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Union Theological Seminary Air Conditions Its Library

NINETEEN FIFTY-SIX was an epochal year for the Library of Union Theological Seminary. It saw the execution of a long-anticipated, comprehensive air-conditioning project. This account is presented in the hope that certain of our experiences will be of practical interest to others facing similar problems and opportunities.

The Background

Fortunately for library air conditioning, books and people require approximately the same environment. Both need clean air, gently distributed, and uniform inside temperature and humidity. These conditions are the basis of all good air conditioning. Beyond these, a library demands, more than most other types of buildings, a quiet environment for reading and concentration; and its bookstacks require, in addition to the removal from the air of fine dirt and oily soot, the elimination of all surphur dioxide.[1]

Union Theological Seminary is housed in a two-block Gothic quadrangle located in upper Manhattan in an area of heavy street traffic. Its forty-seven-year-old buildings are exposed to atmospheric conditions of abrasive dust, fuel soot, chemical waste, and other damaging ingredients characteristic of urban situations with industrial plants nearby. The library "wing" is an integral part of the quadrangle. Its valuable theological collections—totaling approximately 350,000 books, pamphlets, microfilms, and manuscripts—have long been highly susceptible to the processes of physical and chemical deterioration. Original arrangements for the circulation of filtered air have been insufficient for purposes of protection, while regular vacuuming of the books, desirable as it has been under the circumstances, has at best served only to retard their gradual deterioration.

Originally, in view of anticipated costs, it has been thought necessary to limit air conditioning to the bookstacks. However, since the comfort and health of readers and staff were important factors, the first concept was enlarged to include all public service and work areas of the library. Because of the differing physical problems presented by the various library areas to be conditioned, this decision, of course, entailed a more complex engineering approach and the prospect of a much greater cost. Briefly, the library areas involved consist of the following:

Area I. The bookstacks, comprising five levels of glass platforms in an enclosure, with a volume of approximately 160,000 cubic feet.

Area II. The Reference-Reading Room, located over the bookstacks, having a reader capacity of eighty persons and a 28-foot, vaulted decorative ceiling, with a volume of approximately 95,000 cubic feet.

[1] In 1932, the U. S. Bureau of Standards, using funds granted by the Carnegie Corporation to the National Research Council, conducted research which revealed that the principal factor in the deterioration of books in large urban situations is sulphur dioxide, which, in concentration above a tenth part in a million, increased the "copper number," or measure of damaged cellulose of the paper. (Bureau of Standards, *Miscellaneous Publication No. 140*, April 6, 1933).

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Area III. The remaining library space, consisting of public card-catalog room, staff workrooms, and several small reading rooms, together comprising twelve rooms on three floors, with a volume of approximately 90,000 cubic feet.

Area IV. Certain adjacent areas to the north and south which may in the future be incorporated in the library, with a volume of approximately 50,000 cubic feet.

These areas add up to a total of about 400,000 cubic feet. All have been heated by direct radiation and ventilated by roughly filtered air brought in and also exhausted by a system of ducts and risers, with no humidity control. In Area III and, to a lesser extent, Area II, ventilation could be and was supplemented by the use of windows.

In developing the project, we had four basic goals in mind: first, correct air treatment for the collections, including good filtering, sulphur dioxide removal, and temperature and humidity control;[2] second, optimum comfort conditions for readers and staff; third, minimum intrusion of visible air-conditioning paraphernalia, particularly in the Reference-Reading Room; and, fourth, simplicity of year-round operation and maintenance. Since unlimited money was not available, a weather eye also had to be kept on construction costs at every stage of planning and execution.

Perhaps this is a good place for a word of counsel. In preparing a statement of the project for submission to a philanthropic foundation, we had, as a first step, invited a reputable local firm of air-conditioning contractors to submit its estimate of the requirements and cost of the job. Unfortunately, the analysis by this firm, made in good faith, was too superficial to provide an adequate conception of actual cost. In fact, the final cost was approximately 80 per cent above its figure.

From this experience we have concluded that our "second step" should have been our first, namely, to arrange for an exhaustive analysis of the situation by a qualified engineer. In this way, a realistic approach to problems and costs was arrived at, based upon several weeks of careful study, for which a professional fee was both required and justified. The hiring of this engineer for both designing and supervision was the first official step taken in getting the project under way.

The Installation

After study of a number of alternate air-conditioning schemes, a design was finally worked out to accomplish these main objectives: to put the heavy, noisy equipment in the basement; to discharge the cooling tower air without creating a nuisance at street level; to take fresh air into the building at roof level, where it is cleanest; to locate the air units near the areas served in order to reduce return duct work to a minimum; to provide sufficient zoning (area control); to minimize intrusion upon existing architecture, and to make the system easy to get at and to operate.

By utilizing existing ventilating ducts, a false chimney, attic and basement space, an unused book-lift shaft, and other facilities within building code regulations, a logical, compact design was evolved. The system has two cooling towers, and two sixty-ton chilled water machines with pumps in the basement, air handling units in newly created small rooms strategically located, and a fresh air intake down through a large false chimney to filters and fan in the attic. The old horizontal ventilating ducts were used intact and the old vertical riser duct was reversed to send fresh air down to the bookstacks units. The old exhaust was cut off from the bookstacks and concentrated upon the Reference-Reading

[2] Evidence gathered from published sources and from experience of other major libraries which had been recently air-conditioned, suggested a humidity range of 40 to 60 per cent as an optimum standard for readers and library materials.

Room to balance the total air movement.

To clean the air of all fine or sooty dirt, consideration was given to electric precipitators. With pre-filters to catch bulk dirt and after-filters in case of electric current interruption, precipitators do a complete job of dirt removal. However, they are quite expensive, require much space, and call for considerable maintenance. Furthermore, they are not fully justified when the recirculated air, often carrying dirt brought in on shoes and clothing or driven by the wind through unsealed windows, must be filtered at the air units by ordinary filters. So it was decided to use a combination of ordinary throw-away pre-filters, to remove the bulk dirt, and high-quality resistance filters (thick medium) to remove the fine dirt and soot. The power was available to draw the air through, because a fresh air fan was needed in any case to pump air to the remote air units serving each area. A static pressure regulator was included to maintain a constant supply as the filter resistance gradually builds up.

For the elimination of sulphur dioxide, a treated water spray[3] could not be introduced into the fresh air in the attic because of cramped quarters and other limitations. Besides, there is little need for the treatment of the air going to areas other than the bookstacks, and these areas require independent control. However, confining the sprays to the bookstacks unit creates an excess humidity problem in intermediate seasons when it is not warm enough to warrant running the chilled water machines. The fresh air is often still warm and humid enough to leave the sprays with too much moisture for the books. Shutting off the sprays at such times, resorted to in some libraries, lets the sulphur dioxide in, with lingering effect. Therefore, the bookstacks unit was provided with a bypass around the sprays to regulate humidity without turning them off. The air intake to the unit was so designed that the outside air is always passed through the sprays, and removal of sulphur dioxide compares favorably with that of the more expensive installations for large new libraries.

Heating, especially of the bookstacks, has undergone considerable change in the Union design. It was found possible to achieve inexpensively almost all the advantages of the modern windowless bookstacks by covering the windows with tight-fitting plywood panels, except at the stairs where, to meet Fire Department regulations, storm sash was used. These seal the stacks from infiltration, permit higher humidities in winter, and reduce the heat losses to the point where the radiators can remain shut off and the heating can be done entirely with the air system. This eliminates overheating and "chimney effect" from hard-to-control radiators. Along with cooling in summer, conditions now permit comfortable use of the eighty-five study carrels which have been newly installed along the east and west sides of the upper three stack floors. Prior to the present installation, the bookstacks had been untenantable for extended use because of lack of controlled fresh air.

Operation and Control

Our experience reminds us that in air conditioning existing buildings, the controlling of radiators constitutes a special problem. This is, of course, because the radiators were designed not only to keep the interior of the building warm, but also to heat a certain amount of fresh air admitted through open windows. After the air is supplied, already heated, by the new air-conditioning system, the radiators usually overheat. Moreover, the overheating cannot be ended quickly by throwing the windows wide open, since

[3] Sulphur dioxide can be eliminated completely by spraying the air taken in with an alkaline solution. This requires only water treatment such as is in common use for preserving the cooling towers and other components of air-conditioning systems.

the new system builds up slight pressure, which tends to keep the cold air out. At Union, the solution has been to keep the steam shut off to the radiators until about November 15 to permit control solely by the air system during mild weather. After really cold weather sets in, with less chance of overheating, the job is turned back to the radiator by lowering the air system thermostats and setting the fresh air preheat control (at the attic intake) to produce an acceptable ventilating air temperature from the air units, five to ten degrees lower than the room.

Since the maintenance of the system, including daily operation, is an important consideration, special attention has been given to working out physical arrangements for convenient and economical handling by the Seminary's engineering staff.

At each air-handling unit there is a small panel with return air temperature dial, discharge air temperature dial, and control air branch line pressure. This combination furnishes a concise picture of the local operation: the condition of the space, what the unit is supplying to maintain or rectify that condition, and the action of the control in response to that condition. In answering complaints, faulty operation is quickly detected and the cause more easily tracked down.

The operating panel in the basement refrigeration room contains, besides push buttons and summer-winter change-over switch, a pilot light for each remote unit, to show whether it is in operation. The air units can be operated from this master panel, or locally. Wiring and control diagrams hang at all locations. Thus, the starting and stopping of equipment, the checking of operations or control setting, and the change-over from refrigeration to cooling with outside air, are all accomplished with a minimum of effort and with awareness of the system's action.

The cooling plant has been designed to provide several steps of refrigeration under simple, foolproof control at this central panel. Thus, the library staff can turn on its own cooling and feel the response within five minutes, and it can use part or all of the conditioned space at any hour in full comfort. For the engineering staff, the designer took great pains to make every service point easily accessible and well illuminated.

Things We Have Learned

One cannot go through the experience of a complete air-conditioning installation without at least minor trials along the way. On the other hand, granted constant and sympathetic cooperation between designing engineer and library staff during the period of actual construction—in our case, February through June, 1956—the library can carry on normal operations without too much hardship for readers and staff. Here are some observations which may have value for those planning to air condition an existing library:

(1) At the start, with the assistance of the school administration, it is important to determine the physical scope of the projected installation. This is particularly so in the case of areas not now in library use which may be planned for future inclusion with those to receive the benefits of the air conditioning. It may not be feasible to include any substantial additional library areas at a later time unless such future areas are part of the original planning.

(2) Money should be spent to secure adequate analysis of the required installation and its approximate cost. A voluntary appraisal is not likely to provide sufficient data on so complex an undertaking. Included in the cost picture may well be factors "under the surface," such as added electric load, structural alterations to accommodate equipment, materials to mask installations and permit them to blend into existing decoration, and

other items which may not be immediately apparent.

(3) In apportioning total costs of a complex project such as Union's, it has been helpful to set aside a small "kitty" to cover such modifications as may be necessary after the main work is done.

(4) Unfortunately, major construction such as that undertaken at Union stirs up dirt and dust. Despite some care, a considerable amount of dust was deposited on the books, particularly in the bookstacks. Fortunately, this was coarse dust, which can be vacuumed off. Ideally, of course, normal operations should be suspended and all damageable items covered. Since at Union we had to maintain normal library service, such a course was impossible. We now feel, however, that more extensive use of dust walls and, perhaps, of transparent coverings, if only in areas adjacent to actual construction, would have minimized the undesirable effects and that the slight additional cost for such protection would in similar situations be more than justified.

(5) To minimize the intrusion of visible paraphernalia which would mar the appearance of the library, special attention was paid to concealing or masking necessary installations. The wood-paneled, vaulted ceiling of the Reference-Reading Room being of unusual beauty, the conditioned air was introduced through carefully designed diffusers whose wood bases were treated to blend with the original woodwork. Likewise, all ducts and duct openings which appear in public service areas were carefully planned so as to minimize their intrusive effect. Both by placement and by special attention to finishing, the results are such as to leave the average library user unaware that "something new has been added."

(6) By selecting equipment and designing ductwork conservatively, there is almost complete absence of machine noise. One is not conscious of mechanical activity. There is a relaxed atmosphere. However, with the shutting out of street noises, we have become very critical of inside noises and have decided to treat acoustically the supply mains.

(7) We believe it to be desirable for the designing engineer personally to carry through the actual supervision of the installation. Through such participation at Union, helpful relations with the contractors and subcontractors were maintained. The work was aggressively managed and closely controlled. The design received sympathetic handling, as did such modifications as were needed or were still worth reaching for during the course of the installation. This personal and experienced management helps to assure the buyer of full value for the high price he has to pay for a modern engineering installation.

(8) Finally, now that the job is substantially done, we are reminded that the optimum results from an air-conditioning system in our situation call for more than the proper functioning of a soundly conceived installation. We are very dependent upon a willingness on the part of the Seminary's engineering staff and Library staff to make free use of the highly flexible system of controls, so as to manipulate the operation to meet the usual variables of the weather. Therefore, an important consideration has been the gradual education of the Seminary's engineering and library staffs into the principles and intricacies of the system. At many stages of the installation, the supervising engineer took the initiative in orienting Seminary personnel. In addition, as physical arrangements for operation were concluded, detailed instructions were carefully prepared to augment the usual technical literature furnished by the equipment manufacturers. We realize that the new installation adds a highly specialized responsibility to the already heavy duties of the school's engineering staff. We know now that "education" has been a sound investment.