A Study for Preserving and Renovating the Main Building of Solitude at Virginia Tech

by

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Architecture

(Abstract)

The main building of the Solitude complex is one of the oldest buildings on the campus of Virginia Polytechnic Institute and State University. The purpose of this study is to provide preliminary research for the master preservation plan of the historic landmark.

In order to preserve and renovate the building, a field survey was conducted to collect data. Under the guidelines of the Historic American Building Survey, the building has been fully documented on measured drawings, and visible defects have been inspected. Computer programs were used as a means to execute drawings; a written report of the survey was organized according to the major building components.

By using the knowledge of architectural history, building construction, preservation philosophy, and wood preservation technology, the collected data was analyzed, the causes of the defects were diagnosed, and the preservation treatments were suggested. Furthermore, recommendations for adaptive reuse are proposed. Meanwhile, this study also leaves openings for further study in some special fields.
Acknowledgments

This study would not have been possible without the help and support of many people. I would like to especially acknowledge my advisor, Dr. Humberto Rodriguez-Camilloni, for his assistance and patience. This thesis has benefited greatly from his insightful critiques and consistent support.

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Over the past three decades, the scope of historic preservation and renovation has broadened considerably. More and more professionals, including architects, have been attracted to participate in preservation and renovation work. Simply defined, historic preservation is "the practice of conserving man-made structures, sites, and objects because of their historical, aesthetic, or archeological importance" (Glass, 1990). Renovation means the reuse of existing structures by cleaning, repairing, or altering. The concept of adaptive reuse combines historic preservation and general renovation. Today, preservation and renovation practices benefit communities, not only in the aspect of cultural and architectural heritage, but also in other aspects, such as environmental protection, urban revitalization, and economy (Levinson, 1993).

Architectural documentation is the basis of preservation and renovation procedures. One of the fundamental principles of preservation is to fully document the existing condition of the building before any treatment (Feilden, 1982). Architectural documentation should provide information on all items of the building, including factually recording the visible defects. Both written and graphic records compose complete architectural documentation. Based on this, diagnoses and effective cures for preservation problems can be proposed.

As a historic landmark, the Solitude property, including a main building, a log outbuilding, and a log springhouse, is significant to Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg and the local community. The main building of the historic property, known as Solitude, is one of the oldest buildings on the campus of Virginia Tech (Figure 1). Its architectural features provide insight into the evolution of vernacular architecture in Blacksburg and the New River Valley.
area. However, this building is facing increasing danger from environmental and man-made causes. To preserve and renovate Solitude will not only provide an appreciation of a living link to the past, but also offer a unique learning space for both faculty and students. The preservation and renovation of the main building of the Solitude property, which is listed on the National Register for Historic Places, requires a large amount of research in architectural history and technology.

Purpose of the Study

The purpose of this study is to provide the necessary preliminary research for the master preservation plan of the main building of Solitude at Virginia Tech. Using a field survey, knowledge about nineteenth century vernacular architecture, including historic building materials and construction methods, and knowledge about preservation technology, the condition of the existing building is documented and analyzed to provide some guidelines for an actual preservation of Solitude. The items of investigation include

- Foundation and drainage system,

- Structure,

- Walls,

- Floors,

- Roofs, and

- Windows, doors, and other building components.

The specific objectives of this study are

1) To document the existing interior and exterior of the main building of Solitude through measured drawings of floor plans, sections, elevations, and some details;
2) To inspect the existing building systems and to report visible defects;
3) To analyze the causes of the defects and to propose the preservation treatments; and
4) To develop recommendations for adaptive reuse options.

Methodology
The data of this study was obtained from a field conditions survey, existing documents and reports, and related knowledge. The standard of the Historic American Buildings Survey (HABS) of the National Park Service has provided the basic guidelines for the survey and documentation (Burns, 1989). Because several areas of information are explored in this study, they are organized into three chapters. These areas include a background information search, documentation and survey of the building, and recommendations for future preservation, treatments and adaptive reuse. These three chapters are divided as follows.

Chapter II includes the historical overview and computer modeling of the evolution of Solitude. Preservation philosophy and technical literature are briefly reviewed as well.

Chapter III covers the first two objectives of this study. To document the existing interior and exterior of the main building of Solitude, the following were recorded by tape measure in scaled drawings and photographic surveys: floor plans, elevations, sections, and some construction and ornamental details, such as doors, windows, and staircases. The second part of this chapter is a report focusing on the building systems. Through using a field survey, knowledge about nineteenth century vernacular architecture, historic building materials and construction, as well as knowledge about the preservation technology of wood, the following items of the building system were
inspected: the existing foundation, the structure (including wood species, sizes, structural systems, and current condition), and the interior and exterior finishes (including walls, roofs, floors, and windows). Visible defects are reported as well.

Chapter IV discusses the final two objectives of this study. Based on the existing condition and the theory of historic preservation, the visible defects are diagnosed, and preservation treatments are recommended, especially for the foundation and the drainage system. Furthermore, the suggestions for future adaptive reuse, which focus on interior space layouts and interior environmental controls, are provided. The interior environment control plan includes thermal comfort, relative humidity, ventilation, and lighting.
As one of the oldest buildings on the campus of Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, the main building of Solitude has a nearly two hundred-year history. The existing building contains three primary construction phases (Ballard, 1992: Appendix 1). In the theses of Ballard and Yagow, the history of the ownership and the evolution of the building has been expounded. The following discussion summarizes the history of the building and presents visual images of its evolution.

2.1.1 Historical overview of Solitude
On the west end of the campus of Virginia Tech, stands a two-story, white clapboard, L-shaped house known as Solitude, the main building of the Solitude property. As one of the oldest buildings on the campus, the history of the building can be traced back to the 18th century.

In March of 1747, the first permanent settlement of the New River Valley was established by George and Eleanor Draper, with their children Mary and John, in what is today’s Blacksburg area (Yagow, 1985). The settlement was known as Draper Meadow. By 1755, several German and Scott-Irish families had joined this new community.

No solid evidence has been found to identify the date when the building was first built. The name “Solitude” first appeared in a letter from Granville Smith to John Preston on December 13, 1808 (Worhsam, 1988). An another 1843 letter, written by Letitia Preston, a niece of Granville Smith, mentioned the name of Solitude:

“A party of Indians came up the Kanawha—thence to Sinking Creek, thence to Strouple’s
Creek Ingles and Draper were living at Solitude, the present residence of Colonel Robert T. Preston” (Crush, 1957).

Because the Indian attack took place in July 1755, it is reasonable to believe that Solitude was standing at that time. However, dendrochronology studies have shown the earliest part of the existing building to be constructed of trees that had fallen no earlier than 1798 (Heikkenen, 1992: Appendix 2). Some researchers think the name of Solitude, appearing in the letter, was referring to the place rather than the building (Ballard, 1992), but the more reasonable conjecture is that Solitude was built before 1755, and a new structure replaced the original one later.

Possibly, one of the first owners of Solitude was Phillip Barger, Jr. In 1803, Mr. Barger sold 200 acres of land at the headwater of Strouble’s Creek, on which Solitude stands, to James Patton Preston (Kegley, 1980). This parcel of land was sold to Granville Smith, uncle of James P. Preston and the builder of Smithfield, again in 1807. Granville Smith’s niece, Letitia P. Floyd, and her husband, Dr. John Floyd (later governor of Virginia) lived in Solitude from 1812 to 1816 (Yagow, 1985). After Granville Smith died in 1816, Solitude was sold back to James P. Preston in 1822. Robert Taylor Preston, the second son of James P. Preston, and his wife Mary moved into Solitude in 1833. According to Ballard’s report, Solitude stood as a one and one-half story log building, probably covered with beaded-board siding when the Preston’s moved in (Ballard, 1992).

During his residency, Robert T. Preston remodeled and enlarged Solitude several times. Based on the dendrochronology studies, we believe that the first addition probably was constructed in 1834. This addition consists of two ground floor rooms and two upper floor rooms, directly adjacent to the south wall of the original structure. The samples taken from wood members of this section indicate
that they were from trees felled after the growing season of 1834. This means Robert T. Preston probably constructed this addition during the fall or winter of 1834 (Heikkenen, 1990).

The second addition, next to the east wall of the original structure, is composed of a large entrance hall, a large parlor, and two upper floor rooms. A large front porch was added at the same time as well. According to the dendrochronology studies, the second addition was probably constructed around 1851. The joist wood of the section was determined to be constructed from trees, felled after the growing season of 1851 (Heikkenen, 1990). Since 1851, three other additional rooms have been added to Solitude, but the dates are not clear.

The Preston family lived in Solitude until Robert T. Preston sold the house, the outbuilding, and 244 acres of land to the Virginia Agricultural and Mechanical College, which later became Virginia Tech. After Solitude became a part of the property of Virginia Tech, the building served as a faculty house, a student residence, a club house, and classrooms and offices (Ballard, 1992). In all this time, little has been done to permanently change the architectural features of the building (Figure 2, 3, 4). However, the building, nearly two hundred years old, is being jeopardized by environmental and economic factors. Preservation and renovation works are urgently needed.

2.1.2. Computer Modeling of the Evolution of Solitude

Based upon the studies of H. J. Heikkenen and A. S. Ballard (Heikkenen, 1990 & Ballard, 1992), the four primary stages of the evolution of Solitude have been included as a computer simulation (Figure 5).

Solitude in 1801 (Figure 6)

At that time, the structure of Solitude is believed to have been a one and one-half story log building
with rectangular shape. Because many log buildings had a gable roof and were sheathed as quickly as possible in this area (Whitwell & Winborne, 1982), the structure of Solitude is conjectured to have had a gable roof and was covered with siding in 1801. Finally, the existing foundation and floor joists suggest that there was a chimney inside the structure.

Solitude in 1834 (Figure 7)
In 1834, a larger log structure was added to the 1801 log building. Similar to the Hall-and-Parlor style house, this addition consisted of two ground floor rooms and two upper floor rooms. The exterior walls of the section were clad with horizontal weatherboards. Because during the nineteenth century, tin plate became a popular roof material in America, it is conjectured that the roof of the 1834 section was covered by galvanized tin sheets at that time.

Solitude in 1851 (Figure 8)
Apparently by 1851, another large addition was made to Solitude. Unlike the previous sections, this section was a frame structure. Combining the 1801 log structure, the new section was a typical I-form house. A complex hip roof was employed, and two porches were built on the northwest and southeast side of the section.

Solitude after 1851 (Figure 9)
After 1851, some small additions were added, including two rooms adjacent to the northeast wall of the 1834 section, and one room under the porch on the southeast side of the 1851 section. The date of these additions remain unknown.
Figure 5. Speculation as to the Evolution of Solitude 1801 - after 1851
Figure 6. Solitude in 1801
Figure 7. Solitude in 1834
Figure 8. Solitude in 1851
Figure 9. Solitude after 1851
2.2. Literature Review

Preservation and renovation practice demands many skills and techniques. The following literature review will focus on several important aspects, such as building regulations and preservation philosophy, historic building systems and construction methods, and preservation technology of wood. All of these issues are related to the preservation and renovation of Solitude.

2.2.1. Preservation Philosophy and Building Regulation Review

The Venice Charter of the Second International Congress of Architects and Technicians of Historic Monuments (1964) states the basic principles of historic preservation. It identifies the parameters of conservation, restoration, and excavations. This charter sets a very stringent degree towards intervention. Later, some experts of preservation amplify and develop these principles through their practice. J. M. Fitch (1983) points out that the most conservative intervention is usually the wisest policy. Reversibility is an important criterion for preservation. In order to avoid the irreversible degradation of historic buildings, preservation treatment should be easily reversed: "lest done, sooner mended" (Fitch, 1990). H. C. Miller (1993) raises six principles of architectural conservation, including

"to save at all; to be careful not to create something that never existed; to be able to recognize the clues of the past; to be able to recognize the patina of old materials, particularly handmade materials; to be able to find traditional ways to repair and replace materials; to use contemporary materials as an alternative only if the characteristics and limitations of the materials are understood and the effect of these materials to adjoining materials is evaluated, and these are acceptable in the dynamics of the existing materials and buildings."
In the United States, the government enforces building regulations through building codes. There are three model building codes, which are available for use by states and local governments. In the state of Virginia the Basic Building Code, maintained by Building Officials and Code Administrators International, Inc. (BOCA), has been adopted. In The BOCA Basic National Building Code (1984), there is no particular mention regarding historic preservation and renovation. However, Section 103 indicates “alteration or repair may be made to any structure without requiring the existing structure to comply with all the requirements of this code, provided such work conforms to that required of a new structure. Alterations or repairs shall not cause an existing structure to become unsafe or adversely affect the performance of the building.” (BOCA, 1984)

In addition to building codes, the Federal government has established several federal regulations as guidelines for historic preservation. These include The Secretary of the Interior’s Standards for Historic Preservation Projects (1985) and The Secretary of the Interior’s Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (1980). The standards provide ten principles for historic preservation projects, covering environment and sites to architectural and structural features. Some recommendations for applying these standards are given on the following aspects: 1) the environment, 2) the building site, 3) structural systems, 4) exterior features, 5) interior features, 6) mechanical systems, and 7) safety and code requirements. These standards apply to all projects assisted by the National Historic Preservation Fund, and also are recommended to individual property owners.

2.2.2. Historic building systems review

Because wood was available in large quantities almost everywhere in North America, most build-
ings built during the first 300 years of settlement in the New World were of timber construction. The differences in origin, economy, and weather influenced the character of buildings in different regions. Basically, timber construction can be classified into two main structural systems: bearing-wall construction and framed construction.

Bearing-wall construction was a common and very old technique adapted from masonry construction by medieval builders. In North America, this type of structural system appeared as log construction and plank construction (Rempel, 1980). It was the Swedes who introduced log construction to North America. However, the rapid spread of log buildings was largely influenced by the Germans (Condit, 1982). The best known type of log construction is the log house (or cabin), which became a symbol of American frontier life. The distinction between a log house and a log cabin is uncertain. Some literature defines a house as a structure of two or more stories and a cabin as a structure less than two stories high (Whitwell & Winborne, 1982). In the Roanoke Valley, most log cabins evolved from Scandinavian-German construction and Scotch-Irish shape: single construction units of one-and-a-half stories with a rectangular shape (Whitwell & Winborne, 1982).

Timber-framed construction had reached its maturity by the 15th century in Europe. European immigrants brought the technique of timber framed construction to North America. Most buildings constructed during the colonial and early republican periods in the United States were timber-framed, even some log buildings had timber-frame roof and floor systems. According to Lewandoski (1992), the historical evolution of timber framing in North America can be divided into two main periods: pre-1800 and post-1800. In the early period, large hewn and riven timber was used; various systems of framing were employed due to the different backgrounds of immigrants. After 1800, the influence of the Industrial Revolution caused framing to be more uniform in design.
Increasing amounts of sawn timber and fewer sizes of timber were used, and modularity became the rule (Lewandoski, 1992). In the 1830s, a wood, light-frame construction was invented by George Washington Snow in Chicago and named “the balloon frame” (Figure 10). The balloon frame reduced the heavy-member structure to a framework of studs and joists, which could be assembled easily by hand. Later, several modified versions of the balloon frame were developed. The most recent one is the platform frame which uses short, easily handled lengths of lumber for the wall framing (Allen, 1990).

In the Roanoke Valley, the nineteenth century settlers constructed only a few types of folk houses due to the local small agricultural economy. The I-form houses and the Hall-and-Parlor houses were two popular types of timber framed houses (Figure 11). The I-form house is basically a house with a room on each side of a central hall; the hall-and-parlor house has a parlor beside a hall (Whitwell & Winborne, 1982).

Stone foundations can be found in many historic buildings. In Middle Virginia, brick was used for finer houses (Glassie, 1975). In the Roanoke Valley, most log cabins were built on a stone foundation (Whitwell & Winborne, 1982). Cellars were not commonly built by early European settlers (Rempel, 1980). However, some photographs illustrate some expensive houses in Tidewater Virginia having been built with basements (Farrar, 1955). In the Roanoke area, many vernacular houses were built on a crawlspace foundation with stone or brick (Whitwell & Winborne, 1982).

The walls of log buildings were built up of round logs or logs hewn to square or rectangular sections, and laid longitudinally one above another. The spaces between the logs were often filled with strips of wood and stuffed with mud, clay and plaster mixed with horsehair. Many log cabins were
sheathed making them difficult to recognize. The rigidity and strength of the walls depends on the weight of the logs and the security of the joints at the corners. V-notch was a common corner joint in the Roanoke Valley (Figure 12), but half dovetailing, full dovetailing, and saddle notching were occasionally used (Whitwell & Winborne, 1982).

The walls of timber-frame houses became thinner because they were no longer a bearing element. The exterior of walls were often covered by wood siding or brick. Although there are few records of wall construction in the area of the Roanoke Valley, some researchers report the walls of the mid-eighteenth century houses in Middle Virginia area to be approximately five inches thick. The early clapboard siding in this area had a bead along the lower edges. In the same area, the interiors of early houses were often plastered, but the interior wall and ceilings were also regularly covered with boards. Usually, the boards were nailed to studs horizontally and edge to edge (Glassie, 1975).

Floors of both log buildings and timber-frame houses were supported by wood joists or beams. Fine houses usually had floor decking consisting of a finished floor and a floor planking. The most common type of decking was tongue and groove (Allen, 1990). Floor boards were normally made of soft wood, such as pine, because they were easy to work.

Because the gable roof was easy to construct, it was the most common roof type in the early period of the New World (Condit, 1982). In the Roanoke Valley, log cabins normally had gable roofs (Whitwell & Winborne, 1982). The hip roof required more complex framing. It was adopted by Middle Virginia builders in the nineteenth century. The early roof pitch in Middle Virginia was above 50 degrees, by the second quarter of the nineteenth century it had been reduced to below 30 degrees (Glassie, 1975). During the nineteenth century, tinplate became a popular roof material in
America, due to its reasonable cost and durability, it was used on roofs with a low pitch and of many different shapes. Tinplate roofs were painted brown, red, and bronze green (Waite, 1976).

The door and window openings of log buildings were usually sawed out from the walls and were framed to the ends of the logs with wooden pegs (Condit, 1982). For framed buildings, door and window openings were framed out. Before 1830, windows were built according to classical modes of building in the United States. Six-over-six, double-hung sashes were the most popular. The window frames and sashes of constructed during the nineteenth century were generally made from pine (Swiatosz, 1985). Since the middle of the nineteenth century, mass produced, standardized windows have been increasingly supplied by mail order companies. Many companies also manufacture doors, newel posts, and mantels (Waite, 1976).

2.2.3. Literature Review of Preservation Technology of Wood

Wood is a primary building material for many historic structures. Therefore, understanding factors causing wood deterioration and resolution is an essential part of the preservation and renovation of historic buildings. As a kind of organic material, wood can be degraded and destroyed by biological or non-biological deterioration. The primary cause of wood deterioration in buildings is biological deterioration (Loferski, 1992).

Biological deterioration, caused by biological organisms, particularly various species of fungi and insects, is relatively slow and often occurs unnoticed for years before being discovered. Fungi includes decay fungi and non-decay fungi. Brown and white rotting fungi are the two main classes of decay fungi. White-rot fungi attack the wood cell wall substance by consuming both the cellulose and lignin of wood. Normally, they leave a characteristic white color on the wood
surface. White-rot fungi destroy wood at about the same rate as they consume it. The relationship between decay and strength loss is, more or less, a linear relationship (Merrill, 1974). The brown-rot fungi digest the cellulose component of wood and leave the wood with a brown color. The decayed wood is quite soft, and easy to break across the grain. The brown-rot fungi destroy structural properties of wood at a much higher rate than they consume it. A very small amount of decay can cause up to 80 percent wood strength loss (Wilcox, 1978).

Besides the two main classes of decay fungi, others are water-conducting rot and soft rots. The water-conducting fungi can transport water for some distance, wet the wood, and then decay it in a very short time. However, it is relatively rare in the United States. Soft-rot fungi cause decay of the surface layers of wood and seldom extend deeper. It occurs commonly in wood that is either completely saturated with water for a long time, or in wood that has been alternately wet and dry. The dry wood with soft rot usually appears black and scaly (Merrill, 1974).

The non-decay fungi, including molds, stains, and mildews (also called surface molds), attack sugar and starch in cells. The main damage of non-decay fungi to wood is discoloration, from bright yellow to blue-green to black. However the existence of non-decay fungi indicates excessive moisture content in the wood and a potentially perfect condition for insects and decay fungi (Loferski, 1992).

The main insects which cause wood deterioration are termites, carpenter ants, powder post beetles, and the old house borer. In the United States, subterranean termites cause most of the damage (Loferski, 1992). Once subterranean termites have access to a source of water, they can attack very dry wood (DeGroot, 1982). Normally, the ground water is the source of their water.
Because historic structures usually lack termicide soil treatments, they are vulnerable to termite attacks.

Because the primary cause of wood deterioration in buildings is biological organisms, the most effective method of eliminating wood deterioration is to make the environment in the building uninhabitable for the deterioration organisms. Among the four basic elements (oxygen, favorable temperature, moisture, and food) for all organisms, moisture is the one that can be controlled practically and economically. Both brown rot and white rot fungi require water and high moisture content (MC) in excess of 25% to live in wood. Non-decay fungi need less water and moisture content than decay fungi (MC>20%). Most insects also prefer to eat and to tunnel into moist wood because it is soft and contains an abundant supply of moisture. In order to keep wood in buildings dry, the original moisture of wood, rain, condensation, piped water, and ground water have to be kept away from the wood.

If it is impossible to keep the wood dry, eliminating food for deteriorating organisms is the last option. This means treating the wood with chemicals. There are a wide variety of chemicals for treating wood to resist fungi and insects. These include oil-based preservatives and water-borne preservatives. Oil-based preservatives will not cause wood to swell, and will resist leaching, but they affect the cleanliness, odor, color, and paintability of wood. Water-borne preservatives cause wood to be redried after treatment (Verrall & Ambargey, 1978). The treatment methods include pressure processes and nonpressure processes. The proper choice of preservative and treatment method depends on the severity of exposure under which the treated wood will be used. On site treatment includes applications of brush-on and dip treatment. Due to inaccessibility of many
wood members in historic structures, dip and short-soak treatment have limited applications.

The agents of non-biological deterioration include weathering, chemicals, and fire. Weathering factors include actions of water, light, and heat. Some research shows the weathering of wood in the absence of decay fungi removes 1/4 inch of wood surface per 100 years (Fiest, 1988). Surface coatings, treatments, and overlays can protect wood against weathering (Feist, 1982). Even though photodegradation is not a serious problem for structural members in historic buildings, historic finishes and exterior millwork can still be damaged by photodegradation (Loferski, 1992).

Chemicals affect wood in two ways. First, wood can split and crack because of shrinking and swelling caused by penetration of polar chemicals, such as alcohol. Second, chemicals, such as acids, can cause strength loss of wood by permanently modifying the wood cell wall substance. The most common chemical damage in wooden structures is associated with the corrosion of metal fasteners, whose chemical by-products can attack the wood adjacent to the fasteners. The result is that the fastener becomes smaller and the hole in the wood becomes larger, and the joint becomes weakened by both effects (Baker, 1982 and Verrall & Amburgey, 1978). Color change near the fastener is the first sign of the chemical damage. This type of chemical damage can be prevented by protecting wood and fasteners from wetting.

Heavy timber members are excellent performers during fire. If a fire is not long and severe, "the overall strength loss in heavy sections will be small and the residual load-carrying capacity will be closely approximated by using the initial strength properties of the uncharted residual cross section as a base" (Schaffer, 1982). Impregnating wood with chemicals, such as ammonium salts, can
provide substantial protection against fire.

For wood preservation in historic buildings, there are some suggested principles to follow. First, accept the member as is; secondly, repair it; thirdly, reinforce it; finally, replace it if it is necessary. All decisions have to be made based on the safety and serviceability of the wood members (Loferski, 1992).
Chapter Three

Documentation and Survey of Solitude

3.1. Methodology of Survey

Architectural documentation is the basis of preservation and renovation procedures. Because there is no complete architectural documentation of the main building of the Solitude property found in the university library, the physical plant office, or other sources at Virginia Tech, it is essential to collect the necessary data and record the existing fabric of the building for future preservation and renovation. In order to meet the goal of documenting Solitude, a field survey needs to be conducted.

The following parameters are defined for this survey: 1) the survey is limited within the existing structural boundaries of the main building; 2) the date when the survey is conducted is set as the chronological cut-off: thus, before that, all visible architectural and structural features are surveyed; and 3) only selected data is collected on the interior of the building, because two theses had been done already on the topics of the interior finishing and the millwork of Solitude (Yagow, 1985 and Ballard, 1992).

The survey results are reported in two parts: measured drawings, and description and analysis of building systems. The measured drawings are graphic records including floor plans, elevations, sections, and details. In accordance with the principles of HABS, the dimensions for measured drawings are from three sources: documents, hand measurements, and photographs (Burns, 1989). The documentary sources for measured drawings include an uncompleted elevation drawing by unknown former students and measured drawings of the interior millwork done by S. Ballard. The hand measurements are conducted on the site by the author. Some data collected by the team of S. K. Mattingly and the author in 1993 is used for the final drawings. Because it is difficult and
sometimes impossible for one person to obtain a comprehensive set of site measurements, some dimensions for the measured drawings may have to be left for future participants. The photographs include those done by other people and by the author. The film used is 35 mm black-and-white film. The written records of the survey are the description and analysis of the building systems of the structure. In the report, the major building systems, including the foundation, the site drainage system, the walls, the floors, the roofs, the windows, the doors, and the other building components, are inspected and analyzed, and the visible defects are recorded as well.

3.2. Measured Drawings

The measured drawings include only permanent visible architectural and structural features, excluding modern storm windows and doors. All mechanical systems, including lighting, heating, water-supply, and sewage systems, are not in the scope of these measured drawings. Because of the difficulties of the one-person working team and the restrictions of accessing some parts of the building, some architectural and structural features and dimensions, such as the roofspace, and the basement, and as well as the heights of the structure and the three chimneys, have to remain for future participants. Finally, all measured drawings were executed with the aid of computers (Appendix 3).
Figure 13. The site plan of Solitude
(from Capitol Design and Construction Department, Virginia Tech)
Figure 14. The first floor of Solitude
Figure 16. The west elevation of *Solitude*
Figure 17. The south elevation of

S o l i t u d e
Figure 18. The east elevation of

Solitude
Figure 19. The north elevation of

Solitude
3.2.3. Sections

Figure 20. The section A-A of Solitude
Figure 21. The section B-B of Solitude
3.2.4. Ornamental Details

Figure 22. The front door of the 1851 section
Figure 23. The window of Room 11 in the 1851 section
Figure 24. The window of Room 5 in the 1801 section
Figure 25. The window of Room 108 in the 1851 section
Figure 26. The window of Room 2 in the 1834 section
Figure 27. The newel posts of the stair in the 1851 section
Figure 28. The chimney adjacent to Room 1
3.3 Description and Analysis of the Building Systems of Solitude

The main building of the Solitude property is situated on the west end of the Virginia Tech campus. The entire site is located in a landscaped park surrounding the Duck Pond. There is a parking area on the northeast side of the building. A driveway provides access to the building from the main campus road. The building is a two-story, L-shaped house with a principal facade facing the northwest, toward the upper of the two ponds in the Duck Pond area. The building can be entered through four entrances: those located on the southeast, southwest and northwest sides of the building are covered by porches.

The survey of the building was conducted in the summer of 1995. The building was inspected from the outside to the inside, from the basement to the roof. The existing conditions and visible defects are described in the report which focuses on four major building systems.

3.3.1 Foundation and Structure
The building is originally supported by a crawlspace foundation, which was popular in this area. Under the 1851 section, the two-foot high foundation consists of bricks laid on others with mortar. The rest of the building sits on a foundation composed of bricks and stones, except the porch on the southeast side of the building, which has a modern concrete foundation. The sills, about 10 inches high of hewn white oak, are placed directly on the top of the foundation. The joists of the first floor are joined to the sills by mortise-and-tenon connections with deep cuts. The joists are logs of oak with hewn or split tops, and some of them still retain bark (Figure 29). The dendrochronology studies indicate most of the logs are still original to the building (Heikkenen, 1990).
In the twentieth century, a partial basement, about 7 feet high, was built under the 1801 and 1851 sections. For modern conveniences, a water heater has been installed in the basement. The earth in that area has been removed, and a concrete floor and walls have been added. There are two accesses to the basement: one is under the stair of the 1851 section, and the other is directly toward the exterior, under the porch on the southeast side of the building. A concrete stair connects the latter one with the ground.

The whole foundation of the main building lacks an efficient drainage system, because there is evidence on the earth to suggest that flooding had occurred in the basement. As a result, the moisture content of many logs is determined by the author using moisture meter to be as high as 18%. Due to the high-humidity environment, most logs of the first floor have experienced some degree of fungal and insect-related decay. Some logs are attacked by brown fungi and have become soft already, at least on the surface (Figure 30). In the most serious case, the wood fabric can be turned to powder easily by one’s fingers. Insect holes are found in many logs, but there is no evidence to show that insects are still active. The author has learned from the physical plant office of the University that the soil surrounding the foundation has been treated against termites. Furthermore, cracking appears on almost every log. Some cracks are half an inch wide, more than one inch deep, and several feet long. The deterioration of the joists has caused all of the floors of the 1851 section to tilt. Therefore, because of all of the damage noted above, many temporary wood and steel posts have been added to give extra support to the joists.

3.3.2. Walls

Both the dendrochronology and historical studies indicate that the main building of Solitude consists of three major sections and some later additions. The result of this survey supports this view.
The walls of the 1801 and 1834 sections are thicker than the later ones. The thickness of the walls of these two sections is more than 10 inches, which indicates that these two parts have log walls, which were commonly constructed for residential buildings in the early nineteenth century in this area. In contrast, the walls of the 1851 section and later additions are less than 6 inches thick, which suggests that the walls are no longer a bearing element, and a timber-frame structure is employed.

All exterior walls of the building are clad with whitewashed horizontal weatherboards with plain bevels, except the wall of the 1851 section under the porch on the northwest side of the building. The weatherboards are about 5 inches wide and three quarters of an inch thick. From some boards with peeling paint, the wood can be identified as yellow poplar (Liriodendron Tulipifera) and pine (Pinus Spp.), both of which were commonly used for siding in this area. Additionally, most of the weatherboards on the southeast wall of the building have a bead along the lower edges. These boards might be still original to the building, because beaded siding is a common feature of the mid-nineteenth century English and American buildings. The rest of the weatherboards are plain. Finally, an unusual feature of the exterior walls of the building is that the wall of the first floor on the principal facade is treated uniquely: the whole wall is plastered as an interior wall.

The paint on the exterior walls of the building fails in some places. Most of the peeling, cracking, and flaking appears on the weatherboards near the ground and on the eaves boards. Furthermore, stain fungi and mold fungi also occur on some boards, particularly on the northeast end of the 1851 section. Generally speaking though, the condition of the exterior wall of the building is reasonably good.
All interior walls of the building are plastered. The walls of the 1834 section are painted white. Wall paper still exists in the 1801 and 1851 sections, except Room 12 which is painted in light yellow. Room 5, which is considered the oldest part of the building, has wall paper painted in white. The wall paper in the rest of the rooms in the 1851 section is white with patterns. All the wall paper doesn’t appear to be original. Under the wall paper, there is evidence to indicate that the walls were previously painted olive. In the 1801 and 1851 sections, all walls have approximately 10-14 inches high baseboards. In the 1834 section, there is a chair rail on the walls in addition to a smaller baseboard. There is no ceiling molding in the building. Water stains are found on some interior walls, and most of them are in the entrance hall of the 1851 section. The stains indicate roof and joint leaking of the porch roof on the northwest side affecting the interior walls (Figure 31).

Because permission is not available for removing exterior siding or interior finishing of the walls, construction of the walls can not be inspected. However, the construction of the log walls can be conjectured based on information from the spring house and the out building. The walls of the log sections are probably constructed with local oak logs with V-notching, and the space between the logs might be filled with lime/sand/clay mixture reinforced with animal hair. Nevertheless, the wall construction of the timber-frame section remains unknown.

3.3.3. Floors and Roofs
The first floor of the building consists of one layer of wood decking nailed directly on the log joists. There is no finished floor in the building. In the 1851 section, the wood decking consists of one inch thick boards of pine, 4-6 inches in width. Each board is fastened with others by tongue-and-groove connections and nailed to the joists. Although some boards of the entrance hall have been replaced with smaller modern boards, and modern carpet covers the floor of Room 7, the first
floor of this section appears to be original. In contrast, the first floor of the 1834 section might have been replaced with oak flooring sometime in this century. As well, the floor in Room 2 has been planed and varnished more recently, and the rest of the rooms in the section covered with vinyl tiles. Finally, the decking of the three porches has been replaced by modern plywood or preserved wood.

The second floor of the building is similar to the first floor. A broken hole on the ceiling of Room 7 in the 1851 section shows clearly the construction of the ceiling and the floor: the pine boards of the second floor rest on 2 X 8 inch wood joists, and the ceiling of the first floor is finished with a plaster coating applied over a layer of lath fastened to the joists of the second floor by nails. Furthermore, in Rooms 5, 7 and 12, a modern acoustic panel ceiling with an aluminum frame has been added (Figure 32). The second floor of the 1851 section is covered with carpet, and that of the 1834 section is painted gray. Additionally, the floor of Room 12 is 19 inches lower than the second floor of the 1851 section, which suggests that the floor is the original one of the 1801 log section. The entire floor of the 1851 section slopes towards the middle due to the failure of the foundation.

Two types of roofs are employed in the building. The 1851 section is covered by a hip roof, as is the porch on the northwest side of the building. Gable roofs are used to cover the 1834 section and the other two porches. Galvanized metal sheets, probably tin, are used as the roof material. The metal sheets are fastened to the roof at distance of 24 inches apart from center to center. The roof is painted in traditional green to imitate a copper roof. Because of the restriction of accessing the attic, the inspection of the roof structure remains for future participants.
3.3.4. Windows, Doors, and Other Building Components

Most windows and doors in the building have not been changed since the University took over the property, except the doors between Room 2 and Room 4, Room 1 and Room 2, Room 13 and Room 14, and Room 10B and Room 11; those doors are modern flush doors. All windows are double-hung, except one casement window located on the second floor of the 1851 section (Room 11). The wood that can be seen under peeling paint indicates that the window frames and doors are made from pine. All windows used to be protected by shutters, which were removed from the building several years ago due to the deterioration of the frames. Now, a modern storm window and screen has been installed outside each window. Many window sashes are difficult to move, or for others, to stay in position. This is a result of that the frames are out of shape, and the cords and counterweights don’t work well. Additionally, the coat of paint on some windows and doors is peeling, particularly in the 1851 section. Finally, the door frames in the 1851 section are cut because of the sloping of the floors.

For other building components, two stairs, two restrooms, four chimneys, and several fire places have to be mentioned. The stair located in the entrance hall of the 1851 section appears to be the main stair of the building (Figure 27, 33). The newel posts of the stair look similar to the 1870s products illustrated in the Architectural Elements (Waite, 1976). Therefore, it is reasonable to consider the stair is original to the house. The other stair is located in the entrance hall of the 1834 section. In contrast to the 1851 stair, this one has less decoration. Both stairs are in fairly good condition.

One restroom is located on the second floor of the 1851 section (Room 10A), and the other is on the second floor of the 1834 section (Room 14). The toilets in both are modern. Neither of the
restrooms is original to the building.

There are four brick chimneys attached to the building. The structural bonds for the brick walls of the chimneys are close to the Common Bond (also known as American Bond), but the numbers of brick courses between two header courses varies from four courses to nine courses (Figure 28, 34).

In the building, there formerly were seven fire places. Only five of them remain and still have mantels, while those in Room 1 and Room 2 have completely disappeared from the places where they should be. None of the five existing fire places can be used. A. S. Ballard records the styles and details of the windows, doors, and mantels in her thesis, so the same information is not repeated here.
Chapter Four

Recommendations for Future Preservation, Renovation, and Adaptive Reuse of Solitude

4.1. Recommendations for Preservation and Renovation of Solitude

The main building of Solitude has a nearly 200-year history. Part of the existing fabric of the building is no longer original. During this period, some additions have been added, and several remodeling have taken place. These changes are evidence of the history and development of the building. Based upon the available information and current financial circumstances, it is difficult, and not necessary, to renovate the building back to the original condition. Furthermore, The Secretary of the Interior's Guidelines for Rehabilitating Historic Buildings (1980) suggests that the changes should be recognized and respected. It is a wise recommendation to leave the building as it is in accordance with the preservation philosophy. Generally speaking, the part of the building inspected by the author is in a reasonably good condition, however, the foundation and the drainage system needs major preservation measures immediately. Moreover, some further steps for adaptive reuse should be taken when more financial support is available in the future.

Under the current circumstances, the strategy of preservation and renovation of the building should include two parts: general preventive maintenance and special preservation treatments. The general preventive maintenance is the process by which the building is kept in a viable condition to accommodate the activities of the users, and to display its significant historical and architectural features. The special preservation treatments are employed to fix any defect which is jeopardizing, or will jeopardize, the building. If maintenance is well carried out, there will be far less need for special preservation treatments; so the general preventive maintenance is a key issue for the preservation practice. However, in this case, both the general preventive maintenance and special preservation treatments are essential to the building.
4.1.1 General Preventive Maintenance

As the other buildings on campus, the main building of Solitude is maintained by the physical plant office of the University. Through an interview with John E. Beach, the director of building services, the author has learned that the main building is receiving the same maintenance as the others, regardless of its special value. Due to a budget shortage, some necessary preservation treatments, such as reorganizing the site drainage system cannot be carried out, and the historic features of the building can not receive sufficient in maintenance. There is no doubt that enough financial support is the necessary basis for the preservation and renovation work of the building; however, there is still some work that can be done under the current situation.

The first step needed toward preservation and renovation of the building is to install thermographs, humidigraphs, and fire-alarms. Moisture control is a key issue for preservation, thermographs and humidigraphs can monitor the interior moisture and temperature levels of the building to provide necessary data for maintenance and preservation. Fire-alarms are essential to any building, especially wood structures. Therefore, all instruments mentioned above are needed urgently.

Another important measure for preservation of the building is to establish maintenance programming, including maintenance routines and a year-by-year log book. The maintenance should ideally be tackled by routines that range from daily through annual inspections. In the case of Solitude, a quarterly routine inspection is the minimum requirement. This routine should include the following: inspecting roofs, gutters, rainwater disposal outlets, and gullies; checking glazing, paint, and doors; cleaning windows and light fittings; checking all thermographs and humidigraphs to monitor the temperature and relative humidity. Furthermore, every year, all of the electric plant has to be overhauled, and all gutters, downpipes, and rainwater drains have to be cleaned as
well; every five years, a surveyor must make a full report, especially noting structural defects that should be kept under observation. All the maintenance routines have to be recorded as written reports. Finally, the users and cleaners of the building have responsibility to report any defect they note, for instance, broken windows or ironmongrey, leaks in the roof, and insect problems.

In the maintenance routines, cleaning needs special attention. The building requires cleaning because weathering and human activity deposit potentially harmful particles on surfaces. Both dry cleaning processes (dusting, vacuuming, etc.) and wet cleaning processes (mopping, washing, etc.) are necessary to cleaning the building. Before cleaning, some considerations are necessary. F. Stahl points out six special considerations of cleaning (Stahl, 1984). In the case of Solitude, some of these considerations can be used as a guideline: understanding the nature of both the dirt and the surface to be cleaned; using the mildest workable method and cleaning solution in each instance; cleaning only when a useful purpose is served.

Although the physical plant office keeps a work order listings report of the building, a more detailed and special year-by-year log book is needed. The book should be instituted with records of maintenance costs, as well as reports of regular maintenance routines and professional inspections. The function of the log book is similar to the case history of a patient: It can provide important information for future preservation and renovation work.

4.1.2. Special Preservation Treatment

Because of material deterioration and man-made damages, special preservation treatments are necessary. Unfortunately, Solitude has received improper treatment in the last twenty years, such as adding an acoustic ceiling and using different materials for repairing (Figure 35). It is necessary
to emphasize that all the treatments for the building have to be guided by the Venice Charter of 1964, The Secretary of the Interior’s Guidelines for Rehabilitating Historic Buildings (1980), and other related preservation principles. In particular, reversibility and conservative intervention are two important concepts. The preservation treatments include repair, reinforcement, and replacement. Depending on the degree of material deterioration and damage, repair is the first choice, followed by reinforcement and replacement. It is always wise to employ more conservative means to keep original building fabrics as much as possible. All the treatments have to be carried out without damaging the historical value of the building, and to be reversible as well.

Through inspection by the author, some serious defects have been identified that need preservation treatment as soon as possible. The most urgent treatment is to repair the drainage system of the foundation (Figure 36). As the author discusses in the last chapter, the deterioration of the first floor joists is due to the high-humidity environment of the foundation. The current site drainage system is the major cause of the problem. The ground level of the building is lower than that of the parking lot outside, and the building does not have a grade that slopes away from the structure. Once it rains, the rainwater from the parking lot goes to the building, evidenced by watermark in the basement. Furthermore, the entire foundation does not have enough clearance between the soil and the wood sills, especially, where the soil directly contacts the wood siding along the southeast side of the building. This allows the moisture from the soil to attack the sills easily. Most of the paint failure is the result of by moisture attack. Finally, the entire foundation lacks a ventilation system.

The treatment for the foundation should include the following: removing any soil piled against the foundation to leave at least 8 inches clearance between the soil and the wood, and to make a
grade that slopes away from the building 1 inch per foot for 8 feet; reorganizing the rainwater drainage of the parking lot; burying a drain pipe lower than the ground level of the basement along the foundation; opening some vents in the foundation walls for ventilation; finally, covering the soil in the foundation with a soil cover, 6 mil polyethylene sheet, in order to reduce the moisture from the soil.

The joists of the first floor have experienced some degree of fungal and insect related decay. In order to determine the stability of the first floor, a sensitivity study of the joists strength was conducted by the author. A sample joist was taken from the decayed joists. It is a 16 feet and 10 inches long log of white oak (Figure 37). The section of the log is assumed as a 6 X 9 inch rectangle. The maximum load of the joist is calculated under four different conditions: Condition One is that the joist is considered as a select structural grade of white oak; Condition Two is that the joist has the reduced Fb to 50% and E to 80%(similar to No. 2 white oak); Condition Three is that the joist has select structural properties and the reduced section area to 40%; and Condition Four is that the joist has both the reduced mechanical properties and section area at the same time.

<table>
<thead>
<tr>
<th>Condition One</th>
<th>Condition Two</th>
<th>Condition Three</th>
<th>Condition Four</th>
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<tr>
<td>Length of the beam</td>
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<td>202 inch</td>
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<tr>
<td>Fb*</td>
<td>1,400</td>
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<tr>
<td>E*</td>
<td>1,000,000</td>
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<td>800,000</td>
</tr>
<tr>
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<td>105</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td>d</td>
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<td>6 inch</td>
<td>4 inch</td>
</tr>
<tr>
<td>b</td>
<td>9 inch</td>
<td>9 inch</td>
<td>5 inch</td>
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<td>54</td>
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<td>40.2 lb/ft</td>
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<td>Bending</td>
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<td>95.3 lb/ft</td>
<td>43.9 lb/ft</td>
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<tr>
<td>Shear</td>
<td>449.1 lb/ft</td>
<td>449.1 lb/ft</td>
<td>166.3 lb/ft</td>
</tr>
</tbody>
</table>

Where: Fb= Bending Stress, E= Modulus of Elasticity, Fv= Shear Stress, b= Width, d= Height, I= Moment of Inertia, S= Section Modulus
W= Allowable Maximum Load  Δ =Maximum Deflection

* Allowable design value from the National Design Specification for Wood Construction (NFPA, 1991)
From The BOCA National Building Code, the minimum uniformly distributed living load is 40 psf for classrooms and 50 psf for offices, which is translated to 80 lb/ft and 100 lb/ft for 24" on center spacing between the joists of the first floor. So, under the condition one the joist can support the floor as offices and classrooms. Because the joist is supported by extra posts, the deflection can be considered as zero. So, under the condition two the joist still can support the floor as classrooms.

The result of the analysis above is only relevant for the conditions assumed by the author. However, the decayed wood joists still need to be treated. The Secretary of the Interior’s Guidelines for Rehabilitating Historic Buildings (1980) recommends that deteriorated structural members shall be repaired rather than replaced, wherever possible. So, it is not necessary to replace these joists unless there is further deterioration. Once the drainage problem has been solved, the deterioration of the joists should be under control. Reinforcement, which includes physical and chemical methods, might be the proper solution. The physical method for reinforcement normally includes splicing, attaching metal, and using flitch beams; the epoxy reinforcement is a popular chemical method. A more detailed preservation measure should be conducted under a structure specialist as soon as possible.

The author finds that deterioration of the first floor decking to be more serious than the second floor. A major cause of the deterioration is condensation. Because the foundation is not insulated, condensation easily occurs on the floor when the occupied space of the building is heated and the foundation is not. This condition occurs during winter. The deterioration of the wood near the water pipes is worse because of condensation occurring on the metal pipes (Figure 38). In order to prevent condensation, vapor barriers and thermal insulation are needed on the cold water pipes. For the first floor, insulation material with 6 mil polyethylene sheet also needs to be installed on the
side having the greatest source of moisture, which can be determined from humidigraph informa-
tion. Serious man-made damage to the structure, noted by the author, is under the floor of the
restroom in the 1851 section (Figure 39). During the previous renovation process, some floor joists
were cut more than one-third of the depth to accommodate plumbing. The cutting reduces the
strength of the joists significantly. Normally, notching the top or bottom of a joist should not be
more than one-sixth of the depth. Therefore, the cutting will cause some serious problems. The
only solution is reinforcing the joists by nailing a reinforcing scab to each side.

Most of the exterior paint failure of the building occurs near the soil and on the eaves boards. The
former is due to the insufficient clearance between the soil and the wood; the latter is caused by
the leaks of the gutters. Both problems need to be fixed, and all the places where paint fails
should be repainted. The exterior siding is painted by an oil-base paint, which was determined by
information provided by the physical plant office. Normally, the expected life of the paint is 7-10
years, so the entire exterior walls have to be painted every 7 or 10 years. During the period, the
walls still need to be checked every year and any paint failure needs to be fixed immediately.

For the other deteriorated architectural and structural features in the building, the principle
provided by The Secretary of the Interior’s Guidelines for Rehabilitating Historic Buildings (1980)
should be followed: "(deteriorated features) shall be repaired rather than replaced, wherever
possible. In the event replacement is necessary, the new material should match the material
being replaced in composition, design, color, texture, and other visual qualities." According to the
Guidelines, some improper replacements and additions need to be corrected, such as the
plywood decking of the southeast porch, the acoustic ceiling, and the modern boards on the first
floor that do not match the original.

Because of the difficulty of accessing the attic and the roof of the building, the cause of the roof leaks cannot be determined. The preservation measure for the roof, as well as other structural elements, has to be left for future study. Furthermore, the preservation treatments for the building are indeed a complicated task, which demand many other disciplines than architecture; therefore, further preservation measures should involve more experts in different fields, such as wood preservation.

4.2. Recommendations for Adaptive Reuse of Solitude

The main building of Solitude originally was a house and is currently used as offices and classrooms by the Center for Appalachian Studies of the University. The building has been already adaptively reused. As many other historic buildings across the country, its adaptive reuse has given the building a new life, a new function, as well as some necessary changes. Although the exterior of the building can remain as before, the interior has to be changed and some new equipment has to be installed in order to meet the requirements as an education facility. The changes should be considered in at least two aspects: the change of the interior space layout and the interior environmental control.

4.2.1. Recommendations for the Interior Space Layout
Because the building serves as offices and classrooms, it is possible to keep most of its architectural features and original interior space layout. However, in order to meet some code requirements for public buildings, some necessary measures have to be taken, and the recommendation of the Secretary of the Interior's Guidelines should be used: "complying with code requirements in such a manner that essential character of a building is preserved intact."
One of the necessary changes is for the Americans with Disabilities Act (ADA) compliance. There are two restrooms in the building, and both are located on the second floor. It is difficult for handicapped people to access the facility, so it is necessary to relocate a restroom on the first floor. Room 3, which is used as storage, is the best place to be changed to a restroom. Moreover, a ramp may be built on the southeast side of the building, which is close to the parking lot. A controversial issue is whether a wheelchair lift for handicapped people should be installed. If it is necessary, the location suggested by the author is in the entrance hall of the 1834 section, because the closet downstairs and the restroom upstairs can provide enough space for the lift with less change to the building.

Among the other changes for the adaptive reuse, the partition wall between Room 9A and 9B needs to be removed, because the modern wall has divided the original room into two small rooms, resulting in one of the rooms (9B) to be unusable. Another change that will be needed is to reopen the door in Room 12 to the 1834 section, when a lift for handicapped people is installed. This will provide handicap access to the exhibition room from the 1834 section.

4.2.2. Recommendations for Interior Environmental Control

The interior environmental control of the main building of Solitude includes thermal control, relative humidity control, ventilation control, and lighting control. Human bodies are sensitive to the above environmental factors, and the historic building can be affected by these factors as well. So, the entire environmental control not only provides comfort to the occupants of the building, but also creates a proper climate for preserving the wood structure.
The thermal control, including heating and cooling, is closely related to the relative humidity control. Both are two main factors of the interior environmental control. For the comfort of the occupants, the interior temperature of the building should be set around 72 F in the summer and 68 F in the winter; the relative humidity should be in the range from 50% to 60%. Under this conditions, the wood structure and interior finishing can be preserved best. A large temperature change may cause some permanent damages of the mechanical properties of the wood members in the building. Furthermore, the wood structure is sensitive to relative humidity. High relative humidity will cause the moisture content of the wood to rise, and may result in biological deterioration of the wood. Finally, as the Secretary of the Interior’s Guidelines suggest, thermal insulation needs to be installed in the roof space and the foundation in order to conserve energy.

The ventilation is another important environmental factor that is also related to the temperature and the relative humidity. Generally, the ventilation is considered under two major areas: the occupied spaces and the structural cavities. The purpose of the ventilation is not only to provide comfort to the occupants, but also to avoid stagnant air that can produce suitable conditions for growth of biological organisms. In the building, the occupied space currently depends on natural ventilation. Because the building does not receive many users on the day-to-day basis, the natural ventilation is sufficient. However, once the users of the building increase, the current natural ventilation needs to be reevaluated.

The ventilation of structural cavities is more important for the building itself. The inadequate ventilation of structural cavities will cause serious problems; for example, the lack of ventilation in the foundation already plays a role for the deterioration of the first floor joists. In the case of the
foundation, at least four openings should be provided with one near each corner of the building. The total net area of the opening may be calculated by the formula: \( a = 2L/100 + A/300 \) (where \( a \) is the total net area of all vents, \( L \) is the total perimeter of the foundation, and \( A \) is the total area of the foundation) (Sherwood, 1982). The ventilation in the roof space is also important for the structure. Because of the difficulty of entering the roof space, the ventilation of that area has to remain for future inspection.

HVAC (heating, ventilation, and air condition) systems are a modern means to control the interior environment. However, it is a controversial issue to install a HVAC system in a historic building. The Secretary of the Interior’s Guidelines for Rehabilitating Historic Buildings (1980) recommends to utilize early mechanical systems, where possible. In the case of Solitude, the recommendation by the author is to use the existing radiator heating system, the natural ventilation, the movable window air conditioners, and additional humidifiers for a period under instrumental monitoring. If the existing means are able to control the interior environment under a satisfactory condition, it is not necessary to install a HVAC system; otherwise, a HVAC should be installed after a careful study. The principle suggested by The Secretary of the Interior’s Guidelines for Rehabilitating Historic Buildings (1980) is a basic guideline that reads, “Installing necessary mechanical systems in areas and spaces that will require the least possible alternation to the structural integrity and physical appearance of the building.”

Every room in the building of Solitude has an access to natural lighting. Some rooms may receive too much light at a certain time, such as in the summer the rooms facing northwest are over lighted. Because excessive light may not only bring in large heat gain, but also cause damage to
the interior finishing, reducing incoming light by adding blinds or shutters is necessary for the rooms. On the other hand, artificial lighting is necessary to supply extra light when the natural source is not enough. Fluorescent tubes are an appropriate lighting means to be used in the historic building, because the side effect of them, in terms of heat output, is minor. Finally, the appearances of lighting have to be suitable to the historic interior. Indirect artificial lighting sources are recommended for the building.
Chapter Five

Conclusions and Recommendations for Future Research

The main building of Solitude has been standing for nearly two centuries. It witnessed the birth of Virginia Polytechnic Institute and State University; it is an excellent example of the evolution of vernacular architecture in the New River Valley area. However, natural and man-made factors are jeopardizing the building. The survey of the main building, conducted by the author, provides the necessary information for future preservation work. It is the first time that the building has been fully documented on measured drawings, which are the basis of the preservation and renovation procedure. Furthermore, all measured drawings were executed by computers to provide more accurate dimensions.

The building has been inspected throughout, visible defects have been analyzed, and the causes have been diagnosed. Based upon the preservation philosophy and related knowledge, the preliminary preservation treatments for these defects have been proposed:

1) The drainage system of the foundation and the decayed first floor joists are two major concerns in terms of the stability of the building. Immediate preservation measures are needed, including reorganizing the drainage system and reinforcing the decayed joists of the first floor.

2) Vapor barriers and thermal insulation should be installed in the basement to prevent condensation within the first floor system.

3) The building deserves proper maintenance regarding its historic value. According to The Secretary of the Interior’s Guidelines for Rehabilitating Historic Buildings, every replacement of historic features in the building should be carried out after a careful study.

For the purpose of adaptive reuse of the building, the most conservative plan is recommended by
the author:

1) It is not necessary to renovate the building back to the original condition based upon the current limited information and conjecture. Except to add some necessary facilities to meet the code requirements, such as access for handicapped people, the rest of the building should remain as it is.

2) The changes that occurred in the evolution of the building should be respected. However, some modern features that are not suitable for the historic character of the building, such as the acoustic panel ceiling, should be removed.

3) Modern mechanical systems may be installed only when the current systems cannot handle the load and a careful study is conducted under specialists' direction.

Preservation and adaptive reuse of Solitude should be part of a historic resource management program of Virginia Tech. Besides Solitude, the University is the owner and user of other historic properties, such as Lane Hall, the Grove, and Kentland. The administration of Virginia Tech could work as a partner with its faculty, such as the Center for Preservation and Renovation Technology and the Center for Appalachian Studies, and the local community to establish a management program. Under the guidance of a such program, all historic properties on campus can be preserved and maintained better. The experience of some other universities across the nation can be used, such as the University of Oregon (Meachan & Peting, 1995).

This study was conducted not only in an attempt to provide the necessary preliminary research for the preservation and adaptive reuse of the main building of Solitude, but also to provide a comprehensive method for other preservation work. The procedure for a preservation project should begin with a background search, including the history, the related building regulation and preser-
vation philosophy, and related preservation technology. A survey is always the basis of the preser-
vation work, and documenting the existing conditions and inspecting the visible defects are
necessary as well. Based upon only accurate data collected on site can a correct diagnosis and
treatment for the defects be proposed.

As other historic preservation and renovation projects, the main building of Solitude demands
complicated skills and techniques. This study only provides a preliminary proposal for the preserva-
tion work. Because of the difficulties of the one-person working team and limitation of means,
there are openings for future studies:

1) The measured drawings and the survey of the building need to be completed, for example, the
roof structure should be measured and inspected.
2) The joists of the first floor need to be inspected one by one to determine the existing wood
properties and to decide proper preservation treatments.
3) The interior environmental control of the building needs to be carefully studied in order to
preserve it in the best interior climate.

Finally, Because of its significance to the University and the local community, the main building of
Solitude deserves the best preservation and maintenance. The author hopes that this study can
be one step toward preserving the building — the treasure of Virginia Tech.


Kegley, M. B. & Kegley, F. B. 1980. Early Adventures on Western Waters (vol. 1). Orange, VA: Green


Appendix 1

Documentation and Analysis of Millwork:
A Method for Mapping the Evolution of Solitude
A. S. Ballard
(Abstract)

Solitude, a nineteenth century farmhouse and historic landmark, located on the campus of Virginia Tech is currently slated for preservation. The purpose of this study was to trace the architectural history of the farmhouse and adjacent outbuilding through its existing millwork, hardware, and other architectural features.

Eighteenth and nineteenth century architectural pattern books and the knowledge of architectural historians were used to date the interior millwork and hardware in this building. The millwork and hardware produced evidence of at least three distinct design periods. To determine if millwork and hardware dates supported the approximate construction dates commonly thought accurate for the three major sections of this building. The 1801 and 1834 sections of the house exhibit Federal style. Greek Revival dominates the 1851 section, as well as the renovated 1801 section, and the later additions exhibit Victorian style details. The adjacent log and frame outbuilding contained millwork that mixed Federal and Greek Revival elements.

Using this information, along with information obtained from researchers who previously studied Solitude, a sequence of floor plans was developed. These plans show the evolution of the house through two major additions, as well as three smaller ones. The evolution of the outbuilding was also noted.
Appendix 2

The Last Year of Tree Growth for Selected Timbers within Solitude
As Derived by Key-Year Dendrochronology
H. J. Heikkenen

(Abstract)

This key-year dendrochronology study has established that the structural members of Solitude, such as stils, joists and wall logs were hewed and sawed from oak (Quercus spp.) trees that were felled after the growing seasons of 1801, 1834 and 1851.

The year of the best fit for the oak key-year patterns from Solitude were highly significant when aligned with the area oak key-year pattern for Southwest Virginia.
The measured drawings of the main building of Solitude were conducted by the AutoCAD 12 program on a PC. The file format of all drawings is a *.dwg file. There are three drawing files: Soli-1fr.dwg includes the first floor plan, four elevations, and two sections; Soli-2fr.dwg includes the second floor plan; Soli-sit.dwg includes the site plan; and Soli-del.dwg includes the details. In each file, different architectural elements are on different layers, such as walls are on the layer named "walls". The scale of all drawings is 1 to 1. The size of each file is 1,300K for Soli-1fr.dwg, 200K for Soli-2fr.dwg, 200K for Soli-sit.dwg, and 200K for Soli-del.dwg. The disks containing the files are kept by Prof. Schubert of the Architecture Department.
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