid $10 million for the note pertaining to Ruggles Center and $5 million for a note covering the three other vacant land parcels surrounding the building. [17] This equated to a write-down of $11 million on the original loan amount of $26 million, irrespective of outstanding interest and penalties.

Preparation for Occupancy and Resale

In buying the notes, BankBoston was able to clear the title of the property. In addition, it was able to control the site and determine what measures remained to gain occupancy permits for the building. Metropolitan/Columbia had completed nearly all the repair work but had not purged

the indoor air of particulates created from the construction process. The remaining expenditure required to clean up the indoor air in Ruggles Center was minimal. An interview with a BankBoston official confirmed that this remaining cost was less than $75,000. BankBoston's goal was to market a 'clean' building with occupancy permits intact.[18]

Legal Action

In April 1997, the Commonwealth of Massachusetts sued the developer, contractors, fireproofing manufacturer, architect and mechanical engineers involved with construction of the Ruggles Center to recover costs incurred because of the building's hazardous air quality.

The suit was filed in Suffolk Superior Court and alleged that fireproofing material and negligent design and construction caused unnecessary injury, property damage, and financial losses to taxpayers and state employees.[19] It is worth noting here that the local minority investors were limited partners and not liable for damages resulting from this litigation. The general partner, Metropolitan Structures of Chicago, however, is a named defendant. As of the writing of this thesis, the case had not yet been heard.

Marketing

BankBoston began marketing the Ruggles Center in early 1997 at a price of $19.5 million. Early offers from the City of Boston included $8.5 million and $10.5 million.[20] Both were rejected by BankBoston. In April 1997, an ownership group consisting of the Whittier Street Neighborhood Health Center, Madison Park Development Corporation and Trinity Financial offered $15 million, but the Bank was unresponsive to this offer as well.[21]

The Bank finally accepted an offer from Northeastern University at a price of $17 million. This offer most closely matched 'linkage' payments and benefits to the Roxbury neighborhood sought by the City of Boston eleven years earlier from the original development group. The purchase price is estimated here as $12 million for the Ruggles Center and $5 million for the three adjacent development parcels.

Purchase Terms

The successful purchase bid by Northeastern University included a substantial community benefits package as part of the purchase offer for the Ruggles Center and the other three development sites. The City of Boston sought to replace the community benefits that were a part of the original development proposal, to facilitate its revitalization program for Roxbury. Northeastern's proposal came closest in replacing what was lost when the building's prior developers gave the building back to BankBoston.

Specifically, in addition to Northeastern's $17 million purchase price. The school agreed to lease 30,000 square feet on the second and third floors of the building to Whittier Street Neighborhood Health Center rent-free for a period of 31 years. This space will have a separate entrance and elevator. According to officials at Northeastern University, the aggregate value of this lease contribution is $9.3 million. Also in the community benefits package is an agreement to provide parking for 90 police cruisers on one of the three adjacent development parcels. In addition, Northeastern agreed to fund a job creation program for Boston residents, minorities and women (value stated at $325,000 in linkage payments which are paid by a grant obtained by Northeastern University).[22,23]

The City of Boston also required a commitment from Northeastern to develop a hotel and conference center on one of the three adjacent parcels with completion within five years of the closing date. The City agreed to put this development on a fast track for all necessary permits and approvals.

Recovery

Subsequent to its purchase of the Ruggles Center, Northeastern University renamed the building "Renaissance Park and Northeastern University." According to officials at Northeastern, the Renaissance Park has leased-up steadily since marketing of space began in early 1998. As of the writing of this thesis, there was one major lease pending for five floors of the building to a government tenant. Other signed tenants include the Whittier Street Neighborhood Health Center, Harvard Medical International, a pharmacy, and the Gorbachev Foundation.

IV. Financial Summary

Net Present Value 'Before'

This case will illustrate the economic loss caused by the SBS problems. The initial lease with the Registry of Motor Vehicles included the entire building (165,000 square feet, 9 floors) and was unlikely to default due to government tenancy and, as stated earlier, at an acknowledged 'premium' rental rate. Nonetheless, that lease would be in place today had the problems at the Ruggles Center not occurred.

The original lease term was from March 1994 through February 2009, which was 15 years or 210 months. As of January 1, 1999, the lease would be in its 47th month, with 163 months remaining in the lease term. A net present value (NPV) analysis was done assuming 'present time' as January 1, 1999 and a reversion date of January 31, 2009.

Since the lease was a net lease, with the tenant paying for all operating costs in the building, the rental amount represents a net cash flow to the owner. After making deductions for a vacancy and credit loss allowance of 5%, as well as for replacement reserves and assuming an eventual sale of the building at a 9.5% CAP rate. The cash flows were discounted at 11.5%, yielding a net present lease value of $37,400,000. This number was juxtaposed with the 'After' situation at the property:

Net Present Value 'After'

As of the writing of this thesis, the Ruggles Center had been renamed Renaissance Park at Northeastern University and was nearing completion of leasing to multiple tenants. The rent roll at January 1, 1999 was assumed unchanged from the anticipated rent roll at lease-up. Unlike the government tenant that occupied the building prior to the SBS problems, the non-government tenants of Renaissance Park are of less secure credit and shorter lease term. This was reflected in the vacancy and credit loss allowance.

If all of the tenants were non-government, low credit tenants, a vacancy and credit loss estimate of 10% rather than the 5% estimate used in the 'before' situation was used. Since it is anticipated that the building's largest tenant will still be a government tenant, a vacancy and credit loss estimate of 7% was used, reflecting the blend of credit and non-credit tenancies.

Discounted Cash Flow

Ruggles Center - Assuming No SBS

Year	1/1/99	2/1/99	2/1/00	2/1/01	2/1/02	2/1/03	2/1/04	2/1/05	2/1/06	2/1/07	2/1/08	2/1/09
Period	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Income		$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250	$ 4,331,250
Less V & CL		$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)	$ (216,563)
Net Income		$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688	$ 4,114,688
Less Exp.		$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)	$ (6,858)
Reversion												$ 41,146,875
Cash Flow		$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 4,107,830	$ 45,254,705
PV @ 11.5%	$ -	$ 3,684,152	$ 3,304,172	$ 2,963,383	$ 2,657,743	$ 2,383,626	$ 2,137,781	$ 1,917,292	$ 1,719,545	$ 1,542,193	$ 1,383,132	$ 13,665,962

NPV @ 11.5%	$ 37,358,981

Assumptions	
165,000	square feet
$26.25	psf/yr contract
5.00%	Sale Cost
9.50%	Sale CAP
11.50%	Discount Rate
$10.00	T.I. Cost Initial
5.00%	Leasing Comm.

Discounted Cash Flow

Ruggles Center - After SBS

Year	1/1/99	2/1/99	2/1/00	2/1/01	2/1/02	2/1/03	2/1/04	2/1/05	2/1/06	2/1/07	2/1/08	2/1/09
Period	0	1	2	3	4	5	6	7	8	9	10	11
Income		$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500	$ 4,207,500
Less V & CL		$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)	$ (294,525)
Net Income		$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975	$ 3,912,975
Less Exp.	$ (2,701,875)	$ (194,209)	$ (194,209)	$ (194,209)	$ (194,209)	$ (194,209)	$ (1,492,381)	$ (194,209)	$ (194,209)	$ (194,209)	$ (1,492,381)	$ (194,209)
Reversion												$ 39,129,750
Repairs	$ (6,075,000)											
Cash Flow	$ (8,776,875)	$ 3,718,766	$ 3,718,766	$ 3,718,766	$ 3,718,766	$ 3,718,766	$ 2,420,594	$ 3,718,766	$ 3,718,766	$ 3,718,766	$ 2,420,594	$ 42,848,516
PV @ 11.5%	$ (8,776,875)	$ 3,335,216	$ 2,991,225	$ 2,682,713	$ 2,406,021	$ 2,157,866	$ 1,259,716	$ 1,735,700	$ 1,556,682	$ 1,396,127	$ 815,029	$ 12,939,344

NPV @ 11.5%	$ 24,498,765

Assumptions	
165,000	square feet
$25.50	psf/yr contract
5.00%	Sale Cost
9.50%	Sale CAP
11.50%	Discount Rate
$10.00	T.I. Cost Initial
5.00%	Leasing Comm.

Since the Whittier lease was part of a community benefits package and not part of normal market conditions, its lease was 'marked up to market' for the purposes of illustration. In this lease analysis situation, the Whittier lease was marked up to a rate comparable to the lease rates of other larger tenants in the building. A blended lease rate for the building of $25.50 was used in this analysis. Market rents for non-credit and smaller-size tenants was assumed at $27.00 per square foot per year, triple-net, and $22.00 per square foot per year for larger credit tenants.

Tenant improvement allowance and leasing commissions were necessary for this analysis, because the average lease term was assumed at 5 years. Reserves remained the same on a percentage basis. The remediation cost of $6,075,000 was included in the 'after' analysis to reflect costs necessary to make the building ready for re-occupancy. All necessary tenant improvements and leasing commissions are independent of this expense.

Utilizing all this information, a discounted cash flow model was used. Assuming a 'present time' of January 1, 1999 and a reversion in ten years (January 31, 2009) at a 9.5% CAP rate, and discounting the cash flows at the same discount rate of 11.5% yielded a net present value of approximately $24,500,000. The difference between the 'Before' and 'After' scenarios was approximately $12,900,000. This represented the nominal value drop due to events caused by the SBS problem at the Ruggles Center.

The $12,900,000 difference between the price paid for the building by Northeastern ($12 million for the Ruggles Center) and the analyzed $24,500,000 value in the 'After' situation is partially accounted for in the Whittier lease of $9.3 million. The balance of $3,600,000 accounts for other concessions such as the free parking spaces given to the police department, but is mostly an additional write-down for the investment risk undertaken by Northeastern to buy a building in a marginal location that was formerly tainted by SBS.

Notes on the NPV Comparison

In reality, the more risky non-government tenants would warrant higher discount and cap rates in addition to higher vacancy and credit loss deductions. This would impart too much judgment into the equation and thus these were left unchanged. The 'marking to market' of the Whittier lease in the 'after' situation was deemed necessary to eliminate all non-market influences on this project. Otherwise, the above analysis illustrates the contractually-based economic loss due to the SBS problems at the Ruggles Center. However, there are many other costs to consider.

Other Losses Caused by the SBS Problems

The foregoing analysis did not take into account the foregone principal and interest payments to the bank, the opportunity cost after the building's lease with the Registry was canceled, the cost of moving the Registry and the cost of the space the Registry moved into, and the lost employee productivity while the building was still in operation. Other costs also including lost employee productivity during the subsequent move from of the building, and the legal costs now underway between the former lender and the developer of the building, and between the Commonwealth and the developer. Given these additional costs, added to the evidence on contract rents, it is clear that a significant loss in net present value occurred.

Did the building suffer Economic 'Stigma'?

The current office lease rates in the market area nearest to Renaissance Park were stated as $29.00 per square foot per year, triple-net. Many of these buildings are substantially older than Renaissance Park, and none has a location that could be called similar to that of Renaissance Park. The average lease rates within Renaissance Park are $25.50, tending to confirm that there is some economic stigma being calculated into the lease rate by new tenants. This may be due as much to the building's inferior location as to any perception of lingering SBS issues.

A conversation with the property manager indicated that location was and continues to be this project's biggest obstacle. While the government was able to overlook locational preferences in favor of neighborhood revitalization in the early 1990's, the private market remains reluctant to pay Central Business District (CBD) rates for non-CBD office space, irrespective of a building's history.

Footnotes

[1] Christian Science Monitor. 11/15/84 P. B1; New England Suppl./Boston

[2] The Boston Globe. Weds. 10/9/96 City Ed. p. B1

[3] The Boston Globe. Sat. 12/29/90 City Ed. p. 1

[4] The Boston Globe. Sat. 12/29/90 City Ed. p. 1

[5] The Boston Globe. Weds. 10/9/96 City Ed. p. B1

[6] The Boston Globe. Weds. 7/25/90 City Ed. p. 79

[7] The Boston Globe. Tues. 9/5/95 City Ed. Pg. 25

[8] The Boston Globe. Weds. 10/9/96 City Ed. p. B1

[9] *Can Buildings Make You Sick?* Nova video 12/26/95; The Boston Herald 7/7/95 Fri. First Ed. P. 1

[10] The Boston Globe. Saturday, July 15, 1995. City Ed. P. 17

[11] The Boston Herald. Friday, July 7, 1995. First Ed. P. 1

[12] The Boston Globe. Tuesday, September 5, 1995. City Ed. Pg. 25

[13] The Boston Globe. Tuesday, September 5, 1995. City Ed. Pg. 25

[14] The Boston Globe. Friday, July 7, 1995. City Ed. Pg. 1

[15] The Boston Globe. July 16, 1996 Tuesday City Ed. Pg. A1

[16] The Boston Globe. October 9, 1996 Wednesday City Ed. Pg. B1

[17] The Boston Herald. November 8, 1996 Friday First Ed. Pg. 39

[18] Conversation with Mike Glavin, VP of Government Affairs for BankBoston, 6/16/98.

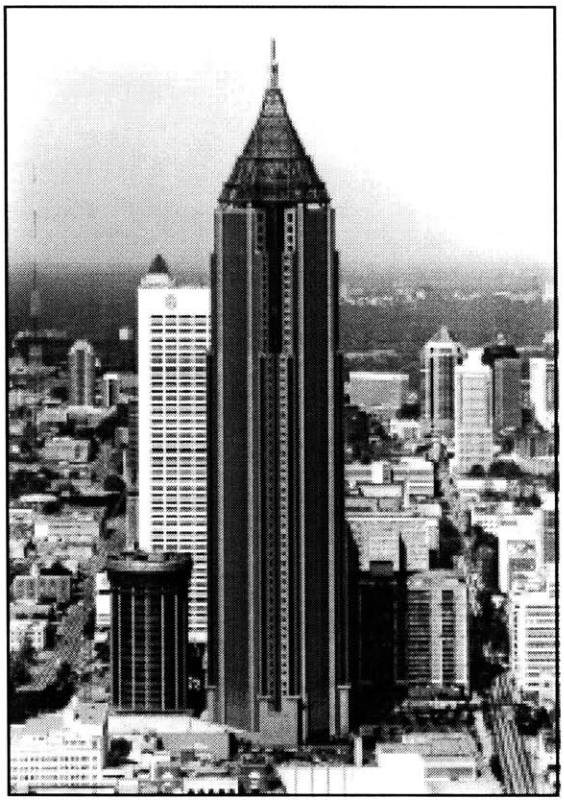
[19] The Boston Globe. 4/4/97 Friday City Ed. Pg. B9

[20] The Boston Globe. 3/22/97 Saturday City Ed. Pg. B1

[21] The Boston Globe. 4/11/97 Friday City Ed. Pg. B5

[22] Ruggles Center Purchase Official. *Northeastern University website* {www.nu-news/Issues/111997n3.html}

[23] The Boston Globe. 4/27/97 Sunday City Ed. Pg. B1



NationsBank Plaza
600 Peachtree Street N.E.
Atlanta, Georgia

IV. Case Study Three - Ernst & Young Atlanta

NationsBank Plaza, Floors 28 through 35
600 Peachtree Street N.E. #2800
Atlanta, Georgia

I. Building Information (circa 1992)

Year Built:	1990-1992
Opened:	April 1992
Developer:	Cousins Properties
Architect:	Roche-Dinkeloo
Development Type:	Office Tower
Ownership:	CSC Associates, Ltd.
Management:	Cousins Properties
Construction Type:	Steel Frame, Glass Curtain Wall
Use:	Class A Multi-Tenant Occupancy
Size:	1,255,570 SF Rentable
Stories:	55

II. Background

In mid-1990, Ernst & Young (E&Y) agreed to take eight floors of space in the NationsBank Plaza (NBP) being developed by Cousins Properties in a joint venture with NationsBank Corporation. Among other things, E & Y planned to consolidate many of its southeast operations into one office, and the 187,000 square feet in eight floors of the 55-story NBP was a good fit for E & Y's approximately 530 workers.

E & Y's management theorized that designing and building environmentally healthy workspace might result in a healthier work environment for the many employees who would be working there. In turn, it was thought this might reduce the likelihood of 'Sick Building Syndrome', a

phenomenon that had become prevalent in the news. These upgrades would cost extra money, but management felt that the benefits might come in the form of a more pleasant work environment, increased worker productivity, and reduced absenteeism.

E & Y based their decision primarily on maximizing the interior environment with the idea that it might improve worker health and, hopefully, productivity. Their decision was not based on an empirical cost-benefit analysis, in recognition of the fact that measuring gains in worker health were next to impossible.

Environmental Design International

E & Y engaged the services of Environmental Design International, Ltd. (EDI) of Marietta, Georgia, to oversee the construction of environmentally healthy office space. EDI used a holistic approach to the various elements that affect indoor environmental quality. For the E & Y space, this program was executed on a variety of fronts. This meant going beyond a review of the HVAC systems and included other items such as construction practices, materials usage, lighting, monitoring, and implementation of a rigorous maintenance training program and development of a manual for continued environmental health.

The E & Y project was described in a 1992 report by EDI's principal, Joseph A. Milam, P.E., in a publication of the American Institute of Architects.[1] Much of what follows is extracted from that text.

III. Preventive Steps Taken

EDI conducted a review of nearly every aspect of what would become E & Y's office environment. A summary of their findings, followed by their action plan follows.

Construction and Furnishing Materials

EDI reviewed the construction materials used in the building shell and in E & Y's office build-out, which would be executed by the developer. According to EDI, "construction materials.....are a major source of pollutants and contain many harmful chemicals that are off-gassed into the indoor environment. In addition, some construction materials and furnishings are more susceptible to microbial infestation than others. " Also, "many materials and furnishings shed significant amounts of fibers, dust, and airborne particulates that are indoor contaminants."

Construction materials specifically examined by EDI included insulation, cabinets, particle board, sealing and spackling compounds, adhesives, glues, wall coverings, tile grout, paints, stains and varnishes, plasters and cements. Furnishing materials specifically examined by EDI included all chairs and desks, office systems, carpeting, draperies, and ornamental fabrics.

In general, materials of preference included latex-based paints over oil-based paints, hardwood plywoods over particle board, water-based glues and adhesives, low-formaldehyde furniture fabrics and continuous-filament carpeting.

Testing of levels of volatile organic compounds (VOCs) prior to occupancy in March 1992

VOC levels were tested in the E & Y space and also in another similarly appointed tenant space in the same building. In fact, the same contractor constructed both tenant spaces at the same time. VOC emissions were 50-75% higher in the other tenant's space. The VOCs measured were Acetone, Benzene compounds, Trichloroethene, Toulene, and Xylene Compounds.

Pest Control

EDI looked at pest control within the building. Rather than wait for the infestation to occur and then treat it with powerful pesticides, E & Y's space was treated with "low-toxicity pesticides to the interior surfaces of wall cavities to minimize future infestation. A mild pesticide was sprayed on all vertical surfaces before the walls were double sided. [The pest contractor] then sprayed this pest control on the other side of the wall and closed it up."

HVAC Systems

EDI thoroughly examined the HVAC system and air dynamics within E & Y's space, an in relation to the rest of the NationsBank Plaza. Compliance with ASHRAE Standard 62-89 (ASHRAE is the American Society of Heating, Refrigerating and Air-Conditioning Engineers - the preeminent organization for the HVAC industry). Standard 62-89 stipulates that a minimum of 20 cubic feet per minute (cfm) of outside air per person be delivered to the space.[2]

EDI found that, due to limitation in the base building HVAC system, the outside air capacity was marginally adequate to produce the 20cfm/person required by ASHRAE Standard 62-89. In practice, the amount of air would fall below the 20cfm level when delivered to the space as built.

However, the 20cfm number assumes a certain airborne particulate level due to air mixing. To mitigate the particulate level and thus ensure adequate air quality, extra filtration was installed in E & Y's air handling systems. In effect, the recirculated air is 'cleansed' before being mixed with outside air.

EDI also made some modifications to the base building's air handling system. The modifications allowed for usage of gaseous-phase and high-efficiency particulate filters. The base building filtration included a 4-inch, 30 percent efficient prefilter. EDI added the gas-phase filter to remove the volatile organic compounds (VOCs), and a 95 percent prefilter to remove fine particulates and any after dusting from the gas-phase filters.[3] EDI credited these filters with much of the air quality improvement.

Test of comparative particulate levels demonstrating effectiveness of additional filtration

Particulate levels were measured in the E & Y space and also from other floors in the same building having only the base building air handling system. The addition of the extra two filters reduced airborne particulates consistently at 80% effectiveness all the way down to .3 microns. In comparison, the other tenant spaces had 0% effectiveness at .3 micron and were comparably effective only at 5 microns or larger.

Copier Room

EDI installed a localized exhaust system in the copier room and connected it directly to the building's toilet exhaust riser. This would, in theory, reduce the levels of paper dust, ozone and other contaminants that come from copy machines. In addition, it was felt that the level of contaminants in this area would overwhelm the gas-phase filters designed to filter lower levels

of contaminants. In many of the more highly polluted areas, including break rooms, copier rooms and cafeterias, separate powered vents with gas-phase filters were installed.

Water

A water purification system was installed in the break rooms, the cafeteria, and on all drinking fountains. The water filters are replaceable and are monitored on a regular basis. These filters are capable of removing suspended particles as small as .5 microns. Aside from health benefits, the filters reduce mineral and scale deposits in ice machines, coffee makers, and soda dispensers. In theory, this reduces the maintenance costs and extends replacement intervals for these items. In addition to removing particulates such as lead and nickel, the filters remove the chlorine taste that often comes with city water.

Lighting

EDI felt that poor lighting often contributed to poor indoor environmental quality and was at the root of many complaints. Examples of problems include glare from computer screens, flickering fluorescent lights, low lighting levels, or 'harsh' lighting levels.

To address this, EDI installed lights with a "very high color rendition factor, an engineering term that [indicates] how good the light is. It approximates natural sunlight very closely. " In terms of lighting levels, EDI made sure there were 50 footcandles of light at all workstations.

Other lighting issues included installation of full-height glass partitions facing the open exterior areas, facilitating natural daylighting. Lighting fixtures were chosen such that they had energy-efficient ballasts and return air and heat removal capabilities. These represented an energy savings and decreased the number of independent vents required, thus reducing ceiling 'clutter'.

Construction Methods

During construction of the E & Y space, EDI installed additional filters on all air handling equipment to minimize dust migration into the air system or plena. At the end of construction, EDI had a qualified duct cleaning firm vacuum the supply and return duct work throughout the space.

Commissioning

The final commissioning process was cited by EDI as one of the most crucial steps in creating and maintaining a healthy indoor environment. This was a process handled directly by EDI. While the commissioning process begins at the design phase, the final part of commissioning is discussed here. The first step was to perform a contaminant flush to rid the building of VOC emissions from new carpet, paint, furniture and adhesives.

EDI requested that all air handling and exhaust systems be run continuously during the last month of construction and the first few weeks of occupancy. Air sampling confirmed that this procedure reduced VOCs significantly, starting at 7,000 micrograms per cubic meter and ending at 500 micrograms per cubic meter. The goal of EDI was to have no greater than 500 grams per cubic meter, which matches the standard set by the World Health Organization.

Test of comparative particulate reduction in E & Y space at end of construction 'flushing'

In the process of system commissioning, EDI discovered that the outside air-handling system serving several floors of E &Y's space was malfunctioning and was not delivering outside air to the space. Since NationsBank Plaza is a high rise, half of its air handling was managed from the roof and half from the ground. E & Y occupies the middle of NBP, so this explains why several but not all of E & Y's floors were being affected. The malfunction was in the ground-level system.

EDI took the opportunity to compare effect of flushing on a floor affected by the malfunction to an unaffected floor. The result was that the unaffected floor was between 64 and 92 percent better flushed than the floor that did not receive flushing.

Human Considerations

While many measures were taken to improve the materials and air quality in the space, EDI realized that there needed to be protocols established to keep the space in healthy condition. For this reason, EDI wrote janitorial and maintenance protocols for the client and shared these with the building operator. Areas covered by the protocols included filter efficiency, system cleaning and general maintenance of the space. For janitorial, EDI reviewed chemical usage such as furniture polishes, vacuum cleaner types, an cleaning chemicals.

Perhaps most importantly, EDI appointed an environmental quality manager within E & Y. This person would handle the day-to-day indoor air quality (IAQ) issues such as logging complaints and reporting odors, leaks, spills, pests and so forth. This person was also the point of contact for more significant issues should those arise.

Ongoing Support

EDI felt that ongoing monitoring of the indoor environmental quality and the systems that were put in place to make it so. Part of this process is performing an IAQ checkup twice a year, at the beginning and end of each cooling season. Issues covered in the checkup include review of mechanical systems, housekeeping effectiveness, space usage, and any changes. The findings of the checkup are provided to E & Y in the form of a written summary.

IV. Financial Summary

Ernst & Young engaged in an effort to build space that would create a better work environment for its employees. This would cost more money initially, but Ernst & Young felt that there were benefits to be gained in terms of risk avoidance (SBS symptoms, employee sick time), and possibly long-term monetary gain (increased employee productivity through fewer sick days or more conducive work environment).

The decision to spend the extra money initially was the most difficult one, because measuring hypothetical risk avoidance and productivity gains is impossible. However, their experience opens the door for measurement that can be used by other firms contemplating the same decision. This thesis will attempt to quantify the financial experience encountered by E & Y for its regional headquarters in Atlanta.

First it would be useful to know what the average tenant improvement (T.I.) costs were for comparable space to the E & Y space. This analysis will look at the total cost of the T.I.'s because the burden of who pays that cost (tenant or landlord) changes with market conditions.

In the case of NationsBank plaza, E & Y spent an additional amount of money to construct their space using 'clean building practices'. This number was looked at as an investment (along with additional maintenance costs associated with extra equipment) and any savings in employee sick days was considered a payback. The 'clean building premium' was estimated to be approximately $2.50 per square foot of rentable area, or $467,500. A conversation with one of the consulting engineers allowed for an estimate of ongoing extra maintenance expense of approximately $8,000 per year (to maintain and replace more complex and expensive equipment, filters and the like).

Then it was necessary to look at some measurement of whether the 'cleaner' and 'healthier' work environment translates into any measurable gains to E & Y. One measure used by E & Y was that of employee sick days taken per year. Subsequent to moving into their new space, E & Y averaged 6% fewer sick days per person per year. While this number is admittedly general and is the product of many human variables including company size, age of the workforce and so forth, it is the best estimate available at this time.

Using the average annual salary of E & Y's 534 employees (estimated to be $50,000 in 1998 dollars) and applying this to the annual sick leave days, it can be estimated that sick days cost E & Y approximately $1,068,000 per year before the improvements and $1,003,920 thereafter, all else constant. This implies a savings of $64,080 per year which would be applied as a credit against the amortized cost of the additional 'clean building' improvements.

In order to make an apples-to-apples comparison, the annual sick day cost savings is divided by the total square footage occupied by E & Y to yield a per-square-foot estimate of sick day cost savings. The calculations yielded a per-square foot savings of approximately $0.34 per square foot per year. This number is thought of as a cash flow, whereas the up-front additional investment is referred to as the invested capital.

Sick Day Savings Calculation

	Old	New	
Annual Sick Days/person	10	9.4	
Annual Cost of Sick Days/person	$ 2,000	$ 1,880	
Annual Cost of Sick Days/firm	$ 1,068,000	$ 1,003,920	
	Calculations		
Reduction in Sick Days (%)	-6.00%	(given)	
Reduction in Sick Day Cost (%)	-6.38%	($1,880 - $2,000)/$1,880	
Nominal Annual Benefit	$ 64,080	$1,068,000 - $1,003,920	
Converted to PSF equivalent	$ 0.34	$64,080/187,000SF	

Assumptions	
534	Workers (187,000 SF / 350 SF per worker)
$50,000	Avg. Annual Salary
250	Work Days/Year
$200	Daily Salary/Worker

The NPV calculation revealed that the investment in 'clean building' technology does contribute a small but positive NPV. On a strictly numeric basis, therefore, the project should be undertaken. When firms consider the other benefits such as improvements in employee productivity (not measurable by this thesis) and the risk management characteristics in terms of SBS symptom avoidance, firms should find the investment a very attractive one.

DISCOUNTED CASH FLOW ANALYSIS

Additional Investment in 'Clean Building' Equipment

Year	1/1/99	2/1/99	2/1/00	2/1/01	2/1/02	2/1/03	2/1/04	2/1/05	2/1/06	2/1/07	2/1/08	2/1/09
Period	0	1	2	3	4	5	6	7	8	9	10	11
Sick Day Savings		$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080	$ 64,080
Maint. & Reserves		$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)	$ (10,338)
Net Income		$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743
Investment	$ (467,500)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Reversion		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 565,711
Cash Flow	$ (467,500)	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 53,743	$ 619,453
PV @ 11.5%	$ (467,500)	$ 48,200	$ 43,228	$ 38,770	$ 34,771	$ 31,185	$ 27,968	$ 25,084	$ 22,497	$ 20,176	$ 18,095	$ 187,062

NPV @ 11.5%	$ 29,536

Assumptions	
187,000	square feet
9.50%	Sale CAP
11.50%	Discount Rate

Footnotes

[1] Designing Healthy Buildings: Indoor Air Quality; Building Performance & Regulations Committee/Committee on The Environment. **American Institute of Architects** (1992). *"A Holistic Approach to Improving Environmental Quality"*. Joseph A. Milam, P.E.

[2] Note: The energy crisis of the early 1970's allowed for buildings to supply only 5 cfm/person, which was supplanted with ASHRAE Standard 62 in 1989 (Thus, 62-1989 or 62-89), after many conclusive studies showed that 5 cfm/person was inadequate. Further, if there is smoking, ASHRAE stipulates a flow rate of 60 cfm/person.

[3] The 'percent' refers to the percentage effectiveness of removing particulates of 1 micron in size or less.

Chapter 4: Conclusion

I. General Findings About SBS

This thesis attempted to answer the following research questions:

1) Does a lingering negative economic effect remain even after a known SBS problem is corrected? In other words, do indoor environmental problems create economic stigma?

2) In consideration of the legal and time costs of SBS, is it economically prudent to spend more money on the design and construction of a 'clean' building purely from a risk management standpoint?

3) Will tenants, in recognition of the productivity and other benefits of 'clean' space, pay more for it?

Of these, the third will only be answered over time as more is known about SBS and also with improvements in the flow of information from producer to consumer of commercial real estate product. In regard to the first two questions, the research and analysis yielded some interesting results:

A. SBS does create economic stigma

Case Study Findings

The case studies were instrumental in showing the challenges created by the occurrence of SBS, as well as the benefits to be gained from proactively addressing SBS issues. In the first case study, SBS was never conclusively proven, yet the building suffered substantial economic losses as a result of the alleged sickness. These losses took the form of cash flow deficiencies, testing and remediation costs, litigation, and re-leasing costs. These events illustrated that SBS need not be proven in order for substantial losses to occur on the part of both owner and tenant.

Regardless of whether SBS is proven, the 'situation' of a purportedly sick building not only impacts the operational performance of a building, but also that an economic effect can linger after the problem has been cured. In the first case study, this stigma was reflected mostly in the term of the lease and not so much in the lease rate. For instance, when the Wheel space in the Fred Building was re-leased, the preferred term would normally have been ten years minimum, but the space was let at a term of 5 years.[1] When other leases in the building came up for renewal, those terms were shortened as well.

In the second case study, the building sustained massive economic losses as a result of the proven SBS conditions in the building. The project went from having a long-term, above-market rate lease with a government tenant to an empty building with no lease and more than $6 million of remediation required just to make the building habitable and marketable again. The project cost $31 million to build but was eventually sold by the lender for $17 million, representing a $14 million write-down from cost.

The strong financial and community position of the buyer of the Ruggles Center, coupled with its decision to rename the building Renaissance Park, have mitigated economic stigma somewhat. However, in this case the economic stigma of this building is primarily caused by its location and not its history with SBS. According to the property manager of Renaissance Park, the most significant challenge in leasing the building is its location in Roxbury, where many tenants and occupants perceive a lack of safety and security because of the crime in the neighborhood. These fears persist despite the fact that the City of Boston police department recently relocated their headquarters approximately one quarter mile away, across from Ruggles Station.

The third case study does not address whether there is a lasting economic effect of an SBS problem, because this case demonstrates the cost effectiveness of preventive measures.

B. Prevention is worthwhile from a risk management standpoint alone.

SBS is curable in most cases and preventable in all cases. With regard to the latter, prevention, the additional capital outlay as a percentage of new project cost is very small considering the risk management component of such an expenditure.

The cases also demonstrated that, in relation to the capital outlay required to re-design, retrofit, rebuild and re-tenant an SBS-plagued building, the preventive measure is still by far the cheaper option. When one considers the total economic cost of an SBS problem, there would be little doubt that appropriate preventive expenditures pay off in the long-run.

Unfortunately, many developers do not have access to information that would allow them to assess the costs and benefits of investing extra funds in the name of 'clean building practices'. They rightfully argue that lenders will not fund beyond 'standard' specification and that superlative construction comes completely at the cost of the developer. This translates into lower or even negative profit margins.

The most endemic problem with SBS is that it is not perceived as a risk. SBS is perceived largely as a psychological problem rather than a physically-treatable (and preventable) problem with psychosocial consequences. In short, market participants are likely to be ignorant of the economic consequences of SBS. This thesis is intended to promote a higher level of awareness of SBS so that better decisions are made at all stages of the development process, from lending

to commissioning and building operations. This spectrum of events in the building cycle necessarily includes most practitioners, and therefore this issue has relevance to most practitioners.

II. Other Findings

This thesis has established that most of the psychosocial symptoms of SBS are subsequent to the onset of physical symptoms. People begin to have a negative impression of a building after they learn that the building has physical problems. The psychosocial aspect of SBS can spin out of control if the physical problems are not addressed professionally, promptly, and thoroughly. Once set in motion, psychosocial symptoms may continue irrespective of what is done to cure the physical problems — especially if there is a delay in correcting these problems or a perceived lack of response in making these corrections.

The research for this thesis revealed that most SBS problems can be easily remedied and/or prevented at low cost. This was supported by financial information, by information obtained through research and by interviews with parties involved in each of the case studies. One might surmise based on how buildings continue to be built and managed that the opposite was the case. This is because there is no perceived 'conclusive' proof that any additional initial expenditure on design, materials or equipment or on monitoring and maintenance practices during the operational phase creates value to the owner of that real estate. These perceptions are linked to the evolution of knowledge and technology on that particular subject.

Recently, there has been a proliferation in literature on indoor environmental quality on the part of government and non-government agencies. These sources often conduct research and prepare studies independently of one another, sometimes performing parallel functions. At the

policy level this creates competition and at the consumer level this creates confusion and a tendency toward hesitancy in accepting new standards.

Due to the efforts of several large governmental and international organizations, the information is being moved toward a consensus standard rather than a fractilized system of interpretations or an imposed Federal law that may reflect political agendas more than the actual needs of the industry. This consensus standard will, in turn, lead to acceptance by the users and practitioners of commercial and all other forms of real estate. This fact is neither surprising nor unexpected, but rather a natural progression from a multidisciplinary response to a new and unknown phenomenon to a multidisciplinary collaboration on the definition, issues, policy and solutions to a known problems.

III. Recommendations

When factors influence the viability and value of real estate, they become a part of due diligence. Until this point in time, these factors have included site contamination, warrantable title, leases, maintenance level, ADA compliance, systems, physical and functional obsolescence, and market conditions. While parts of each of these may touch on SBS issues, none of them explicitly includes SBS. SBS, in an of itself, should be a part of due diligence. Buildings will achieve a higher level of performance when this happens, because SBS due diligence will happen only as the majority of practitioners become knowledgeable and competent in understanding its impact on the value of real estate.

In the same way that a Level I or Level II Environmental Site Assessment (ESA) is conducted, an SBS audit should be conducted by a qualified environmental engineering firm. Developers, owners and managers should move toward a voluntary compliance standard such as USGBA's LEED™ rating system for building environmental quality. Lenders should move toward lower relative interest rates and higher LTV ratios for buildings meeting high standardized ratings. Insurance companies should price property and liability insurance more cheaply for 'clean' buildings in recognition of the lesser chance of litigation based on hazardous environmental conditions.

The third case study highlighted the potential for increased worker productivity due to 'clean' space, and the first case study highlighted the cost of reduced worker productivity due to SBS. While this thesis cannot conclusively prove that tenants would pay more for 'clean' space as opposed to space that has 'unknown' indoor environmental quality, it is worth noting here that the information suggests that with the evolution of information, tenants should be willing to pay more for 'clean' space in recognition of the possibility of increased worker productivity. Indeed, the psychological aspect of SBS would dictate that the mere perception of the space being clean versus unknown or unhealthy typically results in higher productivity levels.

IV. Conclusion

Information is at the heart of prudent real estate decision making. Due diligence is a perfect example of information gathering and analysis in an attempt to make 'good' decisions rather than 'poor' ones. Many important items have become a part of due diligence, including title issues at the very onset of property rights common law, and continuing through more modern developments such as asbestos testing, Americans With Disabilities Act (ADA) compliance,

ability of buildings to handle modern communications cabling and systems retrofits for increasingly computerized offices, energy efficiency, Level I and II ESA's, and a host of other due diligence issues.

SBS can be more damaging than all of these, yet it is given little, if any weight in the due diligence process. If information is at the heart of prudent real estate decision making, then a lack of information is at the heart of imprudence. This thesis has attempted to make a case for the inclusion of SBS into the everyday thinking of practitioners at every step in the real estate development and ownership process. At some point the industry knowledge and awareness of SBS will reach a critical mass at which SBS becomes a part of due diligence, and all parties in the process will be the better for it.

Footnotes

[1] Interview with the property manager of the Fred building.

BIBLIOGRAPHY

"A dearth of fresh air", *The Boston Globe*, Thursday City Ed. p. 18, June 9, 1994.

"A good deal for Roxbury", *The Boston Globe*, Wednesday City Ed. p. A20, June 25, 1997.

American Council for an Energy-Efficient Economy, [website], {www.aceee.org}.

American Society for Testing and Materials (ASTM), [website],{www.astm.org}.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), [website], {www.ashrae.org}.

"Bad air closes Hub's Registry office", *The Boston Herald*, Friday First Ed. p. 1, July 7, 1995.

"BankBoston buys back ex-Registry building", *The Boston Herald*, Friday First Ed. p. 39, November 8, 1996.

"Bank ends Roxbury project; Forecloses on loan on Registry building", *The Boston Globe*, Wednesday City Ed. p. B1, October 9, 1996.

"Barresi criticizes bill paving way for Parcel 18", *The Boston Globe*, Weds. City Ed. p. 79, July 25, 1990.

Boykin, James H. and Sauer, Ronald L., "Sick Building Syndrome and the Modern Office Building", *Real Estate Issues*, pp. 21-27, April 1997.

"BRA approves Ruggles Center acquisition", *The Boston Herald*, Friday All Eds. p. 25, June 20, 1997.

Cousins Properties, Incorporated [website] (re: NationsBank Plaza - Atlanta) {www.cousins-cuz.com/Property_Guide/Nations.html}.

"Diagnosis is in on sick building", *The Boston Globe*, Tuesday City Ed. p. 24, June 14, 1994.

"Dukakis OK's state tenants at Parcel 18; Officials hope Roxbury project can get financing, break ground by spring", *The Boston Globe*, Sunday City Ed. p. 25, December 30, 1990.

"Dukakis returns Parcel 18 bill with changes", *The Boston Globe*, Tuesday City Ed., p. 55, December 25, 1990.

"Effort to buy Registry site falling short", *The Boston Globe*, Saturday City Ed. p. B1, March 22, 1997.

"Employees vacate Registry, T Cell buildings; 'Sick-building syndrome' blamed for skin rashes and respiratory irritations", *The Boston Globe*, Thursday City Ed. p. 39, July 21, 1994.

Environmental Building News, [website], {www.ebuild.com}.

Fisk, Willam J. and Rosenfeld, Arthur H., "Estimates of Improved Productivity and Health from Better Indoor Environments", *Indoor Air V. 7 No. 1*, pp. 158-172, January 1997.

Godish, Thad, *Sick Buildings: Definition, Diagnosis and Mitigation*, (1995).

"Gov. seeks extra $7.7M for Registry move", *The Boston Herald*, Monday First Ed. p. 1, July 8, 1996.

Green Building Information Council (Canada), [website], {www.greenbuilding.ca/GBIC.html}.

Hopf, Harold L., "SBS: Real or phantom risk?" *Canadian Underwriter V65 No. 1*, pp 36, 38, Jan. 1998.

"House clears path for agency to locate at parcel in Roxbury", *The Boston Globe*, Tuesday City Ed. p. 17, July 24, 1990.

Illuminating Engineering Society of North America (IES), [website], {www.iesna.org}.

Institute of Real Estate Management (IREM), *Journal of Property Management,* [website] {www.irem.org}.

International Performance Measurement and Verification Protocol (IPMVP), DOE Document No. DOE/EE-0157, 1997. Also, [website], {www.ipmvp.org}.

International Organization for Standardization (ISO), [website], {www.iso.ch}.

Koetter Kim & Associates, "University Park Master Plan", *Place/Time* p. 34, 1997.

"Legislature rings down curtain on 1990", *The Boston Globe*, Thursday City Ed., p. 34, December 20, 1990.

"Little interest seen in Registry building; Cost of remediation called big question", *The Boston Globe*, Saturday City Ed. p. F2, October 12, 1996.

Milam, Joseph, P.E., "A Holistic Approach to Improving Indoor Environmental Quality", *'Designing Healthy Buildings: Indoor Air Quality*, American Institute of Architects (AIA) - Building Performance & Regulations Committee/Committee on The Environment (COTE), pp 51-67, 1992.

"Move registers high on employees' applause meter", *The Boston Herald*, Friday First Ed. p. 6, July 7, 1995.

"Northeastern picked to develop site", *The Boston Globe*, Friday City Ed. p. B7, June 20, 1997.

"NU picked as buyer for Ruggles Center", *The Boston Globe*, Sunday City Ed. p. B1, April 27, 1997.

"Parcel 18 pact gets Legislature's OK", *The Boston Globe*, Saturday City Ed. p. 1, December 29, 1990.

Pan-American Health Organization (PAHO), [website], {www.paho.org}

Rollins, Vyla and Swift, Gill-Helen, "Psychological issues: a multifaceted problem, a multidimensional approach," *Sick Building Syndrome - Concepts, issues and practice*, pp. 69-83, 1997.

Rayner, Alison J., "Overview", *Sick Building Syndrome - Concepts, issues and practice*, p. 6, 1997.

"Registry to close Roxbury offices; 'Sick building' may reopen in 6 months", *The Boston Globe*, Friday City Ed. p. 1, July 7, 1995.

"Revitalizing Roxbury", *Boston Business Journal*, December 2, 1996.

Rocky Mountain Institute (RMI), [website], {www.rmi.org}.

"Roxbury development stalls again in Senate; Parcel 18 called pawn in bid to privatize zoo", *The Boston Globe*, Sunday City Ed. p. 34, December 9, 1990.

"Roxbury team vies for former Registry building", *The Boston Globe*, Friday City Ed. p. B5, April 11, 1997.

"Ruggles Center purchase official", *The Northeastern News*, News Section, November 19, 1997.

"Senator Owens is assailed for actions on bill to aid Roxbury development", *The Boston Globe*, Thursday City Ed., p. 33, December 20, 1990.

" 'Sick building' owners fault Registry; Warnings went ignored, they say", *The Boston Globe*, Saturday City Ed. p. 17, July 15, 1995.

"Speedy recovery for a sick building", *The Boston Globe*, Tuesday City Ed. p. 12, July 11, 1995.

"State prepares to walk away from troubled Registry site", *The Boston Globe*, Tuesday City Ed. p. A1, July 16, 1996.

"State suing over Registry building", *The Boston Globe*, Friday City Ed. p. B9, April 4, 1997.

"These buildings are hazardous to your health; Television", *The Boston Globe*, Tuesday City Ed. p. 58, December 26, 1995.

"Troubled effort to clear air at registry", *The Boston Globe*, City Ed., September 3, 1997.

"Troubled Ruggles Center heads to auction", *The Boston Herald*, Friday All Eds. p. 36, October 11, 1996.

"21 more become ill in Registry's 'sick building'", *The Boston Globe*, Friday City Ed. p. 18, July 14, 1995.

"Union: Don't delay move; Registry workers want sick building closed immediately", *The Boston Herald*, Saturday First Ed. p. 5, July 8, 1995.

United States Department of Energy (DOE) - Energy Efficiency and Renewable Energy Network (EREN), [website], {www.eren.doe.gov}.

United States Environmental Protection Agency (EPA) - Office of Air and Radiation, "Indoor Air Facts No. 4 (Revised) - Sick Building Syndrome", Document No. 402-F-94-004, April 1991.

United States Environmental Protection Agency (EPA) - Office of Air and Radiation, Consumer Product Safety Commission, "The Inside Story - A Guide to Indoor Air Quality", EPA Document No. 402-K-93-007, April 1995.

United States Environmental Protection Agency (EPA) - Office of Air and Radiation, United States Public Health Service, National Environmental Health Association, "Introduction to Indoor Air Quality", EPA Document No. 400-J-91-003, July 1991.

United States Environmental Protection Agency (EPA) - Office of Air and Radiation, "Ventilation And Air Quality In Offices", EPA Document No. 402-F-94-003, Rev. July 1990.

United States Environmental Protection Agency (EPA), [website], {www.epa.gov}.

United States Green Building Council (USGBC), [website], {www.usgbc.org}.

"Weld defends 'political judgments'; Concedes Registry job deserved 'harder look'", *The Boston Globe*, Tuesday City Ed. p. 25, September 5, 1995.

World Health Organization - Regional Office for Europe, "Indoor Air Pollutants: Exposure and Health Effects", ISBN: 9289012447, 1982.

World Health Organization (WHO), [website], {www.who.org}.