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# NATIONAL BENEFITS OF REHABILITATING EXISTING BUILDINGS

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The rehabilitation of urban buildings, largely composed of residential, office, and commercial space, is increasing. Rehabilitation, known also as repair and alteration or renovation, for nonresidential buildings, has grown from 13.5% in 1970 to 21.5% in 1975 and is projected to reach 24.8% this year. That will represent nearly $19.9 billion of construction this year.[1] The rehabilitation of residential property may reach 38% of the market, which accounts for an expenditure of $32 billion.[2] Thus, we will spend about $52 billion, about 32% of all construction dollars, on the rehabilitation of existing buildings. Of course, buildings that are recognized as historic would represent a small increment of this overall effort; nonetheless, this extensive effort results in recycling, that is, extending the life of existing building stock.

There have been studies that attempt to survey and compare the cost of rehabilitation with that of new construction.[3] Apparently, the cost of rehabilitation, like the cost for new construction, can vary widely according to the nature and scope of work included. It has been the goal of preservationists to establish that the rehabilitation of buildings will be a profitable enterprise. If profitability can be established, then presumably the quantity of rehabilitation projects will increase. Changes in the rate of amortization of depreciation expenses included in the Tax Reform Act of 1976[4] and the establishment of a solid market for rehabilitation have assured the increase of rehabilitation work.

Aside from profit or loss by the individual property owners, are there other benefits realized by the nation? The answer is yes. There are several positive attributes of the rehabilitation of buildings in our urban centers:

- general revitalization of the city
- increased property tax base and revenues
- support for the commercial business segment
- re-creation of community/neighborhood feelings in urban centers
- reduction of energy outlay resulting from fewer commuting workers
- increased use of neglected utility systems
- feelings of identity and pride of ownership

Some disadvantages include

- displacement of low income persons
- increased demand for city services (police, fire, etc.)

In addition to the attributes that have a localized effect, there are two other contributions that have a national impact. First, rehabilitation projects are heavily labor intensive, often 75% of the dollars expended are for labor costs. New construction is usually about 50% labor and 50% materials.

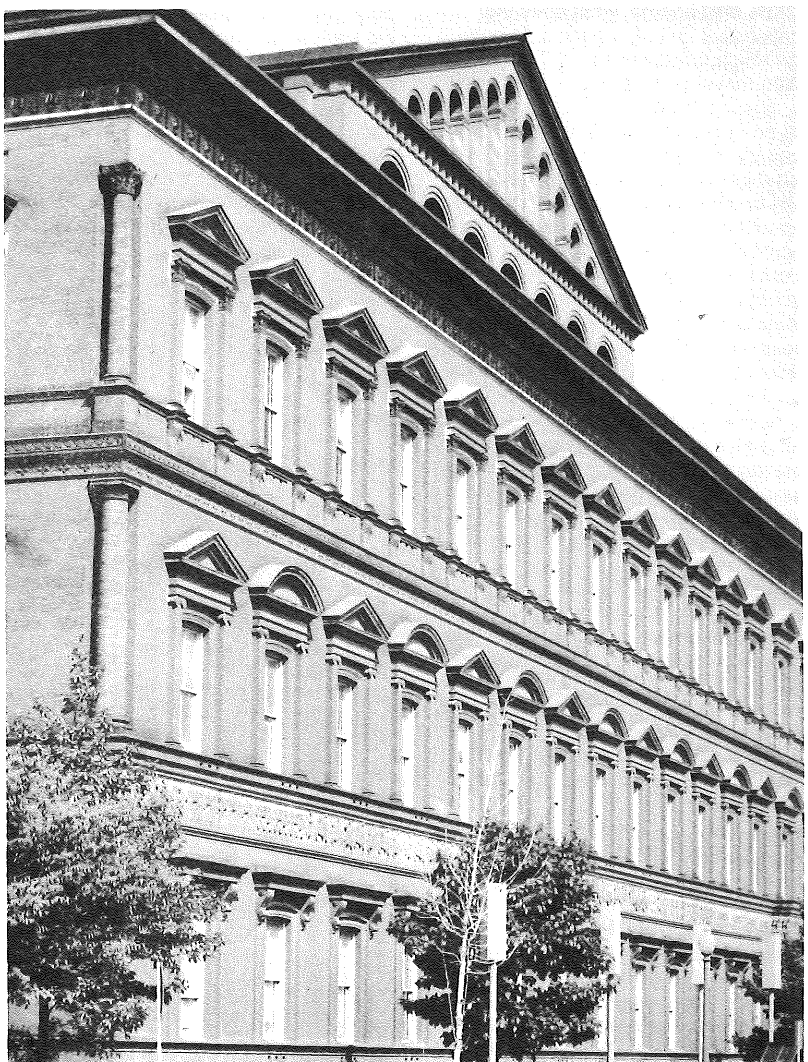

Photo: Baird Smith

*New information points out that certain old buildings, like the Old Pension Building, Washington, DC, require less energy to heat and cool than typical modern buildings.*

That means for money invested in rehabilitation, the greatest part of it goes directly into the local economy to support commerce and increase employment. This is a recognized spin-off value of rehabilitation, which certainly has a positive national impact.

The second major national contribution of the rehabilitation movement may be in energy conservation. As with many aspects of energy research and energy consumption, we are just beginning to discover information about energy use patterns. There is little doubt that a large amount of energy is consumed to build, rehabilitate, and operate all the buildings in the country. An important recent study prepared for the Energy Research and Development Administration (ERDA) has investigated the amount of energy needed to build new buildings and the amount necessary to rehabilitate existing ones. The report is *Energy Use for Building Construction* by Richard G. Stein and Associates, Architects, and the Energy Research Group, Center for Advanced Computation, University of Illinois at Champaign-Urbana.[5] The study surveyed all publicly advertized new construction and rehabilitation work for a base year (1967) in the United States to measure how many BTU's of energy is taken, on a square-foot basis, to extract, manufacture, deliver, and install all building materials, such as lumber, brick, and concrete. The researchers determined that it took **23% less energy** to rehabilitate existing buildings. Specifically, it took an average of 49,900 BTU's/sq. ft. to rehabilitate as opposed to 65,200 BTU's/sq. ft. to build anew.[6] This included all building types—residential, office, commercial, and industrial. (Farm buildings, highways, sewer lines, and other similar non-building construction is excluded from both categories.) This lower energy consumption can be attributed to the fact that most of the structural systems and building materials were in place and reuseable in the rehabilitation project.

On the national scale, how much energy is saved through these rehabilitation projects? In other words, if rehabilitation consumes 23% less energy, what does that mean nationally? One approach is to compute how much energy is saved if the rehabilitation movement increases at its present rate, about 1.4% per year, when compared to no increase. That is to say, how much energy would be saved, in say 1982, if the rehabilitation movement increased from 32% to 39% of the construction market, with a resulting decrease in the amount of new construction. (This estimate uses the same dollar expenditure for construction as is projected for 1977. Of course, the dollars spent in construction could either increase or decrease in 1982.) The savings in energy would equal 30 million barrels of crude oil for the year. That is enough to provide all the energy needed for about 800,000 households for the year. This savings results if the rehabilitation movement increases in activity at its current rate. If it were to increase even faster the savings of energy would be directly proportional. That is, if it were to increase its share of the market from 39% to 46% (reflecting an annual growth of 2.8%) there would be a resultant savings of 60 million barrels of crude oil, enough to provide the total energy needs for 1.6 million homes for a year.

The rehabilitation of existing buildings has not only localized impact but also national impact. There can be little question that this movement encompasses the following positive attributes:

- The labor intensive nature of rehabilitation provides important support for the national economy and increases employment.
- Rehabilitation of more existing buildings will result in the nationwide conservation of energy if there is a comparative decrease in new construction.
- Rehabilitation of existing buildings will also improve their energy-using characteristics and provide additional long term energy savings when compared to an existing building in which there is no rehabilitation.

How important is it to make existing buildings more energy efficient? Since it takes nearly a third of the total energy used in this country to operate residential and commercial buildings, any effort to reduce the usage will have a direct impact on lowering energy consumption for the entire country. In order to reduce energy consumption, one needs to understand how energy is used in these buildings. On the average, it takes 53% of the total energy to heat the buildings, 12% to provide hot water, 8% for air conditioning, 5% for lighting, and the remaining 15% for cooking, refrigeration, and other miscellaneous items.[7]

How do historic buildings fit into this picture, and can we make any generalizations about energy usage in these older buildings? It may be a recognized fact that old buildings are deficient with regard to meeting modern health, safety and general welfare standards; however, important new evidence would suggest that certain old buildings may be excellent energy conservers requiring only changes in building operation and minor physical alterations.[8]

This evidence is reported in an important research report prepared for ERDA *Energy Conservation in Existing Office Buildings*, written by Syska and Hennessy and the Tishman Research Corporation, both of New York City.[9] The research involved contacting the owners of over 1,000 office buildings in New York, from which 436 were selected for further investigation based on such criteria as 1) willingness to cooperate with the study, and 2) existence of complete financial records covering fuel and energy expenditures for the 5-year period 1970–1975. From this building subpopulation, 44 sample buildings were chosen for an indepth analysis of the energy consumption. The consumption was measured by evaluating money expended for utilities (electricity, fuel oil, coal, etc.) through the 5-year period.

After analyzing the data, the researchers found that energy usage had dropped about 12% after the oil embargo of 1973. Interviews with the owners determined that simple operational controls such as fewer hours of operation, lowering the thermostats in winter, and turning off lights accounted for the reduction. There was little evidence of analytical approaches or any quantitative knowledge of energy usage in the buildings. Nevertheless, there was a substantial drop in the energy consumption.

The report studied several aspects of the energy usage in these buildings. The most important, relative to historic buildings, were the results of analyzing the age of buildings to determine energy use. When building age and energy use per square foot of space were compared, the report found that the *oldest* buildings used the *least* energy. The following table indicates this comparison.[10]

| **Dates** | **No. of Bldgs.** | **% of Bldgs.** | **% of Area** | **Energy Consumption Range (1000's of BTU's/sq.ft.)** | **Average Consumption (1000's of BTU's/sq. ft.)** |
|---|---|---|---|---|---|
| Before 1900 | 3 | 6.8 | 1.1 | 83-115 | 95 |
| 1901–1919 | 8 | 18.2 | 12.8 | 76-135 | 105 |
| 1920–1940 | 18 | 40.9 | 28.3 | 68-223 | 109 |
| 1941–1962 | 12 | 27.3 | 36.2 | 66-198 | 126 |
| 1962–1970 | 3 | 6.8 | 21.6 | 78-163 | 115 |

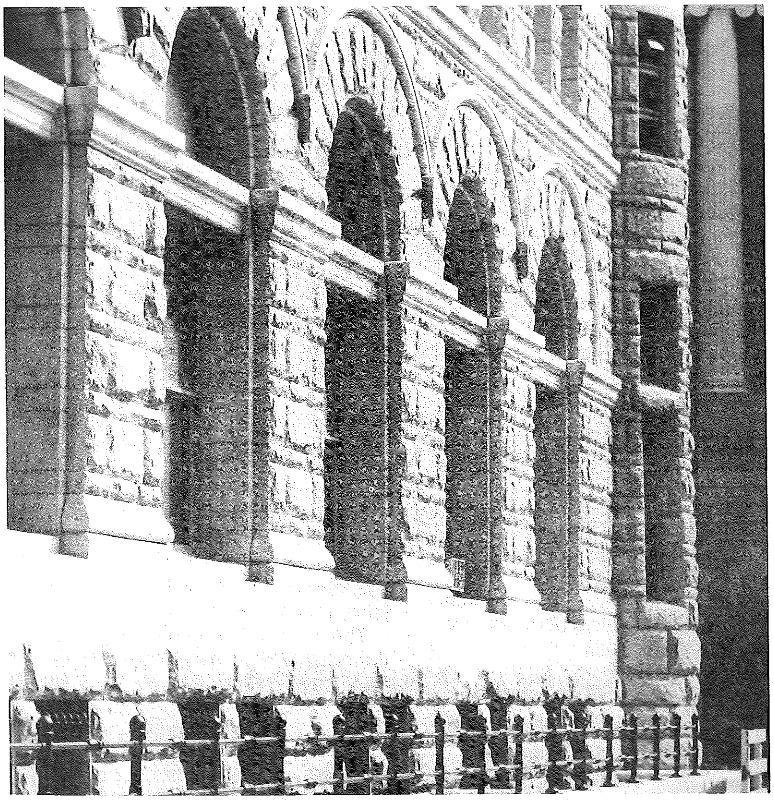

Photo: Baird Smith

*Here, the heavy granite walls at the base of the Old Post Office Building in Washington, DC, show how the wall mass (over 5 feet thick) modifies the thermal resistance (R factor) of the wall, lengthening the time that heat is transmitted from the exterior wall surface into the building.*

The results clearly show that the oldest buildings, those built before 1900, used only 95,000 BTU's/sq. ft. per year, whereas those built after 1941 consume the most energy. It is not surprising that the newer buildings, often characterized as glass boxes, were found to consume the most energy.

Some of the physical characteristics of the buildings and the various mechanical systems used are quite interesting.[11] For instance, the average building area was over 300,000 square feet and the buildings averaged over 1000 occupants. Nearly three fourths of the buildings had cavity wall construction and only 2% used doubled-paned glass. Additionally, over 60% of the buildings were heated with radiators, with only 13% having fan coil units.

The results of this study are impressive. They point out that old buildings use less energy than newer ones. But what does this really mean, and why did these old buildings use less energy? Apparently, the answer can be attributed to two principal characteristics of these buildings. First, the buildings were heated and cooled by an accumulation of outdated mechanical equipment which probably provides a level of comfort below that which is provided in most new construction. The buildings may have been cooler in the winter, hotter in the summer, and had a lower level of light. Fortunately, this is the goal of most energy conservation programs since it has been established that many of the comfort levels established for new construction are too high and waste energy. Thus, it would seem that the type of mechanical equipment existing in these buildings, and the lower comfort level provided, partially contributed to the lower energy usage.

The second important physical characteristic that resulted in these buildings using less energy relates to the older types of building construction. The following characteristics, typical of old buildings, apparently contribute to the lower use of energy in both heating and cooling cycles.[12]

- **Wall Mass** It has been determined that existing walls of large mass (thick brick or stone) have the advantage of "high thermal inertia." This inertia modifies the thermal resistance (R factor) of the wall by lengthening the time scale of heat transmission. For instance, a wall of high thermal inertia, subjected to solar radiation for an hour, will absorb the heat at its outside surface, but transfer it to the interior over a period as long as 6 hours. Conversely, a wall having the same R factor, but low thermal inertia, will transfer the heat in perhaps 2 hours.
- **Ratio of Glass to Wall** Old buildings which have low ratio of glass to wall, less than 20%, will be better energy conservers than buildings with high glass-to-wall ratios because windows are a principal source of heat loss and gain.
- **Operable Windows** The fact that most old buildings have operable windows will result in measurable energy savings because the fresh outside air is readily available during mild months so that energy consuming heating and cooling systems will not have to be operated.
- **Cavity Wall Construction** The presence of cavities in most masonry and wooden construction in old buildings provides a definite increase in the thermal resistance of the wall and increases the positive benefits of thermal inertia.

The two new reports cited above help to establish important points about energy conservation in historic buildings. First, that any efforts which will increase the quantity of buildings that are rehabilitated and reduce the quantity of new construction, will provide an important conservation of our national energy resources. Second, new evidence points out that many existing buildings may already exhibit excellent thermal characteristics and low energy consumption. It would seem, therefore, that a thorough understanding of the thermal characteristics of a building and a better understanding of the performance of existing mechanical equipment is necessary before unnecessary renovation (up-grading) efforts are undertaken. Information seems to indicate that old mechanical equipment and the existing physical characteristics of many old buildings may already achieve the required savings in energy usage. Thus, the conclusion seems to be that conserving our cultural and historic resources also results in the conservation of our national energy resources, both in terms of the energy saved in rehabilitation versus new construction, and in the inherent savings in energy due to the greater thermal efficiency of older buildings.●

Photo: Baird Smith

*Windows are a principal source of heat loss and gain because glass has little thermal resistance. The side walls of the Old Post Office Building comprise about 20% window area, thus, this building would use less energy than most modern buildings where the percentage of window area can approach 100%.*

Photo: Baird Smith

*Most old buildings have operable windows, resulting in measurable energy savings because the fresh air from outside is readily available during mild months. Therefore, energy-consuming heating and cooling systems will not need to be operated.*


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