

# **THE CONTRIBUTION OF RESTORATION AND EFFECTIVE OPERATION AND MAINTENANCE PROGRAMS ON INDOOR ENVIRONMENTAL QUALITY AND EDUCATIONAL PERFORMANCE IN SCHOOLS**

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## **ABSTRACT**

There is a demonstrated link between effective facility management programs for cleaning and maintenance, and environmental quality of schools. The quality of the school environment, to include air quality, determines an overall sense of well-being, and shapes attitudes of students, teachers and staff. Attitudes affect teaching and learning behavior. Behavior in turn affects teaching and academic performance.

## **INDEX TERMS**

School environments, Environmental quality, Cleaning and maintenance, Educational performance.

## **INTRODUCTION**

This focus on school environments recognizes that total environmental quality is related to human performance indoors. It is becoming increasingly recognized that the indoor environments of schools are directly related to human health, image, self-esteem, and attitude, all of which affect academic performance. To date limited research has been conducted to examine the relationship of restoration and cleaning effectiveness with total environmental quality, to include IAQ, and ultimately with educational performance.

## **METHODS**

In this research the literature on environmental quality in school environments and educational performance was reviewed. Environmental quality data collected after the 1997 restored Charles Young Elementary School in DC were examined and compared with educational performance observations and data.

## **RESULTS**

The key findings of the work start with the identifiable and measurable environmental conditions required of all high performance schools and the basic finding that a academically successful school must radiate a sense of well-being (health). The information gathered for this case study indicates there must be a serious, if not passionate, desire, accompanied with positive action, to restore non performing schools to a constant healthy state. Effective restoration is achieved through good design that addresses total environmental quality to include good air quality, general sanitation, noise control, lighting, glare reduction, soothing color, general comfort provided by temperature and climate. The healthy school environment is kept at a steady state only by a thoughtfully organized cleaning and maintenance program. When a school environment is transformed from a state of hopeless deterioration to a healthy

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condition, attitudes of the students, teachers, parents, and surrounding community turn energetically positive so as to allow for effective teaching and learning (Berner, 1993).

## **DISCUSSION**

Previous studies have shown that cleaning, maintenance and restoration, when consistently implemented are cost effective and can lead to measurable environmental improvements. An EPA sponsored study, "The Total Building Cleaning Effectiveness Study," conducted by Research Triangle Institute in collaboration with the professional cleaning industry, demonstrated for the first time, that an organized cleaning program contributes to reductions in particles, volatile organic compounds (VOCs), and biological pollutants in the range of 50-90% (Franke, 1997).

The importance of a healthy school environment to enhance the learning process has been demonstrated in many studies (Maslow, 1956). However, many school facilities throughout the United States, estimated at more than 50%, have environmental problems. Problems are mostly related to water damage, inoperable HVAC systems, and ineffective cleaning.

In many center city schools, students and teachers far too often find themselves in a physical environment that adversely affects their morale, and, in some cases, their health and physical safety. The reason Charles Young Elementary School case is so important is that up to this point, hard evidence is scanty to indicate that when a school building is in disrepair, student achievement suffers. But most importantly, there are no cases that demonstrate when schools are restored in a thoughtful manner educational achievement, in the way we measure it today, is greatly improve. In the case of Charles Young School, improvements in educational performance that have accompanied restoration have been exemplary.

In early 1997 the environmental conditions a Charles Young School were by any environmental health standard fully unacceptable. Throughout the building, water damage was evident. Water was entering the building constantly. There were numerous roof leaks, rotting windows, and broken steam pipes. On occasions, young students mistook escaping steam as an indication that the building was on fire. Mismanaged moisture caused visible mold growth on plaster walls, ceiling tiles, window frames, carpet and hard floors, and in ventilation ducts.

The HVAC system is the school was in disrepair. Most exhaust fans were broken; the heating air-conditioning system did not work. Temperature fluctuated in ranges from 60 to 100 degrees F. Humidity levels often exceeded 90%.

Pest infestation was serious. Cockroach remains and fecal material were evident in all parts of the building. Birds had nested in the upper regions of the building interior and their droppings had seriously contaminated the air intakes of the HVAC system.

Floor surfaces throughout the building looked uninviting, and worked against the educational benefits derived from open classrooms. Carpet surfaces could not be restored; they were extensively water damaged, worn, and separated. In many areas deteriorated carpet posed tripping hazards.

Hazardous materials and conditions also existed in the school. Peeling lead paint was found on window frames, doors, and stairwell banisters. Discarded unknown chemicals were leaking onto the floor in the school's mechanical room.

Prior to 1997, Charles Young was a school where nearly half the students were below national test averages for math and reading. In the minds of DC officials, there was an obvious link between students' environment and educational performance. The school facility was rapidly deteriorating. On top of that, students were constantly exposed to a surrounding neighborhood that faced a high level of social instability-unemployment, rising drug use, violence and crime rates.

The majority of the restoration tasks at Charles Young Elementary School were accomplished between June and September 1997. Two hundred and thirty-two windows were replaced to create brighter rooms and keep moisture and peeling lead paint out of the school. Throughout the school lead paint was contained and removed. Roofing and brickwork was repaired to prevent water intrusion. Moldy and water damaged materials were removed. Leaking ductwork, steam, and water pipes were replaced. Abandoned 55-gallon drums of chemicals in basement rooms were removed as hazardous waste. The basement area was decontaminated to eliminate residual chemical hazards. Pest management measures were instituted. Bird nests and droppings were removed, pest barriers were installed, food and water sources were removed.

The carpet industry donated the replacement of over 45,000 square feet of carpet. Selected carpet floor coverings came from a variety of manufactures and were matched to comfort, lighting, color and texture and sound control needs of rooms throughout the school. Most important to the restoration effort, the carpet industry insisted on effective maintenance. The carpet industry provided training, maintenance schedules, and effective vacuums; carpet cleaning equipment and supplies to sustain a healthy condition and inviting appearance of their product.

The HVAC system in the school required a major overhaul. The central fan system was made operational; fan motors were replaced as necessary. The chiller was replaced; new boilers were installed for heating; and exhaust systems were upgraded. Over 100 ventilators were overhauled through electrical repairs, part replacement, and cleaning.

The school and its educational strategy depend on an environment that is attractive comfortable, open, free of glare and noise. The inviting open classroom design of Charles Young Schools has been demonstrated to provide a well lighted, comfortable environment, highly effective in developing the educational performance of students. The use of carpet in the Charles Young School makes satisfactory sound control simple and economical to achieve. Effective sound control in open space classrooms is virtually impossible to achieve without carpet (School Facilities and Transportation Division, State of California, 1986).

Table 1 illustrates data collected in the most health sensitive portions of the building: In the fully carpeted Pre-K Kindergarten area, and the lunch room which has a hard floor surface. The data suggest that indoor environment of Charles Young School is properly maintained and exhibits no sign or traits of a unsanitary environment or of an indoor air quality (IAQ) problem building. Maintenance of the school emphasized daily vacuuming of high traffic areas, disinfection of hard floors, scheduled extraction cleaning of all parts of the building including carpet.

**Table 1.** Summary of Environmental Quality for School Year 1998-1999

<i>Location</i>	<i>June 1998</i>	<i>December 1998</i>	<i>June 1999</i>	<i>Observation</i>
Outdoor Air Quality Fungi	460-780 CFU/m <sup>3</sup>	490 CFU/m <sup>3</sup>	610-1020 CFU/m <sup>3</sup>	Normal range no dominant species
IAQ Fungi Over Carpet (Pre-K)	250-260 CFU/m <sup>3</sup>	180-240 CFU/m <sup>3</sup>	670-1640 CFU/m <sup>3</sup>	Normal in relation to outside
IAQ Fungi Over Hard Floor(Lunch R)	270-720 CFU/m <sup>3</sup> (*)	440 CFU/m <sup>3</sup> (*)	290-510 CFU/m <sup>3</sup>	Normal and in some cases (*) slightly higher than over carpet
Outdoor AQ Bacteria	<10 CFU/m <sup>3</sup>	10 CFU/m <sup>3</sup>	20 CFU/m <sup>3</sup>	Normal
IAQ Over Carpet Bacteria	40 CFU/m <sup>3</sup>	<10 CFU/m <sup>3</sup>	<10 CFU/m <sup>3</sup>	Normal in relation to outside
IAQ Over Hard Floor Bacteria	210 CFU/m <sup>3</sup>	20 CFU/m <sup>3</sup>	40 CFU/m <sup>3</sup>	Normal but higher than carpet
Respirable Suspended Particles (RSP) Outdoors	35 ug/m <sup>3</sup>	22 ug/m <sup>3</sup>	29 ug/m <sup>3</sup>	Normal City RSP
RSP Over Carpet	33 ug/m <sup>3</sup>	15 ug/m <sup>3</sup>	32 ug/m <sup>3</sup>	Normal RSP IAQ in relation to outside
RSP Over Hard Floor	64 ug/m <sup>3</sup>	40 ug/m <sup>3</sup>	40 ug/m <sup>3</sup>	Elevated, <40 desirable
TVOC Over Carpet	31.4 ug/m <sup>3</sup>	152 ug/m <sup>3</sup>	35.6 ug/m <sup>3</sup>	No problem likely
TVOC Over Hard Floor	24.1 ug/m <sup>3</sup>	93.6 ug/m <sup>3</sup>	87.9 ug/m <sup>3</sup>	No problem likely

\*Collected and Submitted to the Carpet and Rug Institute by Air Quality Sciences, Inc., 1999.

High level of housekeeping and maintenance are essential in making the classrooms work. In August 2001, prior to the school year cleaning of the facility, a cleaning effectiveness analysis was conducted throughout the building with a focus on the sanitation condition of flooring. A pre sampling investigation found there was no health complaints related to the building in any way. There were no indications of IAQ problems or student or teach health response to allergens. An environmental cleaning effectiveness sampling technique use widely in the food sanitation and food processing industry was applied throughout the building to a variety of flooring materials prior to their cleaning. The sampling methods for both bacteria and fungi are economical but at the same time highly effective in detecting unsanitary conditions as indicated by gram negative bacteria (GNB) and mold growth (CFU).

The levels of measured bacteria and fungi exhibit no sign of a unsanitary or problem building even at a time of year the building's cleaning state was stressed by year of continuous use and

at a time in the Washington DC summer when relative humidity levels remained at levels in excess of 90% on some days.

Since the restoration at Charles Young Elementary School, the school radiates a sense of well-being. It is widely reported by teachers and staff that many students are reluctant to leave in the afternoons because they like the school environment that many call a "safe haven." Teachers and staff throughout the school district and in the school want to there and many of the best teachers at the school elect not to retire. The restored school is the pride of the community. Parents often visit the school and some even take classes in reading. The District of Columbia is using Charles Young Elementary as the model for restoring 9 other schools in DC. Attendance is up from levels that existed prior to the restoration. Attendance has risen from 89% to 93%. Prior to the restoration, many parents in the community moved their children to private and special schools throughout the area. Since the restoration, many of these students have returned to Charles Young School, and students from other schools throughout the district are seeking admission.

An analysis of test results shows that the school is much more than indoor environmental showpiece. Since the restoration in 1997 there have been many remarkable and documented improvements in the common measures of academic performance.

**Table 2.** National Test Results

<i>Standard Test Results</i>	<i>Before Restoration Y1996</i>	<i>Post Restoration Y 2000</i>	<i>Observation</i>
Math Scores	Below Basic 49% Basic or Above 51%	Below Basic 24% Basic or Above 76%	25% of non performing students have been motivated
Reading Scores	Below Basic 41% Basic or Above 59%	Below Basic 25% Basic or Above 75%	Reading improvement suggests better mental concentration

**CONCLUSION AND IMPLICATIONS**

The Charles Young Elementary Schools has been successfully restored to a health environment. The school building with acute indoor environmental problems has been transformed into a model school environment. The essentiality of continuous cleaning, maintenance and repair for the in the prevention of future indoor environmental quality problems has been demonstrated. The most important result in this restoration example is the documented and measured fact that educational performance and achievement has risen dramatically at the school. It is the strong suggestion and demonstration that there is a direct connection between healthy school environments; behaviors and attitudes of students, parents, and educators; and academic performance and achievement.

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