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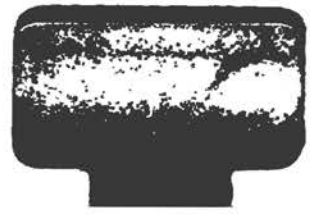

PERFORMANCE OF BUILDINGS

Proceedings of a conference held as part of
the 1960 Spring Conferences of the
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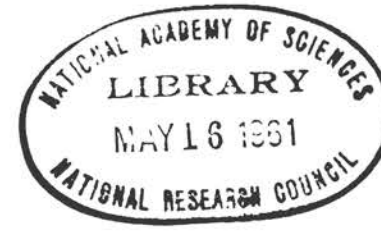

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The Building Research Institute gratefully acknowledges the contributions to building science made by the participants in this conference.

Milton C. Coon, Jr.
MILTON C. COON, JR.
BRI Executive Director

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Abstracts of Conference Papers

PERFORMANCE INFORMATION NEEDED BY THE ARCHITECT
By Ralph T. Walker, Voorhees Walker Smith Smith & Haines

The importance of maintenance to the life of any building is discussed as a major factor contributing to good performance. The need for continually updating building standards is also stressed, to enable the owner to save on excessive maintenance costs. Use of check lists to determine clients' preferences both in terms of building and of building site is noted, and the need for full understanding between all parties involved during the design stage of the building, rather than after it is completed.

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PERFORMANCE INFORMATION NEEDED BY THE CONTRACTOR
By Charles F. Dalton, John Lowry, Inc.

Methods of selecting a contractor are discussed with importance laid on his full participation in the selection of materials and development of costs. Stating that the mechanical work in the modern multistory building averages about 40% of the total cost, the author emphasizes the need for proper planning of space for its installation and future maintenance. The timing of the construction schedule in accordance with advice from the contractor, and the advisability of supervision by the architect and the owner are also discussed. Need for changes in present procedures as regards the lump sum bid are noted.

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PERFORMANCE INFORMATION NEEDED BY THE PRODUCT MANUFACTURER
By C. F. Rassweiler, Johns-Manville Sales Corp.

Careful and accurate analysis of the need for, and the type of service expected from building materials are stated as necessary before the material or product manufacturer can be expected to satisfy both conditions. Methods used by the Armed Services in providing suppliers with such information are cited as being thorough, and are recommended to the building industry for study. The need for collaboration of the architect, engineer, contractor, product manufacturer and owner to solve problems of communication is stressed. Basic principles of new product development are outlined, with attention called to the fact that the often tremendous expense involved makes it mandatory that the manufacturer know in advance that the market for a product will be at least as great as that for the product to be replaced. Citing a leaking roof as an example, the author points out that the manufacturer needs specific information as to all circumstances concerning the installation of

the roof and its subsequent maintenance, before he can make improvements in any product used in roofing, and he urges development of such information and its transmission to the manufacturer. Such information should then be evaluated in terms of how much the building owner would be willing to add to the first cost of his building, in order to build it with materials giving longer life and lower maintenance cost.

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COMMERCIAL OFFICE BUILDINGS
By G. R. Bailey, George R. Bailey & Co., F. L. Gilbert, Philadelphia National Bank, and H. W. Wilds, New York Life Insurance Co.

A three-part discussion among owners of large commercial office buildings, this report details a number of the problems faced by owners in the maintenance of their properties. It is urged that maintenance problems and costs be considered at the design stages of the building, and that the prospective manager or operator of the building be consulted at this stage, rather than after the building is completed. Details of difficulties encountered with such items as method of drive for cooling tower fans, chilled water and condensate pumps, zoning of air conditioning and heating, etc. are discussed. Methods used by the Natl. Assn. of Building Owners and Managers to assemble building performance information are described, as well as its service in terms of a review of preliminary plans for a building and recommendations with respect to the over-all economics of renting, maintaining and operating the proposed structure. Principles of preventive design which would help to eliminate subsequent corrective procedures are stated.

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INDUSTRIAL BUILDINGS
By Robert F. McCaw, Power Engineering Magazine

This paper reports on the results of a questionnaire sent out to owners of industrial buildings to ascertain their maintenance and operating problems, and the extent of uniformity in these. Questionnaire dealt with six selected building components: roofs, walls, floors, plumbing, electrical system, and heating-ventilating-air conditioning system. Results of the survey are discussed, and a tabulation of responses is included as an appendix to the paper.

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RESIDENTIAL BUILDINGS
By Ralph W. Boone, The Dow Chemical Co., and James J. Boyle, New York Life Insurance Co.

A summary report is given of responses to a questionnaire circulated to a number of large residential development owners, covering in some detail the components of residential multifamily buildings, both garden apartments and multistory. Owners were requested to report both failures and extraordinary performance, and to try to assess causes for both within the classifications of: research, manufacture, design, construction, maintenance, and construction economies. A second survey on single family houses, undertaken with the cooperation of members of the Society of Residential Appraisers, is also summarized. In this case, information was requested on three general areas of the residence: foundations, basements and slab-on-grade construction; the house shell; and mechanical equipment. Respondents were asked to consider these areas individually with respect to their contribution to maintenance and operation problems, and to relate, where possible, one or more

suggested solutions to the problem from a list of seven solutions provided. Detailed conclusions are drawn from the responses, and a tabulation of results is included as an appendix to the paper, as well as a selected list of comments made by the appraisers.

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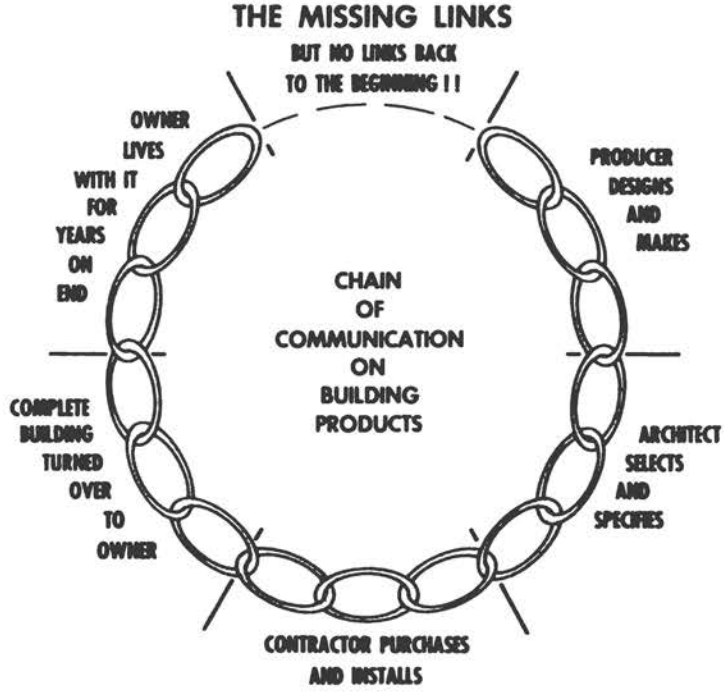
INSTITUTIONAL BUILDINGS
By Fred J. Hildebrandt, Harley, Ellington & Day, Inc.

Report is made on a survey conducted among schools, colleges, universities and hospitals. Responses were received from 32 organizations in 19 states representing all areas of the country, with about 60% of the respondents being those who operate a number of such buildings, including General Services Administration, the Navy, and the Veterans Administration. Questions dealt with architectural and structural considerations, mechanical equipment and electrical systems. A list of ten conclusions and recommendations resulting from the responses is presented.

Introduction

By Howard E. Phillips,* Building Engineer
American Telephone & Telegraph Co.

Nearly $20 billion are spent each year in the U. S. for maintenance and repair of structures —that's more than a third of the amount we spend for all new construction in this country each year. These figures are from the U. S. Department of Commerce, and they do not include the house service costs (such items as sweeping the floors, cleaning the windows, washing the walls, providing heat, light, etc.). If you added these cost items to the operating cost of the buildings, the total would probably approach the $54 billions we spent last year on new construction.



*PHILLIPS, HOWARD E., degrees in engineering and architectural engineering from University of Illinois— post-graduate work at University of Louisville, George Washington and Columbia Universities— Member of American Institute of Architects, American Society of Civil Engineers, and Chairman of Building Operation and Maintenance Study Group of Building Research Institute— served with U. S. Army Engineers before joining AT&T.

When you consider that the amount of money we spend to maintain and operate buildings is almost equal to the amount we spend for new construction, then you realize the importance of devising ways to improve the performance of buildings.

This Workshop on Performance of Buildings is the second workshop-conference our Study Group in BRI has held on building performance. In the year 1959 we held a workshop-conference on windows as an experiment, to try to obtain performance data on a building element. We have planned this conference to analyze the entire building, to get over-all performance-in-service information and to find out the most important problems of the building owners and operators.

The objective of our Study Group is "to establish a channel of feed-back communication from building owners and operators, whereby information on performance and upkeep of buildings and building components can be made available to architects, builders, manufacturers and building research groups." The chart on page 1 illustrated this objective. It shows how the manufacturer designs and makes the building product, the architect selects and specifies it, the contractor purchases and installs it, the complete building is turned over to the owner and he lives with it for years on end, but there are no links back to the beginning--there is no channel to feed back data on performance-in-service from the owners to the producers, architects and builders so that any problems can be corrected in new construction.

Papers and discussions at this conference will present many of the problems of the building owners as a means of clarifying their nature, and will challenge architects, builders, building product manufacturers and building research people to develop solutions. In addition to the printed proceedings, BRI will have on file in Washington copies of all of the completed questionnaires, survey forms, etc., used to form the basis for the reports presented by the participants in this conference. These will be available to all BRI members who may wish to investigate further specific items.

We hope that this workshop-conference will highlight some of the major problem areas, so that more detailed studies can be made by other groups on those of the greatest magnitude and importance to the owners and operators of buildings.

PERFORMANCE INFORMATION NEEDED

Chairman - Howard E. Phillips
Building Engineer
American Telephone & Telegraph Co.

Performance Information Needed by the Architect

By Ralph T. Walker, * Consultant to
Voorhees Walker Smith Smith & Haines, Architects

In 1940, when our firm was designing a series of air bases in the West Indies, we were suddenly confronted with former President F. D. Roosevelt's idea that the design should be such that the structures would only last 25 years. I asked the Colonel in charge when the President expected the lack of maintenance in Government work to catch up with his idea of time. It is obvious that even a very shoddy material with good maintenance will outlast an excellent one which receives none whatsoever.

Those of you who travel much will recognize that ships like the "Queen Mary, " for example, from the moment they make the tidal waves in their launching on the Clyde are not only constantly repainted but are in constant repair, and even with this regular attention, the "Queen Mary" and "Queen Elizabeth" have not more than 25 years in active duty. Very few building owners, however, have this concept about a building. There is a strange idea in almost everybody's mind that a new building should somehow or other take care of itself, with the result that suddenly the maintenance engineer is confronted with a sizable amount of the work to be done. Of course, good owners maintain their buildings adequately. One such owner, a client of mine, is the Irving Trust Company. Their building at No. 1 Wall Street, finished in 1930, still looks, in most of its public rooms and corridors, as if it were finished but yesterday.

I, myself, have lived in one house for nearly 40 years and know there are yearly replacements, yearly repairs and yearly painting to be done. Our heating system, however, is 25 years old, and more miraculous, a kitchen window ventilating fan which was installed in 1926 is still functioning. The grave question is will they, like the deacon's one-horse shay, suddenly fall apart leaving us freezing on some low degree day, and with noses plugged with kitchen odors. On the other hand, I am sure you do not believe all mechanical equipment is perfect.

My theme is — no matter how well you build, and there is no reason why you should not build as well as you can, you will have to maintain buildings in repair from the moment they are built. The weather is no respecter of architects, engineers or owners; the heat

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*WALKER, RALPH T., studied architecture at Massachusetts Institute of Technology; Member of American Institute of Architects (Fellow), National Academy of Design, Royal Institute of British Architects, Philippine Institute of Architects; 33rd holder of the Rotch Travelling Scholarship, winner of the AIA Centennial Medal.

expands, the cold contracts and the dirt of our modern society throws its film of grease and dust over smooth and textured surfaces alike.

As a whole, I like engineers as clients, provided they are reasonable men who do not think a standard is so precious that it will last forever. I once said that we should take out a standard every five years and shake it out to see what moths may be hidden within it. We live in a world of constant change and a standard five years old may be as obsolete as the pyramids at the present time. Still, within the minds and hearts of men, there are the same desires. The human eyes, the human nose and the precious ears, which are much too often offended these days, are the same which enabled the Greeks and the Japanese to achieve beauty. We might try to achieve the ability to live in quiet and in enlivening circumstances.

The first things we might ask of a client are: How do you want to live in the place we are designing for you? Are you sensitive to form and color? Are you desirous of what we used to call "Child's Restaurant antisepsis?" What do you think modern electrical appliances may accomplish in establishing for you a life of more emotional depth?

Years ago I helped the New York Telephone Company set up a technical committee to review its building standards, and at that time protested at the use of the word, "standard", because it seems to suggest that a standard is something which, having once been tried and found successful, should maintain itself indefinitely. We had one such standard in review, one which had been developed at the beginning of the century and caused one stumble after another—a toilet room floor raised just one step above the floor level to which it was attached. It was not only costly but stupid, especially so where the high ceiling of the normal telephone exchange building permitted the use of the hung ceiling. In changing this, the result achieved was that instead of a relatively small area of tile surface and an enormous amount of plaster walls requiring constant repainting, there was the same amount of tile surface and only a ceiling to be painted, because the ceiling was placed just above the tile.

The problem is, of course, one which falls into two phases: 1) how do you build to save excessive maintenance, and 2) have you enough money to do it? It is said of architects that they are always somewhat extravagant and would like to take possession of a client's pocketbook. In contrast, I have had a client tell me that the building must not only be cheap but must look cheap as well. There are many sad sides to this cheap building, inasmuch as the cost to maintain it is one which is almost in geometrical progression into an immediate future obsolescence.

Now we come to a point in connection with building which has caused me a great deal of concern. In my brief lifetime, in persisting in an attempt to satisfy "ornery" clients with their strong whims and even stronger prejudices, I have found the cost of building in the past 50 years or more has risen (except at the time of the great depression) in an almost constant upward curve. At times it has risen so precipitously that it would seem impossible to anticipate a platform of reasonable costs, or those that are stable enough to endure from the period of design into the actual time of building, to the effect that regardless of how cheap the building might be it will eventually cost more to build and to maintain.

Perhaps the standards of cleanliness are more potent in these times than they were years ago. We seem willing to clean endlessly glass walls which, unless washed, are murky indeed and so lose a great deal of their effectiveness. We seem willing to clean endless corridors of walls which do not give sufficient borrowed light to warrant their cost, which

afford little privacy to the life of the executive and which, acoustically, spill the secrets of private lives as well as those of business.

What the client is looking for has many times caused me a great deal of concern. Sometimes he seems merely to be seeking the straight delight of praise of his building in Fortune Magazine, this delight being thought of as an acknowledgment of a fashion which, like the wind, is gone in a seven-day wonder.

In recent times, in our office, we have prepared many kinds of questionnaires and check lists which we have presented to clients to ascertain the client's preference rather than his prejudices. We once received a letter from a very satisfied client which said: "We are grateful because you gave us what we needed and not what we wanted." We are not using these lists to the same extent as heretofore, because we found there was a tendency to close off discussions and to create prejudices rather than preferences. The most successful of these check lists have been related to the purchase of sites, which too often are bought with more enthusiasm than judgment, and this is especially true of sites in rural areas surrounding our major cities. We have always believed that the client and the architect, and the engineers who design water and sewage disposal plants, should together examine a site before it is purchased. There are many times when the architect's experience with relating the cost of building to site would be exceptionally good for the client to have, and this is also true of the advice given by the sanitary engineer. I am not forgetting the many social problems inherent in moving office personnel into new and strange surroundings.

We have found that, if a client has built and operated many buildings, he will have an operations manager who has many ideas about building and material performances. They are generally worth looking into, but they are also always worthy of some further discussion rather than mere acceptance. It is not unreasonable to ask a client, or one of the client's engineers, to visit several of the more recently erected buildings of a similar character to the one proposed, so as to find out from the men who are operating these buildings whether certain ideas have proved as successful as expected when incorporated in the original design.

As I said before, we must realize that we are in a world of changing patterns and techniques, and that either a successful method or failure, once accomplished, does not necessarily guarantee that a repetition will furnish the same results. It seems to me that a repeat should only be accepted after further investigation.

The contractor who has been painting my house bemoans the fact that lead and oil and casein bases are disappearing from the local market; that roller-applied paint needs a different character of base and therefore is supplanting something everybody thought most desirable heretofore. Is he just being old fashioned, old hat, or is he wishing for the tried and the well-worn, or is he protesting the roller?

Probably one of the things that the architect needs most from his client is a realization that a building is not built without some worry and concern, and that it is better to be critical, extremely so, during the design stage than after the building is completed. This critical attitude does not in any way demean the prestige of either party, nor the architect's position as an artist. In our office, we have always tried to have the client, the architect and the builder join in a series of conferences in which materials, their costs and their performances are discussed thoroughly. This should give the client the best results in the long run.

I said I like clients who are engineers, and largely because of the fact that the experiences of the architect and engineer are quite similar in character. Also, if I may say so, I shy away from a client who is building for the first time—I have lost many friends that way. Of course, what all architects would like to have is a client with sufficient money to do a substantial and at the same time a forward-looking building, because the architect is desirous of adding to his reputation as well as performing a service for the client.

Inasmuch as this brief paper has not been specific, I would like to suggest that it would be very difficult to be specific without getting into endless discussion as to the practical and aesthetic value of certain materials. A survey of conditions which exist at the time the building is being designed is probably the most desirable factor in practically guaranteeing its success.

Performance Information Needed by the Contractor

By Charles F. Dalton, * Vice President
John Lowry, Inc.

In preparing this paper, I gave a great deal of thought to the phrase "the performance of buildings." I went back over the history of several of the buildings I have been connected with in past years and have found, in most cases, when the building is completed, and the contractor's work has been accepted by the architect and owner, the owner moves in, occupies the building, and puts it to the use for which it has been built. All parties shake hands, give a great sigh of relief and start off about their normal business--the architect and builder to other buildings, the owner to business as usual. Unless there has been some outstanding defect in the workmanship or material in the building, that is the last the builder hears except for a casual comment from the owner in a chance meeting.

Information, coordination and decision are three words that have a powerful meaning in the construction of a building. The original decisions or selections made by the owner are of prime importance in the success of any building. First, he must select a capable architect, and next a capable contractor. There are several methods of doing this. First, when the architect completes plans and specifications they can be issued to the contractors promiscuously and anyone who cares to can figure the job. This usually results in a long list of bidders and you take the risk of choosing either an inexperienced contractor or one who makes an estimating error in trying to get the job. A second method is to have a selected list of qualified contractors agreed upon by the architect and owner from whom bids are taken based on completed plans and specifications. In both cases the contractor is expected to follow precisely the plans and specifications, and his suggestions for improvements are generally not required.

A third method of selecting a contractor is on a negotiated basis. With this method, the contractor is made a part of the team of owner, architect and contractor, and becomes a responsible party in making major decisions. He can and should sit in with the architect on the selection of materials and the development of costs. A negotiated contract can be awarded on a lump sum, fixed fee or percentage basis, whichever is best for the particular building program involved. If the contract is awarded on a negotiated basis the owner, without incurring extra costs in most cases, has the contractor's staff available for consultation with the architect during the development of the plans.

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*DALTON, CHARLES F., Member of New York Building Congress; associated with this firm of building contractors since 1934.

During the development stage by the architect, the owner or building operator should supply any information he has on existing buildings, and this information should come from a studied program and not from a last-minute, cursory inspection, and especially not from the method used by a vast number of building owners. This method consists of calling in the building superintendent and depending on his memory or pet peeves to prepare a report for all to be guided by. This so-called method wastes a lot of valuable time and is usually based on the particular superintendent's likes or dislikes, seldom on facts. A manufacturing concern maintains all types of records regarding the operation, maintenance and service of equipment, but if the roof leaks, either the service department patches it or a roofing contractor is called in, and the only record kept is in the accounting department, reading, "Roof repaired, X number of dollars." Except in rare cases, the construction of a building is a major operation for any company, and very often consumes a lot of the time of top executives, people who are undoubtedly able to make decisions regarding finances, size of buildings, location, etc., but generally have very little information regarding everyday maintenance problems, except for the cost involved.

It is strange how many people forget the meaning of the word "teamwork" as soon as they step outside the sports arena, or, if they do remember it, they think it applies only to their business. A building being erected for an owner is most certainly his business. It is essential that the architect and contractor have the utmost confidence in each other, and the owner should have confidence in both of them. If a team is based on one strong player, it gives him an extra heavy load to carry, and this type of team finds it difficult to win when the going gets tough. When one of the members of the team decides to play the part of the prima donna, it usually results in the other two parties gathering their forces to knock him off his high perch, rather than concentrating on the proper development of the building. Each member of the team should play his position to the best of his ability, but he should not try to play the other positions.

I believe that some of the best examples of teamwork have been exhibited in the skyscrapers of New York. The Time and Life Building, on which we were joint venturers with another contractor, is an outstanding example. Not only is the contract on a joint venture basis, but two interests, Rockefeller Center, Inc., and Time, Inc., own the building. Both of the owners have had a vast amount of experience in the building field which, despite the ability and willingness of the architects, engineers and contractors, may be one of the important factors in having the team function efficiently.

Now that the team of owner, architect and contractor has been properly organized and the design work well under way, let's turn to the basic function of the contractor, which is to deliver the building as it has been conceived by the owner and developed by the architect.

The erection of a building is a logistical problem. It is a problem not only dealing with materials and their delivery, but also the dissemination of information in the form of drawings, specifications, schedules, etc. Information must be furnished to subcontractors and material suppliers on time. It must be coordinated between subcontractors and material suppliers in the form of shop drawings and schedules. Late information, usually resulting from indecision, very often leads to a compromise in order to keep the building on schedule. A compromise is more often than not unsatisfactory, and adds substantially to maintenance and repair bills after the building is completed. A man in a sales or service department is very conscious of such terms as "lead time" and "deadlines" in his own business, but it is very difficult to impress upon him that the same type of scheduling applies to the construction of his building. As an example, an architect may be able to get the owner to agree on the type of doors to be used, but it is difficult to explain that

this information is not complete until the hardware has been selected and that, as incomplete information, it is not much use to the contractor. Therefore, information in the right place, and at the right time, is one of the first orders of business and, if properly accomplished, removes a lot of the pressure in scheduling materials to the job site.

Although the selection of materials is an architect's function, very often the cost or availability of the material is unknown to the architect or owner. One way of getting the information is simply to call the supplier. However, as the purchasing of materials is the contractor's responsibility, he is often in a better position to get the correct information. I have found too many suppliers quoting prices without regard for the other work that may be affected, or without regard for trade union jurisdiction. As a typical example of this, when luminous type ceilings were fairly new, an owner for whom we were working wanted to install some hung ceilings. We quoted prices on several types and, after review by the architect, the information was forwarded to the owner. A few days later we got a call in which the owner said, "I have found a hung ceiling much better and a lot cheaper than the types you have suggested. Call so-and-so of such-and-such company, as he gave me a price of $2.00 a square yard." When we called the firm in question, we found that their price was for furnishing and installing the material. However, they would take no responsibility for the cost of the installation, only for the material delivered to the job, and even at that, the price was based on stock sizes, without regard for whether they could be used on this particular job. The net result was that the $2.00 a square yard quoted was hardly sufficient to cover the cost of one square foot. If the product manufacturer is going to quote prices installed, he should spend some time to determine the correct price for the area in which he is selling. He should also try to determine which trade or how many trades will handle his product in order to avoid jurisdictional disputes at the site. These disputes are very costly and time-consuming.

Workmanship requires the constant vigilance of the contractor, both at the job site and in the shops where materials are being fabricated. I believe that the majority of mechanics want to deliver a first-class product and have pride in being able to do better than average work. It is the occasional sloppy workman that the contractor is looking for, as he is the trouble maker. It takes but one poor bricklayer to cause trouble on an entire wall. If his joints are not slushed in properly, they will be a constant source of leaks which are difficult to find after the building is completed. Manufacturers of building materials spend vast amounts of money developing better products. They then deliver this material to an agent, subcontractor, or dealer, who, through lack of actual knowledge of good workmanship, will install the material improperly, resulting in a bad reputation for the material and its manufacturer.

The amount of mechanical work including heating, ventilating, air conditioning, electrical work, plumbing, sprinklers and elevators, in a modern multi-story building will average about 40% of the total cost of the entire building, and very often, will use a substantial portion of the area on each floor for shafts, closets, fan room, etc. The finished floor to finished floor heights are often determined by the air conditioning ducts in the ceiling and the electric ducts in the floor fill, or by the size of equipment in a fan room.

Because of the phenomenal growth in the use of air conditioning and electrical work in modern building, a real shortage of able journeymen mechanics has developed which will slow down a normal building schedule if proper precautions are not taken. The normal precautions are to award the subcontracts in the very early stages of the job, push the approval of shop drawings, expedite the delivery of equipment and keep a reasonable space available for the installation of material as it arrives on the job. If the workmen lose time

because of slow deliveries or because of the lack of space to work, they will leave the project. If your job gets the reputation of starting and stopping, it is almost impossible to keep it manned with any sort of mechanics, and especially in trades where there is a scarcity.

The mechanical work in a building encompasses, if not all, certainly the vast majority of the moving parts in a building. These are the working parts of a building and they require constant maintenance by trained personnel. They are usually the parts that wear out or become obsolete first. They are also the parts that the average owner knows least about. I have attended job meetings where all present are experts in every trade until one of the mechanical trades is mentioned, then all eyes are focused on the mechanical engineer for his words of wisdom, which he usually delivers to an audience that is aware only of the fact that he is speaking English.

The owner's maintenance or operating engineer should be selected because of his knowledge of the equipment being installed. He should be fully familiar with all operating parts of the equipment together with the location and use of all controls, alarms, valves, etc., and he should be on the job long before the work is finished in order to have first-hand knowledge of all the systems. Although the average contractor or subcontractor should expect a certain number of calls from the maintenance engineer, he should know his equipment in case emergency repairs are necessary.

Whether provided by a subcontractor or the general contractor, safe working conditions for each workman on the job are the responsibility of the general contractor. The loss of a life or the maiming of a workman because of unsafe working conditions goes far beyond the monetary value that insurance companies or the courts place on such accidents. The extent of its effect is difficult to estimate except where it shows in the increased insurance rates. Work in the construction industry has its hazards and speed, possibly, is the greatest cause of accidents. Therefore, where an unusually fast schedule must be maintained, extra precautions should be used for the safety of the workmen, including, if necessary, special personnel to provide and inspect the working areas for safety. Very often the boss himself presents the greatest hazard by insisting on riding the hod-hoist, refusing to wear a hard hat, or generally disobeying every safety rule simply to show he is not afraid to take chances.

The cost of construction work has increased between 100% to 150% since 1945, depending on which cost index you refer to and the type of information used to prepare the index. A large part of this percentage has been due to the increased cost of labor and materials, which has kept pace with the general inflation of the country, but the part that has been due to better buildings is very seldom mentioned. As I have said before, the mechanical work has increased in scope. Instead of a few, poorly ventilated toilet rooms, the modern building's toilet rooms are often a thing of beauty; the heating system has become an air conditioning system for year-round comfort instead of simply keeping the building warm in the winter; the electrical work has changed from essential lighting and a few power outlets to a system that must be capable of supplying power to run an electric razor or a supersonic calculating machine; and the elevators have ceased to be a simple means to reach an upper floor and have almost become electronic monsters poised at the first floor waiting for sufficient passengers to start the race to the top of the building and back again.

All of these improvements are costly to install and add substantially to maintenance costs, especially if cheap materials and equipment are used. When the contractor is asked to work with the architect and owner to effect some economies in order to meet a budget,

these are the parts of the work that usually become the prime targets. The owner should have sufficient knowledge of operating and maintenance costs to enable him to balance them properly against construction expenditures. Otherwise, he is apt to make decisions that in reality are not economies, but rather make him liable for increased costs.

The speed schedule to which a building program is geared should be the contractor's responsibility and, if possible, this should be set at "cruising speed." A schedule that is too slow is expensive, and one that is too fast is not only expensive but encourages the acceptance of poor workmanship and the use of inferior materials. A contractor's knowledge of the time consumed in completing each trade or obtaining factory-assembled material should be used to develop a reasonable progress schedule. The progress schedule should not be limited to field work, but should also indicate the time allotted for the supplying of information by the architect and owner, together with time allowed for the preparation and approval of shop drawings.

A good contractor welcomes supervision or inspection of the work. That is to say, he welcomes reasonable supervision and inspection by the owner and architect. Unless the owner's requirements are extremely technical, it is strongly recommended that he leave the inspection to his architects and engineers. If it is decided, however, that the owner, architect, and engineer are all to have inspectors on the job, their duties and the extent of their authority should be made known to all parties concerned. Confusion caused by the overlapping of inspection is one of the most expensive of the hidden costs in any building, as it adds nothing to the building but cost.

The establishing of guarantee dates becomes a troublesome item at the end of a job. Most owners and architects are not satisfied with the contractor's guarantee, but also want the guarantees of the subcontractors and material suppliers. The subcontractors take exception to the average architect's date, which is based on the acceptance of the building. They maintain this date should be based on the completion and acceptance of their work. In some cases, an owner will occupy the building for as long as one year before he and the architect will agree on a date for starting guarantees.

If responsible contractors have been hired, the date becomes purely academic, except for the inspections that should be made before the guarantees expire. The usual procedure in our office is to notify the owner approximately one month before the guarantees expire and ask him to inspect the work, and to notify us if any repairs are required under the terms of the guarantee. If this inspection was made by the owner, architect, engineer, and contractor, it naturally would be a better inspection and it might help in future planning.

A good contractor should maintain an efficient and able estimating department, not only for the purpose of bidding on jobs but also for checking estimates on various parts of the work, and to cooperate with owners and architects in planning their buildings. Information in the form of plans and specifications is as necessary for estimating as it is for the erection of a building. However, some owners and architects have recently decided to supply but one or two sets of drawings to contractors, and to make them purchase additional sets of drawings necessary to estimate the work properly. The number of sets of drawings issued to a contractor for bidding purposes should be controlled, and a deposit to assure the return of all drawings and specifications is in order, but the purchase of drawings by a contractor for bidding purposes is an additional expense beyond normal operating costs, and it is an expense that will eventually be charged to the cost of the work and paid for by the owner.

Another phase of estimating that should be corrected is the present method of assembling a lump sum bid. I have used the word "assembling" because, despite the fact that a

general contractor should estimate most of the work himself, he must depend on subcontractors and specialty suppliers for their prices. These prices are never delivered to the general contractor until minutes before his bid is due, and very often the price is nothing but a feeler by which the subcontractor hopes to discover the going price for his work. This condition, plus the filling in of up to 15 to 20 pages of unit and alternate prices, strains the average general contractor at the seams, and some changes should be made. I would suggest that better cooperation between the owner, architect and contractor on this subject would relieve the last minute pressures of bid and enable the contractors to submit better bids.

In closing, let me once again call your attention to two expensive items that add nothing to the structural strength or the architectural beauty of a building, but only add to the cost, namely, indecision and confusion; and to another item that is extremely important to the success of any building, and that is information in the right place and at the right time.

Performance Information Needed by the Product Manufacturer

By Dr. C. F. Rassweiler,* Vice President for Research & Development
Johns-Manville Sales Corp.

First, I would like to make a few general statements to show that the building materials manufacturers do have a real interest in seeing that the building owner gets his money's worth. The reason for this is because it is to the building materials manufacturer's own personal advantage to do so. Another generalization I want to make is that the architect, the contractor and the building material manufacturer all have a very important stake in seeing that the owner gets his money's worth when he takes over a completed building. If we did not have a consistent and strong motivation to see that building materials are as good and as effective in their performance and quality and cost as possible, we wouldn't stay in business very long in an industry as highly competitive as the building industry. In order to see that the materials that go into a building do serve the owner's need to the greatest extent, it is necessary for us to start out by knowing what the eventual owner wants and what the eventual owner needs.

One of the great principles of product development is the fact that you must, before you start developing a product, know exactly what the product is supposed to do. A product development objective is achieved by identifying a truly urgent need, and matching it with the technical possibility of satisfying that need. Unless you have a clear, complete and accurate analysis of the nature of the need, and the nature of the service that a material must give in order to satisfy that need, then you waste your time and money on development, because you make something that is of no value. Therefore, from the product development angle, it is vitally important we get information from the building owners as to what they really need in the way of materials.

As Ralph Walker has already stated however, the question of what the owner thinks he needs and what the owner really needs are frequently not the same thing. Therefore, this question of the information we want to get is more than a casual one. The information we need must be the result of a very careful and accurate analysis and the collection of considerable data, which is not an easy matter or an inexpensive matter. Since materials are now one of the major roadblocks in the Defense Department, it has been my good fortune to spend considerable time in the last few years working with several groups trying

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to break this materials roadblock. In this activity, I have been tremendously impressed with the job that the Armed Services do in providing their suppliers with the kind of information that we need for the building owners. However, I am also tremendously impressed with the extreme difficulty involved in providing this information.

For instance, if you take a weapon system and try to get this information, first they must exactly and clearly define a mission which that weapon is supposed to accomplish. They must then clearly define the environment in which it must accomplish this mission; they must analyze the personal influences of the individuals who are going to use that system; and they must relate those things all back to some sort of a composite picture of performance and to the cost. Then, having done that, they must take every element and every material that goes into that weapon system and measure the effect it can have on the ultimate performance and the cost, if it varies in its properties, in order to identify those particular elements and those particular materials which are critical to the performance of the mission or to the cost, so that attention can be concentrated on those items which really are significant. Now, this is a matter that takes several years of work by a staff of highly trained mathematicians and the use of some of the finest computing equipment available in the United States. Many of the problems on which we need information are not big enough to justify that kind of an expense and therefore, very frequently, we don't get the kind of information we need.

There is one other reason why building materials manufacturers are interested in the activities of this Committee and the efforts being made to get information from the building owners to the architects, engineers, contractors and manufacturers, and that is that the means of communicating this kind of information are quite inadequate today. Actually, this is due partly to two things. One is something that I have already mentioned, and that is the extreme difficulty of collecting intelligent and clearly analyzed information about the effect of materials on the performance of the building, or anticipating what it will do in a proposed building. The other factor, frankly, is the breakdown of communications between the building materials manufacturers themselves. I would leave myself open to a great deal of criticism if I did not frankly admit that many times the things that the architect, or the contractor, or you as owners tell to building material companies never reach the people who actually use that information in developing products. Because they come in at the sales end ordinarily, they have to go through channels before they get to us, and I have to admit that our internal communications are not as good as they might be.

Aside from these generalized conclusions, let me say that I, personally, have a particular interest in this subject. I have been involved with the Building Research Institute and the Building Research Advisory Board since their inception and, from the very beginning, I have strongly urged that one of the major objectives of the Institute and the Board be to identify and analyze accurately the major problems that must be solved to provide better buildings, because you cannot solve a problem until you know what it is. You cannot solve a problem until you have a good analysis of it. You cannot solve any problem connected with building unless the analysis and the identification of it is a joint effort of the architect, the engineer, the contractor, the building materials manufacturer and the owner. This is an objective which I think is absolutely vital to accomplishing many of the things that we all want to accomplish in our industry.

One of the basic principles of product development work is that no product is good simply because it's hard, or durable, or beautiful. A new product is only good if it serves the need of a consumer better than other alternate materials available for the same purpose.

Another basic principle of product development work is that a product is absolutely valueless unless somebody will buy it. In other words, it is not only necessary that a product meet the needs of a customer but it also must have incorporated into it things which will motivate his decision at the point of sale. Unfortunately, at the point of sale, at the point of decision, frequently it is extremely difficult to demonstrate or prove the superiority of a product in terms which are of most importance to the long-range interest of the owner.

There are three basic considerations that apply to a new product. First, it must meet a need and it must serve a purpose, but it is important that this need and this purpose be powerful enough and strong enough to motivate people to give up something they have used for years and gamble on something new. Another principle of product development is that if you can find a customer who needs something badly enough, then you have a wonderful opportunity to develop a product which will return your company a profit, if you can accomplish it technically. However, you can spend a lot of time developing a product which meets the customer's idea of what is better, and then find it is of such minor interest to him that he says, "Oh well, if you give it to me at the same price, that's fine, but of course I wouldn't pay you a penny a pound more for it, because it's not that important."

Therefore, in considering things that might be done and the information we want, one of the things we need to know is how urgent the problem is. We need to have an evaluation of the effect upon the ultimate performance of a building and its cost before we can decide whether solving this problem is going to have a major effect, or whether it is going to be so minor that it's probably not going to result in the product actually being used. Second, it costs a lot of money to develop new products, to provide the capital expenditures for producing them and to do the promotional work necessary to persuade people to give up the product they have been using and accept something new. We can only afford to carry on this expensive operation when the need is both urgent and more or less universal. Therefore, when we talk about information, we want information which is concerned with basic general requirements and needs in the building industry, needs and requirements and problems that concern not just one or two buildings, or one particular contractor, but which are common to a great part of the industry, so that their solution assures a large general market rather than simply a specialty which is never going to pay off the plant and the development costs.

The third factor is that the product to be developed must not only have the possibilities of solving the need or the problem, but it must also do it in such a way that it is possible to demonstrate at the point of sale that the product really will do this. For instance, durability is one of the hardest possible things to sell, because it's the hardest possible thing to prove at the point of sale. So, to get down to the question of specific things which the materials people would like to learn from the owners, I'm going to use as criteria the seriousness of the problem, the universality of the need, and how improvement can be demonstrated.

So far as motivation of sale is concerned, low initial cost is unquestionably the most important factor in making a decision about materials. I am not at all sure that it really is particularly important, considering what the owner usually spends on gingerbread after he's cut the basic requirements of the building to the minimum, but in any case the question of low initial cost is primarily a joint responsibility of the architect, the contractor and the building materials manufacturer. Together, as a team, we have the responsibility for working out the ways by which a person desiring to build a building can get protection from the weather, and reasonable comfort and convenience. We should be able to specify and create for him a building which will accomplish that purpose. The building owner is

not asked to make any decisions about that except as they relate to cost. However, so far as initial cost is concerned, the place the building owner comes in then becomes a question of what he is willing to pay for some pluses over the minimum of protection from the weather, reasonable comfort and reasonable convenience. And again, in this case, we have a responsibility as a building materials manufacturer to give him these pluses at minimum cost, whereas the building owner has a responsibility to limit himself to things he really wants and not ask for a lot of supplementary things he just happens to think of at the last minute.

Second, take the question of structural life and the maintenance of the structure. By and large, I believe that the materials used for the basic structures of buildings are capable of providing about all the actual life that a building needs, if they are properly used and given reasonable maintenance. There are, of course, some exceptions to that, and one of the things that should be an objective of this Committee is to ascertain the places where materials are not performing that way.

I will mention two examples, both concerning roofs. One of the most common complaints about buildings in terms of structure and performance is the fact that the roof leaks. Now, here is an area where we would like more information, because it is a difficult problem to approach, for a variety of reasons. In the first place, it is an area where we get the greatest variation of opinion between one owner and another. Roofs are bonded for 20 years and very few owners ever collect, yet, at the same time, a number of people are vigorously and vocally dissatisfied with the performance of their roofs. Here, we are more concerned with the sensitivity of the system to variation in construction or in application than we are in a basic change in the nature of roofing. Therefore, we need not just complaints that the roof leaks, but a complete picture of the circumstances concerning the installation of that roof and its maintenance. Usually roofs are not the responsibility of any one person concerned, because the roof deck comes from one source, the roofing material comes from another, and the insulation comes from a third, and any one of the three may be responsible for the fact that the roof is unsatisfactory. When we talk about roofs we're talking about something we want to last for 20 years and at the moment I don't know any place where it's harder to predict in advance what the life of a system will be than it is in connection with the roof.

Now, let's go on to the question of maintenance and general upkeep. By maintenance I do not mean the maintenance of the structure as a structure, and its protection against the weather, but rather the need for repainting, the cost of keeping toilets clean, and the cost of replacing items of that sort. This is an area in which the building materials manufacturers are vitally interested. If there is any way that the material can contribute to reducing the cost of the maintenance of the building, and the cost of keeping it attractive, we certainly want to take advantage of that as a means of improving our products and increasing our sales. This is the place where I think it is more important for the building owner, in expressing his desires, to measure the sensitivity of his maintenance costs to variations in the materials. For example, someone recently said that 10% of the cost of keeping a building clean is sweeping the floors. A statement like that might lead to the question, how can we develop materials to reduce that cost of keeping the floors clean--and then someone else will point out that regardless of what material you put on the floor, you are going to sweep it every night anyway. So here is a place where there is absolutely no sensitivity to the material in most considerations, except perhaps in a kitchen.

Therefore, although we are interested in this area, the information we would like to have from building owners about advances and improvements they would like in materials to

reduce the maintenance and the cost of keeping buildings attractive should be examined in the light of how much the building owner would be willing to pay in the initial cost to achieve this saving in maintenance. And, is he talking about a saving which is real, or is he simply talking about the fact that he is disgusted with the amount of money he spent?

Now finally, I want to discuss the intangibles. I recognize the importance of initial cost, but I am a little cynical about the urgency of the materials problem in connection with the actual life of the structure itself and their effect upon the maintenance of the structure, because too frequently I see at the point of decision about what materials are going to be used, that the decision is made not on these considerations, but on the basis of intangibles. I believe that there is an emotion attached to buildings, particularly to small homes, that makes it extremely difficult to persuade people to depart from their normal modes or traditions. There is an emotion attached to a great many large buildings, also. For example, back in the 20's when everybody had a lot of money, the Fisher brothers were building their new building in Detroit opposite the General Motors main office building. A very good friend of mine who knew the Fisher brothers very well told me this story. He said the president of the Indiana Limestone Association came to see him and said, "Charlie, I want an introduction to one of the Fisher brothers because those idiots are going to put marble all over the outside of their building, and I can prove they can save a million dollars and get just as good life by putting on Indiana limestone." My friend was very much amused, but agreed to get him an introduction to one of the Fisher brothers When he came back at the end of an hour, he said, "Charlie, he listened to my whole story, I showed him the illustrations, I showed him the curves, I showed him the data and when I got through, he said, 'I don't question what you say, I agree that we could save a million dollars and the building would last just as long if we put on Indiana limestone,' but then he stuck his foot around the side of the desk and said, 'You see that shoe? I know I can buy shoes just as good as that for $6.00 a pair, but I pay $25.00 a pair for these shoes and we're going to put marble on the outside of the Fisher building.'"

These are the intangibles, and they're important. In a high percentage of buildings, the intangibles are important because the man who is building it or the company who is paying for it has an emotional attachment to that building. It is the visible symbol of the company. This is equally important to the speculative builder who is building for sale. In small homes, for example, they often install the most expensive flooring they can possibly buy, because they think that few square feet of flooring may sell the house. Thus, these intangibles are not just things that interest people in corporations who have tremendous sums of money to spend on buildings but they also have a tremendous value to the most practical speculator who is building a building on a shoestring with the idea of selling it to somebody else at a profit.

This is the area in which we need information, and this is the hardest information to get, because each new building has to be different. And, if you satisfy this desire for one building, then the next person who builds a building won't buy it anyway, because he wants to be different. All I can say is, this is a good example of the difficulties we have in trying to find out what the building owner wants, and this is why we are so hopeful that the Building Research Institute and this Committee will get us some of the information we need.

Open Forum Discussion

Moderator - Howard E. Phillips, Building Engineer,
American Telephone & Telegraph Co.

Panel Members - Messrs. Dalton, Walker and Rassweiler

Mr. Phillips: On the preceding pages are reports from the architect, the builder and the building product manufacturer to tell the building owners and other building industry people the kind of information they need to do a better job. The building owners will discuss these reports, but first, I would like to mention a few things before we get into the discussion:

1) There are some troubles in buildings which the owners cannot lay at the doorstep of the architect, builder or product manufacturer. At times, the owner may have demanded too low a cost on the initial building, resulting in higher maintenance and repair costs, or he may have insisted on getting the building built too quickly, at the expense of good quality construction.'

2) There are also many reasons why performance-in-service information does not get back to the place where it can do some good.

   a) The producer very naturally wants the world to know about the good points of his product, not the bad.

   b) The architect doesn't want it thought that his choice of products and techniques could stand improvement.

   c) The builder wants no possible reflection on the excellence of his work.

   d) The owner, especially if he is renting out his space, doesn't want anything published indicating that this building has any faults.

And so, in the ordinary course of events, those who design and make our products never do hear some of the things that would help them most to improve and perfect those products.

U. S. Department of Commerce statistics show that maintenance and repair costs run to nearly 1/3 of the money spent for new construction,

and that total costs to maintain and operate buildings nearly equal the new construction figure. Shown in Figure 1 are a few similar figures from the telephone industry as samples to illustrate comparative costs for new construction and maintenance. This chart indicates that maintenance and repair represent about 1/6 of our new construction program, and our total building operating expense is about 2/3 of the new construction budget.

A breakdown of the maintenance expense for a metropolitan area shows where the maintenance money goes, (See Fig. 2.) and another chart (Fig. 3) shows the money spent for house service labor.

Figures 4 and 5 are sample charts we have developed to help us select a material, based on relative square foot costs, in order to get the proper balance between first cost and maintenance, and to take into consideration the life of the product. Of course, there are many other factors which have a bearing on whether you select one material or another, but too often a decision is made to use a material without considering the comparative annual costs. With this analysis you can give the proper weight to initial and maintenance costs and arrive at a proper balance between the two.

I'm sure there are many other ideas which will come out of this meeting to assist in our "Operation Feedback," and obtain more information on performance of buildings. We hope that this workshop session will bring to light some of the problems, needs and desires of the building owners and users for the research, design and manufacturing side of the building business to the end that solutions to many of these things can be worked out in the future.

We believe that a frank exchange of ideas can be helpful for all concerned and that improved products, better adapted to the needs of the user, and better buildings, will emerge as a result of this discussion. So, we are hoping to stimulate a free and honest flow of questions and answers. To the extent that this takes place, all of us can better appraise where we now stand, and can better chart the future direction of research, design, construction and manufacture.

A. G. Winfield, DeBell & Richardson, Inc.: Is it less expensive to tear down a building after 25 to 35 years than to continue to spend heavy maintenance funds? The Empire State Building might be used as an example.

Mr. Walker: I would prefer to use another example, one that Howard Phillips told me about, and that's the A. T. & T. building at 190 Broadway. He says that they expect that building to last 100 years. I have attended meetings in Paris and Rome, in buildings older than that. In fact, the Minister of Reconstruction about 10 years ago occupied an office building at the Palais Royal in which the carpet was from the early 18th century. He sat at the desk of Louis XV who lived about a century before; the decorations of the room were Louis XIV which was another century before that, and he sat amid a great deal of dignity and charm. The only thing was that the plumbing was pretty horrible. I think that we in America throw away things much too fast. I remember when Ritz-Carlton Hotel was torn down people abroad were shocked. That hotel which was being destroyed had meant a good deal

COMPARISON OF ANNUAL EXPENDITURES

TOTAL OPERATING EXPENSE vs NEW CONSTRUCTION

Based on the Bell System for 1959

Figure 1

BREAKDOWN OF MAINTENANCE EXPENSE

(Including Repairs but Excluding House Service Expense)

Based on Telephone Buildings Located in a Metropolitan Area

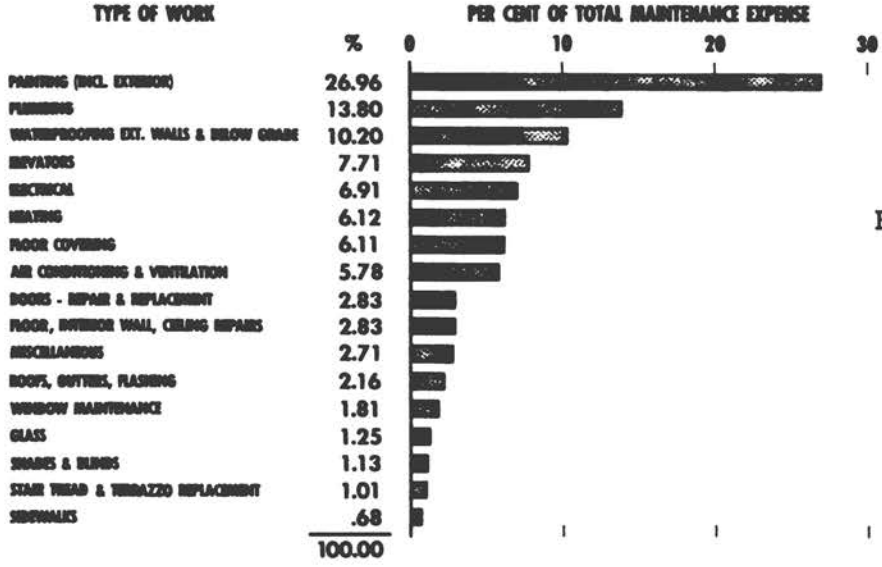

Figure 2

BREAKDOWN OF HOUSE SERVICE LABOR IN TELEPHONE BUILDINGS

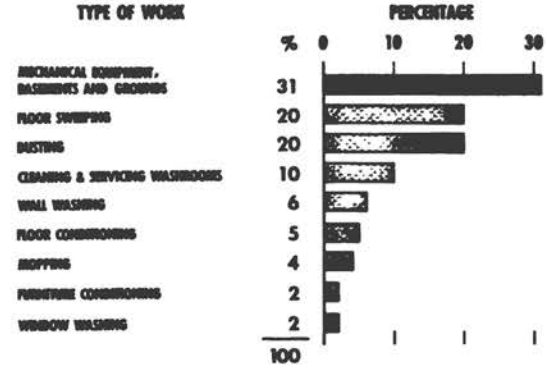

Figure 3

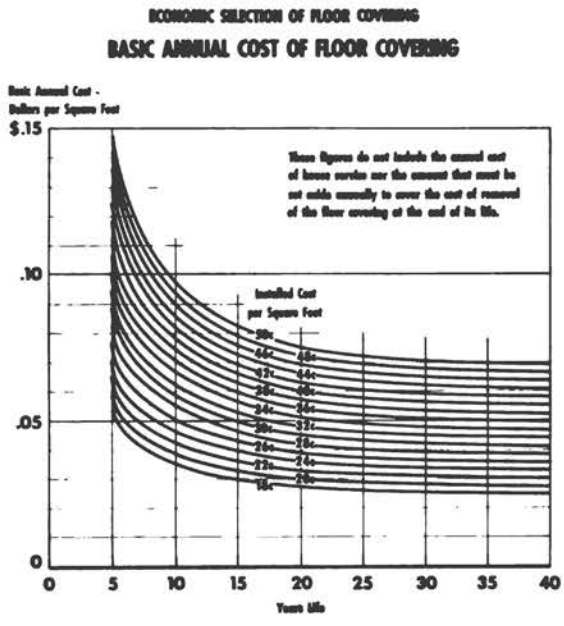

Figure 4

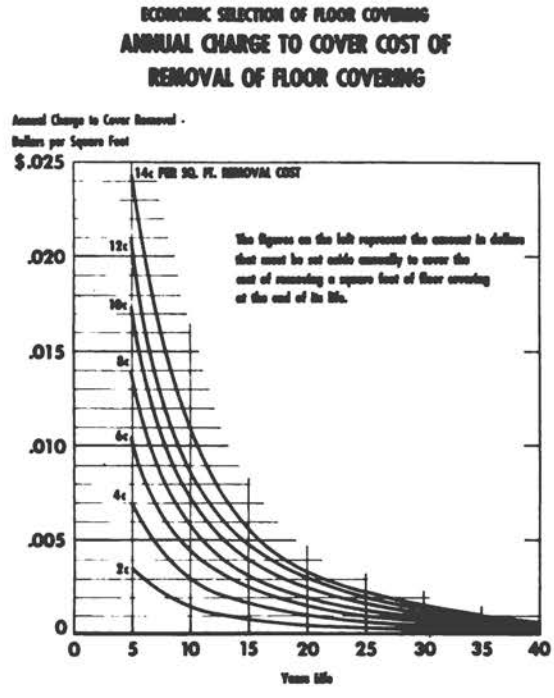

Figure 5

to many people coming here from abroad. There is one good thing about old buildings, and this is probably true of the Empire State Building also, when you have to put air conditioning in them you still have ceiling height enough to do it, and you have enough room at the walls to do it. One Wall Street has been completely air conditioned because we had sufficient ceiling height to put in the ducts; it was easy to modernize. I think that obsolescence is a matter of fashion more than anything else. In many ways the older buildings still have some value that should be maintained. Parts of my home are 175 years old, and I have no feeling that building is obsolete at all, although once a bank would not loan any money on it because it didn't have a basement, and parts of it had sheetrock walls, and third, it was on a dirt road.

C. T. Grimm, Zonolite Company: Since it would be presumptuous for a manufacturer to ask an architect to specify a material without giving him a good idea of its installed cost, what do you believe is the best source of these data? Does your firm regularly supply manufacturers with information on installed cost of their products?

Mr. Dalton: We do not quote manufacturers installed costs on their products, but we have never refused where a manufacturer may have come in on occasion to ask us for advice as to the cost and how it might fit into the building, or regarding trade jurisdictions. We have always worked with the product manufacturer to help him as much as we could. We feel that this helps the building program.

Charles H. Stark, Owens Illinois Glass Company: Leading engineers have stated in recent architectural publications that the American architects fear to use researched

and proven new products and that they are 20 years behind manufacturing research. They state that you find the reverse of this in Europe. Do you feel that this is true?

Mr. Walker: No, I don't think that is true. One of the things that has interested me in going around the world has been the dependence upon American techniques. I think that our building techniques are far ahead of those that you find anywhere in the world. And, you find more men on the job anywhere you go in Europe or in places like the Philippines. While their labor is always much cheaper, I have twice made the observation that building costs are quite similar. With our more expensive labor and our more expensive materials, there is not too much difference in actual cost, especially in relation to economy. The panel construction technique that we have developed in this country is the envy of almost all the architects abroad, and I think that aluminum is at present developed here as highly as it has been anywhere in the world.

There are some foreign architects who have done a very remarkable job of developing new techniques, one of them Nervi of Italy. He's not only an architect and engineer, he is also a builder, expert in the use of concrete. On the other hand, we don't need to think of the foreign architect as being the father of concrete, because a man named Ransome of the Turner Construction Company at the very beginning of this century established a concrete form factory. We used glass long before Europe did, and Gropius is not the first user of glass in large quantity by any means. You'll find, around the world, men who do some things in a new way. Men like LeCorbusier, for instance, have not been inhibited in their use of materials, nor has Mies VanderRohe. They have been what I call grammarians. They have found new techniques and refined them. However, American engineers, and I say this as an American architect, have been fully aware of the possibilities within the techniques of modern times. Certainly you find no building in the world in which steel is used more economically or in which panel construction is used more economically, and which is so fully integrated in terms of all the other factors, as you find here in the United States. There is no street, even in the reconstructed streets of Germany, that looks anything like Park Avenue.

Mr. Rassweiler: May I comment on this point? Mr. Walker is defending himself and I would like to say a word in favor of the architect. Ever since 1946 I have been going to Europe periodically to make surveys on building materials used there. I was there three years ago and visited every building research institute on concrete and I certainly do not think the Europeans are more progressive in the use of new building materials than the Americans. You will find in use certain materials such as foam concrete in Sweden and certain colored panel materials in Germany which are different from those we are using here. You'll find by and large, however, that Europe is much more tied to traditional building materials than the United States, and to traditional methods.

Panel Discussion

Moderator - Howard E. Phillips, Building Engineer,
American Telephone & Telegraph Co.

Panel Members - Robert B. Beach, Exec. Vice President
Natl. Assn. of Building Owners and Managers
G. Harmon Gurney, Chief Architect for Housing
New York Life Insurance Co.
Harold V. Schmidt, Vice President, Plant Design &
Construction, Western Electric Company, Inc.
E. L. Schulz, Technical Advisor
John W. Galbreath & Co., Inc.
C. H. Topping, Senior Architectural & Civil Consultant
E. I. duPont de Nemours & Co., Inc.
and Messrs. Dalton, Rassweiler and Walker

Donald Whiston, Mass. Institute of Technology: Where does the responsibility lie to insure the correction of building defects which become apparent after occupancy? What means are available to the owner, other than delaying the acceptance of the building or parts of the building, to insure the correction of defects?

Mr. Dalton: This depends entirely on what the alleged defects might be. If it is a defect in the functioning of a piece of mechanical equipment, obviously that's one circumstance; if it's a leaking roof two or three years later, that's another circumstance. I don't know whether I can answer it any better than that without knowing what the individual defect might be.

Mr. Phillips: Part of the question was, is there any other way of getting the defects corrected outside of delaying the acceptance of the building. Now, this is an unfortunate thing, but I guess that the only way to force the issue is to hold up money. That usually brings an architect or engineer or contractor to his feet about as fast as anything.

Mr. Gurney: May I speak on that, as a building owner? We find that our main problem on defects that turn up in a building, and this occurs even sometimes before the guarantee runs out, is to pinpoint whose responsibility it is. Nine times out of ten the material dealer or the contractor or the architect will point that finger at someone else, and the difficulty is to determine where the fault lies. It has been our experience that generally the person who really takes the rap on it is the owner.

Mr. Schmidt: A reputable contractor, one who has been in business a long time, and who is interested not only in the job he has just built and finished for you, but in the future work you may have for him, isn't going to run away from such a problem. I resolved one in Kansas City not so long ago where the sash in an entire building went bad. Supposedly it was anodized, and we had a certified statement from the anodizer, but it started to go to pieces. We went in with our own chemist and found that it had never been anodized. Of course, this cost the contractor a lot of money. He had to replace the sash in the entire building. The sash contractor himself took no responsibility and bore none of the expense. I doubt if the anodizer will ever get another piece of business from that contractor, or from us. But the general contractor as a rule is reputable, he has been in business for a good many years, and he wants to stay in business. His reputation means a lot to him.

L. Economides, Voorhees Walker Smith Smith & Haines: You have indicated disappointment in the lack of physical coordination in the design drawings of some projects. Since your firm has a complete design staff, you must know that it is possible, with sufficient effort, to prepare construction drawings which will enable all parts to fit perfectly. Do you think that the cost of such effort is warranted and, if so, why isn't it widely practiced?

Mr. Schmidt: It is a matter of cost. I'm sure architects and engineers will all agree that one of the most pertinent questions that has been imposed upon them over the years has been the cost of design, whether related to cube or to square feet, or to any other factor. I've had people offer to design a building for 2¢ a square foot, but I've seen some of those designs produced for 2¢ a square foot. The building costs many times more than it would have cost if there had been 4¢, 5¢ or 6¢ a square foot to spend on the design. It's really a matter of how much you want to spend, how complicated your job may be. We check drawings, and check them very carefully. I know that Mr. Walker's firm checks drawings very carefully, but there are many, many engineering offices that do not check them. You've all seen building plans in which the high voltage conduit, the sanitary drain pipe, the air conditioning ducts and the lighting fixtures all occupy the same square foot. We've even had lighting fixtures shown on drawings at places where there were columns.

Louis Menk, Albert Kahn Assoc. Architects & Engineers: In the case of a "negotiated" contractor entering into the decisions on choice of materials during the development of the plans, is there not a danger of overemphasis on material costs, of which the owner is always conscious, at the expense of proper selection on the basis of design, intended use and other enduring considerations?

Mr. Dalton: I don't think so. Referring back to the job that we finished about a year ago with Mr. Walker's firm, in which the owner did want to cut back cost, this happened to be an insurance building, and the top prices were fixed by the insurance commission in the State. Mr. Walker's office recommended several different types of materials and treatments for the exterior of the building, and we made various estimates for comparison. Between the two of us, we submitted the problem to the owner and showed him exactly what

he could get for a set amount of money. The final selection, of course, had to be his, based on the recommendations of the architect as to the satisfactory performance of the different materials that were suggested.

Grayson Gill, Grayson Gill & Assoc.: To what extent does a national organization like A. T. & T. delegate responsibility for setting up owner's criteria for building design, particularly with reference to regional factors having an influence on them?

Mr. Phillips: Our headquarters staff does not deal with architects or contractors, except our consulting architects. We don't award any contracts through our headquarters organization. These responsibilities are all delegated to the operating companies in the different parts of the country. The chief engineers of those companies have the over-all responsibility through their building engineers for engaging architects, awarding contracts, and so forth. The building engineer is the coordinator, and he deals directly with the architect in awarding contracts for buildings.

Grayson Gill, Grayson Gill & Assoc.: Negotiated contracts are not recommended by the Associated General Contractors of America. Their advantages are obvious to the architect. Shouldn't the A. G. C. statement of policy be qualified by the A. G. C. Board?

Mr. Dalton: I didn't know the A. G. C. was against the negotiated contract. I know several of its members in the New York City area that are rather prominent in the operation of the A. G. C., and I don't know one of them that would turn down a negotiated contract. I think if they have such a policy it should be modified.

Ralph Boone, Dow Chemical Co.: Do you feel the architectural and engineering schools could do more to highlight the "performance of buildings" with field trips to existing buildings to witness and hear explanations of the good and poor examples?

Mr. Walker: Yes, unquestionably, but of course this gets into a totally different field from what the colleges are training students to do these days. One of the things students probably need most is more attention to what we have come to call the "tool trade." They should be familiar with such things, so they understand what it is they are going to work with. While it is true that school is sometimes the only place for the average architect to give free reign to his imagination design-wise, still I think there is insufficient attention given to technical matters at most architectural schools. I am not sure whether this is the case at engineering schools or not.

C. T. Grimm, Zonolite Co.: A few cases have come to light where a slight increase in cost for the additional fire protection of steel frames above building code requirements has considerably reduced insurance rates. Has your study group investigated this possibility for reducing ultimate costs?

Mr. Phillips: In our own business, we generally rely on architects to determine what the code requirements are for fire protection and structural steel frames in the particular building, in the particular State where it is located. However,

as to its affecting insurance rates, in our business we don't carry insurance; we are our own insurance company. But we do lean over backwards in terms of necessary fire protection, to be sure that we do have our equipment properly protected.

Mr. Schulz: In general, in modern office buildings today, by the time you've taken all of your credits you end up with a minimum rate by adhering to the code requirements, and you get no benefit in your insurance rate for additional fire protection.

R. Brown, Tremco Mfg. Co.: What do you want building owners to tell you that will help you to do your job better?

Mr. Dalton: I think if the owners would set up some kind of a program so that they know what materials they want to use and how they want them put together, they could reduce their costs substantially. Indecision is one of the highest priced things we have on a job. With the mechanics already on the job, too often the architects and the owners come to the job every second day and take a look at something and decide that isn't the way they want it. Then the mechanics have to take it back down and put it up a different way, and they begin to think that they are working for U. S. Mint. You can't control costs then, no matter how you try. So, if there is indecision at the top echelon of architect and owner, it certainly should be resolved if possible before the mechanics are on the job.

Louis Menk, Albert Kahn Assoc. Architects & Engineers: In the picture of total economy of buildings, the balance between initial cost and maintenance costs, what part does the present day tax structure play with maintenance costs being an item of deductible expense, while initial cost is an item of capital?

Mr. Schulz: In general when we think of total owning and operating cost, we think in terms of the amortization of the investment, the annual tax on that investment, and the maintenance charges as well as operating charges. There is a complete financial balance spread over an anticipated life of equipment. Taxes play a relatively small part in this. If the question was asked in terms of trying to get a quick write-off, that's an entirely different subject. That is a matter of selection of different types of equipment, and in general is not practiced by, shall we say, the long-term investor.

Mr. Phillips: I would like to comment on that, too, with respect to the chart that I showed on selection of floor covering. Those curves were made up on the basis of average cost of money, taking into consideration both debt and equity capital. The chart also took into consideration the proper depreciation rate of the material, and all of the various taxes. As Mr. Schulz said, it makes a great deal of difference who is setting it up, and what the tax structure is with respect to that particular owner.

Now I would like to open this discussion up to building owners. Mr. Beach, would you like to give your reaction to the viewpoints presented by the architect, the contractor and manufacturer and give us any thoughts you have on this approach to the problem?

Mr. Beach: I work for an organization that speaks for the owners and managers of large buildings: office buildings, institutional buildings, public buildings, etc. The general purpose of a meeting of this kind is to proceed from generalities down to specifics. Generalities are fine, but they don't produce answers. Theoretically, our group, which does represent a very substantial building ownership, should be able to do research work and incidental studies comparable to what the mathematicians and engineers in the Defense Department do with these new missiles of theirs, and come up with a report to you which would answer all the questions of the architect, the contractor or the building material manufacturer. I say, theoretically we should; practically, we don't for a number of reasons. We don't have the facilities; we don't even have, proportionately I presume, the facilities that the telephone company has to produce some of its intimate studies.

We have an activity, however, where we do bring in the experience of the owner and the manager, probably primarily the manager, because he lives with these buildings more intimately than anybody else does, to assist the architect, the contractor and the material man in the original planning of the particular building. In this activity, we find there are certain specific areas which are, you might say, more critical than others; the first one we run into everywhere is cost. Back in 1946 a good many investors were fearful of putting up new buildings because of what they then conceived to be the terrific cost. And yet, we have been told, and we know full well, those costs have increased by 100% to 150% since that day and still we are building buildings. The answer, of course, is that when the need is there, the building will be produced and the economics will take care of themselves.

I don't know that I can say anything at the moment to solve this cost problem. The chairman recommends a reconciliation of first cost with ultimate cost. But, like the young couple starting out in life, we often aren't concerned about the ultimate cost of things but about the first cost. There are some very substantial interests that can look a long way ahead, but the average investor who is putting his money into a building, even a very wealthy corporation, is very much concerned with the first cost, because someone has to go before the board of directors and paint a pretty picture of what is going to be constructed if the board is to recommend the expenditure.

Aside from cost figures, the problems that come to our attention can be divided quite naturally into exterior and interior. When it comes to the exterior problems, we don't profess to be architects but we do have to look at the thing from the practical reaction that may develop. We are very much impressed with what the architects are doing these days to try and make the new buildings look different and be different from all the other buildings that are lined up in a row. I am told that VanderRohe walked up and down the streets of New York pondering for a long time how he was going to make the Seagram building look different from all the other buildings, and finally he got the bright idea of using bronze on the outside. It looked wonderful in the $10,000 model that they had of the building. As to the building itself, we can all form our own opinions on whether it looks quite as impressive as the model did.

In Cambridge, the other day, we came across a design of a building with something that was quite new to me, random windows. We've all seen random floors, but here was a building with random windows and, believe it or not, after we had lived with the model for a day or two, it didn't look so extraordinary. It didn't jar our sensibilities quite so much as it had at first glance, and perhaps the company in question wanted something distinctive; maybe that's the answer. In Detroit, even more recently, we examined a proposed building for the Civic Center with six-sided windows. It is one of Mr. Yamasaki's contributions to the new look in construction. Of course, our approach to a six-sided window considers how difficult it would be to clean; how much it would add to the cost of maintenance and operation. Architecturally, the result would be very handsome and I am satisfied that they are going to build it, so you will have a chance to see how it looks, and we'll have a chance to see how it operates.

Mr. Phillips: Mr. Beach, on any of these projects where you've been in on the early planning, have you been able to go back and follow up, and find out what happened in the maintenance end of it?

Mr. Beach: If you mean by that the actual operating cost involved, we do, but in a general way. We make a report on several hundred buildings, and I am afraid the individual building gets lost in the general average. Like the architect and the contractor, we don't get back ourselves to the same building as often as we would like.

Mr. Phillips: In our study group, we've talked about what kind of medium to use to get this information. We've used questionnaires and personal contacts and surveys of different kinds. Do you feel that the questionnaire or survey form you use provides reliable data on maintenance costs, etc. ?

Mr. Beach: The survey form that we use applies, you might say, to actual average operating costs of a very large number of buildings. I can say one thing for it, it is the most accurate thing that anybody has. It isn't as complete and as accurate as we would like to have it, but it's something that nobody so far has improved upon. We are trying to improve it each year ourselves, but even the Government has to use our figures for average operating costs. However, we are always prone to say the average isn't necessarily the best, and this is obviously not the best. When you know what the average ceiling cost is, your job is to improve upon it, because the average isn't, and should not be, good enough.

When it comes to individual properties, I don't think that questionnaires really tell what you want to know. I think you have to visit the building in person and talk with the engineering staff, and really make a basic study of that particular building. Only in that way can you get the kind of answers we are trying to get here.

Mr. Phillips: A questionnaire might well point up over-all problem areas though, don't you think?

Mr. Beach: I think they very definitely point out the over-all problems. The interior of the building is where the economics of operation really apply. The floor

layout, its flexibility, what the tenant likes and will pay for, and what the owner, by long experience, likes and is happy to pay for are the important considerations, rather than how something looks on a piece of paper. On the other hand the economics frequently depart somewhat from the ideal. For instance, 8' corridors look very nice, but we always recommend 6' where the corridor does not carry too much of a load, because when you figure the usable value of that extra 2', it can amount to a very substantial amount of money in the course of a year's time.

Mr. Schmidt: I would like to confine my remarks to a specific phase of this problem. The Western Electric Company is somewhat peculiar in that we own, we occupy and we manage our properties. We also design many of our own properties, maintaining an organization of architects and engineers for our own use which is supplemented, depending upon business needs, by the use of outside architects and engineers. We have 22 manufacturing plants at the minute, with a 23rd one just about to be constructed, ranging in size from just under a million feet to our largest, located in Chicago, which is almost 5 million feet. Then, there are 33 distribution centers ranging in size again from 175 thousand to almost a half million square feet and we operate in 46 of the 48 states on this continent, with quite extensive problems.

My own activity within the company really has three main divisions, one of which is pointed directly at this problem of feedback. We conduct periodically an inspection of every one of our properties, and this is not a cursory type of inspection; it involves many engineers and, depending upon the size of the property, considerable time. Information gained through these inspections that points out improper design, improper construction, and improper maintenance is fed back to our own design group, where it is correlated, analyzed and catalogued for use in future design activity. I am sure that you all agree that this is a very valuable adjunct to building design. We also operate a plant service organization, set up as a group of consultants, because all of these units in plants are organized autonomously as nearly as possible. This service gives them information not only on their own maintenance problems, but information correlated from the over-all broad inspection of all properties, so whatever is gained through inspection is disseminated to all parts of the company. The third activity needs no identification, that is, the plant design and construction activity for the company.

I would like to make a comment on one of Mr. Walker's points, the question of coordinated design. I don't think there is any question that in the buildings of today design is becoming more and more intricate. The problem of utilization of cubage is becoming more and more vital and, unless you do a good job of designing your mechanical and electrical components, the cost of the interferences and the extras becomes tremendous. I would appeal to every architectural and engineering firm, whether it is a coordinated unit or one in which the architect subcontracts the engineering work, to bear in mind that checking the drawings is paramount in delivering, on behalf of the contractor and the owner, a building at a reasonable cost. This business of trying to build into the building a design dreamed by somebody and not put on paper and checked can be very expensive.

Mr. Phillips: Mr. Schmidt, could you discuss a little further this coordination survey group that you talked about which goes back and evaluates plant design. This ties right into our feedback approach.

Mr. Schmidt: It has another function, of course, because we are constantly on the alert for the injection of operating hazards into our plants. We are very, very careful concerning fire or explosion hazards. I think our experience insurance-wise, loss-wise, has been outstanding in this area, simply because we do maintain an alert observance of the occupancy of these buildings and plants. The occupancy, as I pointed out, is strictly a function of the local management of the given plant; they are the economists, but we're continually looking down their throats and over their shoulders to make sure that good judgment is used, and I think it has paid good dividends.

Mr. Schulz: There is one point which I think ought to have further definition. I think that we can consider there are three types of buildings, or building owners. The first type was mentioned earlier, the speculative builder whose prime concern is first cost only, in anticipation of unloading the property within a reasonable number of years. The second group, which falls in the extreme opposite category, would be the institutional and monumental type buildings where first cost, or even operating costs, may be secondary considerations. These are public relations investments, advertising investments in the form of construction. The third group I would call the investing owner, who is primarily concerned in a long-term investment and must consider his investment in the light not only of first cost but of total owning and operating cost.

The data that BRI is searching for is closely available within this third group, because these people have been building up this kind of information. The investing owner of office buildings has also been building up these data. In our particular case, we don't do it alone; we operate as a team with the architect and his engineers. This morning it was mentioned that 40% of the value of the building is now going into mechanical, electrical and elevator equipment. There is a building going up on Park Avenue right now with a total investment for elevators, electrical, mechanical equipment and plumbing representing almost 50% of the total cost of the building. I feel very strongly that the engineers should sit in on all preliminary planning of buildings as the architects' right-hand men.

As regards the manufacturer, we look to him to convey his information through the contractor, the architect and engineers during this planning period. Actually, we shoot for a balance between the esthetics, the physical layout of the property, its ease of operation and maintenance and the over-all economics. In many cases, a first cost considerably above the lowest cost possible may well prove in 5 to 10 years to be the most economical investment.

To return again to feedback of information, I repeat that I believe a considerable amount of this information is available through the sources that have been making these studies. The owner has information, the architect and the contractor have information, the manufacturer has information. That information could be assembled and be of great value to everyone,

not only from the standpoint of development of future buildings, but from the standpoint of developing new products for incorporation in our future buildings.

Mr. Gurney: My activities in the New York Life Insurance Company actually entail residential buildings, and statistics on residential buildings are fairly scarce, whereas on commercial buildings and industrial buildings there seems to be a great deal of information available. Unfortunately we have not been in the construction of buildings, in the actual planning and operation of buildings, long enough to have collected very much basic data. Therefore, I am a little confused as to just how we could participate in feeding back to the architect, the builder and the material manufacturer any basic information we might have.

As far as we are concerned, in the residential building field, we would like to be able to build a building that would last for 25 years some day, because with the kind of maintenance and the care that we take in the operation of our buildings we might be able to make it last for 50 years. However, I don't believe that I know of an architect who ever really designed a building for 25 years, that is, a multistory building. One of the things that plagues us most in residential construction is the fact that the things that we put into our buildings become obsolete before they wear out. While we are interested in first cost in a building, we are more interested in getting information on the estimated life of a particular material, and we have very great difficulty getting it. We also find it very difficult to get information on yearly maintenance and repair cost. If we could get this information we would be glad to maintain records which we could feed back to the architect and the builder.

Some 10 years ago we finished a large 3,000-unit project in Great Meadows; Roy Walker Smith happened to be the architect on that job. It amazed me to get a call from them about a year ago saying that they would be very much interested to send a team of men out to this job again to make a very detailed survey. They did send a team out, we turned them over to our operating people, and they made a very detailed analysis of what had happened to these buildings which they had designed 10 years before. I am citing this example because I think it would be very valuable if the contractor would do the same thing, and also the material dealer. I noted in Mr. Dalton's material about the different types of contracts that he mentioned a negotiated contract where the contractor sat in as part of the team with the owner and the architect. I would like to know more about how that works. Another question that's plagued us for some time is the question of prequalification of subcontractors. I would like to ask Mr. Dalton whether he feels that the prequalification of subcontractors on the job actually affects the principal cost of the job. Another problem we have encountered is with mechanical equipment. Even though it is very carefully detailed and there is architect and contractor supervision on the job, we find that very often we end up with most of the equipment very inaccessible, located where it presents terrific problems for our maintenance people. We are very much interested in how this sort of a problem could be solved.

Mr. Dalton: On the negotiated contract, I go on the assumption that a contractor is going to make a profit on the job, so he would get a lump sum, negotiated or however he gets it. You can't stay in business very long if you don't make a profit. And, whether the profit is 1% or 10%, if it's fair, the contractor is entitled to it. On today's market, and I am not talking about small homes, but about the type of buildings Mr. Schulz mentioned, somewhere in the neighborhood of 90% of the work is done by subcontractors on a lump sum basis. There has been a lot of discussion about general contractors becoming brokers, and perhaps some are, but I would like to use the term managers, rather than brokers. On today's market, most contractors in the metropolitan areas have been forced to sublet their brick work, concrete work, and things that they used to do themselves.

That figure of 90% may be high, or maybe it's a little low; maybe it's 94 or 95% of the work that's actually done by subcontractors. So, therefore, the little bit of cost in the building that you're actually negotiating for is the profit you are going to let the contractor have, plus his general conditions and maybe his insurance protection, temporary services and temporary maintenance. The New York Building Congress has gone into the subject of prequalification of subcontractors quite extensively, and has issued a report that I think is excellent. I don't remember all the details of the report right now, but one thing pointed out in it is that you know you are going to get a good mechanical contractor and, as we said, the mechanical work now runs 40 and 50% of the cost of multistory building. However, this system does have a drawback, in that it is conducive to collusion in bidding. I think, however, that you are more apt to get a good contractor than be hurt by the collusion that might be going on between the contractors.

Mr. Topping: I was very much interested in Mr. Walker's remark that the durability of buildings is affected more by the care given the buildings than by the original selection of material. This has been a matter of considerable interest to our company. Well before the United States got into World War II, we were asked to design and operate a powder plant, and to design it to last one year, because it was going to be a very short war. We did our best. I think it was 363 days after the plant went into operation that the steam line fell down because of structural support failure, and the tumult raised because of that failure was mitigated only slightly by the tongue-in-cheek criticism we received because we missed the target by two days.

I had the interesting experience some years ago of serving on a BRAB committee which reviewed and studied the findings made for the Navy on temporary buildings for the 5th Naval District, which includes, generally speaking, the area from Washington to Norfolk. One of the things we became involved in was defining what a temporary building is, because we were examining so-called temporary buildings built in World War I, and they were still going strong. We tried to define this by looking at the causes for building a temporary building and at least some of us finally came to the conclusion that a temporary building was built that way for one of two reasons. One was that it was to be portable, or that it was to be built as a temporary building for economy reasons. Of course, economy

can mean economy in terms of dollars, or materials, or labor to erect it, or labor to operate it, but the underlying reason is either economy or portability.

In this study we found among other things that it was perfectly possible, as Mr. Walker said, to design buildings that would last a very long time, using cheap materials, if you postulate there will be sufficient maintenance. You should set your sights on which type of economy you are seeking; this can radically affect how you design buildings. We also found that the things that gave you trouble in these temporary buildings were, curiously enough, all connected with water. There wasn't a one in which water did not play a part. For instance, warehouse platforms sank and caved in because there were no gutters on the eaves. Water discharged on the platform and ran toward the building, after the platform got out of level a little bit; ran down between the expansion joints and cracks between the platform and the building; seeped into the earth supports, and you know what the end of that was. In a freezer building they put the vapor barrier on the wrong side of the insulation. You know what that means. The eaves and overhangs on some barracks were made 6" wide. When nobody closed the windows, the rain came in and ran all over the floors. This didn't bother the Navy; the Navy calls the floors decks anyway, and a deck is made to be swabbed daily with lots of water. It didn't make any difference then, that the ceiling below was of vegetable fiberboard, but it did later. These were errors in design, if you consider, perhaps as second thought, what the buildings were to be subjected to.

This idea of economy, I think, is applicable to buildings in general. A good many people think that this is a false way to look at buildings, particularly some architects. However, it's a perfectly good way to look at your decisions in any part of building design. Even if you decide you want to have a very expensive and decorative building, you may find that you do that because it is more economical than spending your money for advertising in another way. Please understand that I am not speaking for strict "bare bones" economy in building design, but rather recognition of some basis on which to make decisions. If owners would do this I think they could solve some of the dilemma in conveying to architects what they want. The architects grope for the bases of owners' decisions as to what would be the apparent function of building.

The chemical industry is very much economy minded when it designs its plants. If a material is to be manufactured, an estimate is made as to its market, what it can be sold for, and then you design a plant so that you can make a profit on the sale of that chemical. If you design your plant so that it is so expensive, either in first cost, operation or maintenance, that you cannot make a profit, then you can't build a plant. Naturally, first cost is of very great importance, but the first cost is a very heavily weighted consideration. Why not cost in the long run? Well, the cost in the long run in a chemical plant isn't very long. The cost of money to the chemical industry is quite high and the salable life of a chemical product can be quite short. Consequently, we look for economy in building and it usually has to be in the first cost. Now, this is a source of distress to material suppliers, architects and builders, in some cases, until they find out why we are doing it.

Dr. Rassweiler pointed out that the only good material is a material you can sell; if it isn't salable, it isn't any good. If we can't make money on our plant, we are not going to build a plant. In looking at the economy of our building we do just what he says the weapons system analysers do—look at each section of it to see if what is asked for is worthwhile. This comes as a surprise every once in a while to those who have specified what they want for the buildings. In this particular case, I am speaking for the architect and builder, because we do design and build our own plants, usually, to the dismay of A. G. C. and A. I. A. However, we have employed large architectural firms very profitably and very satisfactorily, and we do usually detail a large engineering organization to supervise the job and, in the case of construction, a good deal of the work is taken care of by subcontract.

As an example of our analysis of the cost of various parts of buildings, some years ago we designed and built an industrial toxicology laboratory. The initial estimate came out far above what the industrial department expected to spend for it, so we did the usual going through to find out where we could pare and not seriously damage their ideas of usability of the building. One of the things that turned up was a very innocent-looking "all weather room," as they called it. In this room we were supposed to be able to run the gamut of temperatures from the Antarctic to the deep tropics and on up to the Arctic, and hold the climate within a fraction of a percent of any point on the way. When the costs of that were analyzed, the scientists almost fainted. So, they backed off and got out of it at a fraction of the cost, and were quite happy to do a great deal of giving on the tolerances that they would allow.

I would also like to back up Dr. Rassweiler's acknowledgment of the dissatisfaction of owners with roofs. We felt called upon a few years ago to study that problem ourselves, and we came up with some figures that surprised us—$1.50 per sq. ft. per year for the maintenance, not replacement but maintenance alone, for insulated roofs and a $1.00 per sq. ft. for uninsulated roofs. This is because of the way we use our roofs. We now build level roofs for economy and because they make attractive pieces of real estate. They're only 12' above your equipment, and provide a handy place to install small equipment, air conditioning, fans, small heaters and pumps, all of which have to be maintained. When you walk around on these roofs, drop tools, spill oil, etc., the roof is ruined in a hurry. This we decided was intolerable, and we set about finding ways to improve our roofs using conventional materials. By this means we substantially reduced our maintenance cost, and have had gratifying drops in complaints about roofs. A report on our studies has been published in the form of a monograph by BRI and is available for public distribution.

The greatest need now is for study of building materials and component systems. A necessity for systems design appears to be of extreme importance. The architects are in a good position to do this, but they are often handicapped, frustrated and thwarted in their efforts.

Mr. Phillips: One of the things that I see emerging from this over-all review and workshop session is the fact that the owners need to know more about ultimate costs, the balance between first cost and maintenance. Another subject

that seems to need further action, as our surveys indicate, is a way to get good, reliable performance data on buildings. In some way, we should develop a better means of collecting these data. Also, I get the feeling, after discussing and reviewing a lot of these comments, that someone in the building industry should see what can be done to improve workmanship. And, a fourth observation is that mechanical equipment is a real problem; not only the initial cost, but the need for more packaged equipment, and less custom work on the site. Something should be done to improve the control or, possibly, minimize the maintenance of this mechanical equipment. Another one was, of course, whether or not we can cut down the very high cost of maintaining floors. This is one of the biggest items of cost in maintaining and operating a building. Also up near the top of our list of problems is the cost of painting. Unlike any other building trade, almost everything produced by the painting contractor is 100% visible. Therefore despite its high ratio of maintenance cost, we receive more human pleasure and comfort for these maintenance dollars than for most others. Paint is also, in most buildings, the best means of protecting surfaces from corrosion and other elements of destruction. Another item causing concern is plumbing and heating. I was very surprised to find plumbing maintenance costs up as high as they were, and then, of course, one that I mentioned before, wall maintenance. Whether it's brick or one of the new types of curtain walls, we don't seem to get sufficient data from building owners on wall maintenance. Finally, one other observation, there seems to be a feeling that feedback is more important to the architect than it is to the contractor or the manufacturer; that the architect is more likely to do something about it. I feel that certain manufacturers are equally anxious to know if certain materials are presenting problems.

Introduction

By Ronald Brown, * Vice President
The Tremco Manufacturing Co., Ltd.

The ensuing reports are, respectively, reports dealing with commercial office buildings, industrial buildings, residential buildings and institutional buildings, drawn up by members of the BRI Building Operation &Maintenance Study Group who have attempted to determine the degree to which each of these classes of buildings as now designed and constructed fulfills its intended functions. They present information on outstanding features and shortcomings which have become evident through operation and use of a building, and state problems of the owners and operators of these types of buildings as a means of clarifying their nature and stimulating research and development of improved design techniques, construction methods, building products, and maintenance and operation procedures.

In studying this material it is important to remember that it is not the intent of these committees to point the finger at the architect or the product manufacturer or the contractor who erects these buildings, in seeking the causes for excessive maintenance costs which relate to design and construction. We need to recognize that there are other problems which involve the owners to a considerable degree and which, while they can be controlled by architects and engineers, sometimes through habit or custom are overlooked or accepted because they are so much a part of normal operations. Therefore, we ought to review some of these briefly.

In considering the factors involved during the planning and erection of a building which result in excessive maintenance expenditures, we must recognize first the necessity for keeping costs of construction down, and second, the drive toward completing the building as quickly as possible. The specifying authority, in the first place, is usually under pressure from the owner to keep the job within a given figure. This may result in the intentional omission of certain requirements from the specification, for example, the use of auxiliary sealants in curtain walls, or the weight and quality of metal windows specified, just to name two.

The question of cost also revolves around the policy of selecting contractors on the basis of competitive bids and then requiring certain performance standards from those contractors.

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While most of us accept the practice of competitive bidding, I think we should recognize the dangers in terms of the subject that we are considering. When a contractor is forced to bid as low as he possibly can in order to get a job in a highly competitive market, he is then forced to do the job in a way that will just meet the specifications and still afford him a profit on the operation. In addition the contractor often needs money on which to operate his business, and will perform work under unfavorable conditions sometimes in order to complete the job and get his money. If he were to attempt to complete the job under the most favorable conditions it might result in excessive labor cost and a net loss on the entire job. As an example, applying insulation to a concrete deck that isn't entirely dry is likely to result in the failure of the roof later on, and yet a contractor may not be able to wait until the concrete deck is entirely dry. Another example is that of applying sealants to aluminum curtain wall grids while the grids are wet with condensation. The contractor can't afford to have his men standing around on the job until the condensation dries off the aluminum members, yet this may result in the failure of the seal and subsequent leaks.

Let's consider the matter of rushing the job to completion and how this may result in costly maintenance later on. A good example of this is in forcing the glazing contractor to close in a building in bad weather so that the plasterers and other trades can get on with their work. This may result in a failure of the glazing job, and leaks around the windows later on. A third factor is that there is often a lack of a clear-cut line of responsibility, so that when trouble occurs later on, it is almost impossible to pin the cause of the trouble on any one factor. An example is an installation of a curtain wall where leakage could be blamed on the fabricator, the erector, the architect, the contractor or the manufacturer of a sealant. Damage could perhaps have been avoided, had all of the factors met together before erection to agree jointly just how the members were to be sealed adequately, and to consider all of the problems arising and reach an agreement with respect to the solution of these problems.

Another example is where the owner of a building finds that the bond on his roof is worthless because it's impossible to determine whether the difficulties of the roof are the fault of the architect, the general contractor, the roofing contractor or, maybe, the material manufacturer. This kind of a problem may have been avoided by a meeting between the architect, the roofing contractor, and the general contractor before they started the job in order to agree that all of the conditions were right for the installation to be made. Many problems of this kind could have been avoided had the area of responsibility been clearly spelled out in advance, and had there been a clear-cut standard of performance outlined in the specifications which, while sometimes more costly, would enable the contractor to do his best work and still come out with a profit.

Finally, in considering the question of building maintenance and the way in which a certain element of a building stands up through the years, something should certainly be said about the care of the building once it is turned over to the owner. Lack of a preventive maintenance program can materially increase maintenance costs and decrease the service from the various elements provided during the erection of the building.

Commercial Office Buildings

By George R. Bailey,* F. L. Gilbert and
Horace W. Wilds

Mr. Bailey:

Building managers and operators are inclined naturally, when they find certain things wrong with their buildings, things that they think could have been designed differently, to say why on earth did they design it that way? And yet, we know, as has been observed, that very often these faults are due to the circumstances under which the buildings were built. So, even though many people in our end of the business are being somewhat critical, in the back of our minds we understand the underlying problems that cause some of our difficulties.

There are three authors for this report on "Commercial Office Buildings," each of whom worked separately. It is, therefore, broken up into three parts. As an introduction to what will follow, permit me to point out that it is our understanding and interpretation of the spirit of this conference that those of us who face from day to day the problems of managing buildings are to bring to your attention, or "feed back" if you please, the particular problems that vex us in the routine of building maintenance, and in our efforts to show a profit, an economic justification, for ownership. It is easy to criticize; we hope to avoid taking a destructively critical attitude, for we too realize these are problems that cannot be solved with the snap of a finger. Let us, rather, review some of these problems in order to keep them before the creative elements of the building industry, namely, the architect, the engineer and the manufacturer.

Most of us realize very thoroughly the necessity of maintaining our buildings, and never letting them begin to run down. In a large office building, this means maintaining a multitude of things. Yet, once you have a cracked piece of glass here, a scratched door there, and something missing somewhere else, your building is beginning to run down. If you don't keep those little things up, even though they are troublesome and the expense may seem out of proportion, after a given number of years your building is observably run

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down, and the tenants begin to grumble about sloppy maintenance. And, eventually, you can reach the point where the cost of bringing your building back to what it originally was is extremely expensive; the money that should have been spent in maintenance from year to year has been disposed of otherwise.

The problem of maintenance is similar to the problem of the architect who is restricted in what he can spend. If we are permitted to spend what should be spent on proper maintenance, the buildings can be kept up, and not allowed to fall into the second-class status many of them find themselves in, just because one thing after another has been permitted to run down.

Mr. Wilds:

First, I would like to present a few points which I hope will promote better understanding between those of us who operate the buildings, and the people who design and build them. Architects, of course, are creative artists; this is as it should be and we respect them as such. Engineers design the air conditioning and other mechanical and electrical equipment, tell us what type and size it should be and where it should be located. The builders take the architects' and engineers' plans, and the owners' money, and change them into a beautiful building. When this is done, they all stand back and admire it, and everyone congratulates them and tells them what a wonderful job they have done. The owner is pleased, even though it may have cost him $25 to $50 per square foot, or more.

So, off go the architect, the engineer and the builder to another job. Then we, the manager and operating men, come along, and sometimes we find there is a big difference between technical design and practical operation. So, we conclude that architects, engineers and builders are only human like the rest of us, and they can make mistakes. Nevertheless, for the life of the building someone must operate and maintain this building, and in so doing will spend for operation, maintenance and alterations an amount equal to the cost of the building every 10 to 15 years.

Probably what the architect needs most from his clients is the realization that a building must be operated efficiently and/or economically, and for this reason it is best to be extremely critical, from an operating standpoint, during the design stage rather than after the building is completed. And, what the building manager and operator want is recognition that they, too, know something about a building and what should go into it. We also want you to respect our judgment because, right or wrong, if in our opinion a building is not practical and economical to operate, we are going to do what we can within economic limitations to make it so.

Mr. Gilbert:

As one of the objectives of this conference, we are attempting to determine the degree to which our buildings, as now designed and constructed, do fulfill their intended functions. We, as operators of buildings, are asked to present shortcomings which have become evident, in order that problems may be clarified and research developed from proof. I would like to outline for you and discuss briefly some of the shortcomings of air conditioning equipment, as I have observed them in various installations, both in our city and elsewhere, particularly throughout the East.

The first, and probably one of the worst, headaches is the method of drive for cooling tower fans. Those of us who have been trying to cope with belted fans have had nothing

but trouble. This is particularly true where the distance between the fan pulley and drive pulley is more than four feet. In our case, where this distance is seven feet, it is almost impossible to keep belts on the pulley, or to keep them from wearing out very rapidly as a result of friction from uneven wear and the effects of the outdoor elements. Wear occurs in our case even though we use special stainless steel core belts. Even an installation of 4-inch wide timing belts with specially geared pulleys only lasted for approximately 250 hours of operation.

This poor experience with belts was entirely due to inability to keep the drive pulley in alignment with the fan pulley, since the fan assembly is fastened to the wood of the cooling tower and is subject to exposure to the outside elements, with a resultant misalignment of fan and motor assembly. The sag of these V belts over a seven foot span is also a contributing cause of the wear and their failure. I make a plea for a direct gear drive for cooling tower fans and, if belts must be used because of economy, then can they not be designed so that the fan assembly and the motor assembly are fastened to the metal and not to the wood?

Second, I would like to mention the matter of chilled water and condensate pumps, particularly where these pumps operate under specifications calling for mechanical seals. Many of our installations have been experiencing difficulty in keeping these seals tight, and replacing them is quite a complicated process requiring mechanical equipment and know-how which the average office building staff does not possess. After much difficulty in our first six months of operation, we had a standard packing gland installed on these pumps, and we have had no further problem. Now our engineers can repack a stuffing box in a short time and have the pump back on the line. Many of our building operators have also reported difficulty with the bronze sleeves of these pumps. Some of them reported as many as three sets of sleeves worn out in one air conditioning season. I would like to suggest that these sleeves be either monel metal or stainless steel. We have replaced our bronze sleeves with stainless steel of 500 Brinell hardness, and after two complete seasons they have shown practically no wear. The original bronze sleeves lasted for only one month of operation. Fortunately, we had sufficient capacity and enough compressors to get through the season while these new sleeves were being installed, which is a good example of the value of an installation utilizing several compressors, rather than just one large one.

From the standpoint of operating economy, it is much better and more efficient to have smaller compressors and more of them. Of course, there may be an economical angle to such an installation which may preclude it. Also, I would like to suggest there is a place where auxiliary, perimeter secondary pumps are a must, and that is where you have a perimeter high velocity cooling system. You can get along in the summer without air conditioning if one of your pumps breaks down, but you can't get along in the winter without heat. Unfortunately, some systems are designed for economy reasons with only one pump for each zone. Our air conditioning system installation was about half completed when I suddenly discovered that we only had one pump on the secondary system. All the piping had to be disconnected, new pumps had to be hurriedly bought, and we had to make an installation of auxiliary pumps.

Next, I would like to make a plea for an adequate fresh air supply. I think one of the greatest problems in air conditioning systems is a lack of fresh air. Many of our systems are now designed for 100% fresh air, which is very valuable to us, particularly in the spring and the fall. This is the time when we have our greatest problem with air conditioning, when tenants in one portion of the building complain of being too cold, and the

opposite side of the building is too hot. In many installations this situation cannot be adequately taken care of, due to the fact that on the winter cycle you have hot water in your lines, and on the summer cycle you have chilled water. However, I understand that some installations have what is called an intermediate cycle, where chilled and hot water can be blended to have tepid water in the lines, or warm water in one zone and chilled water in another.

I would also like to recommend that wherever possible adequate meters be installed both on electrical equipment and water supply. We have been fortunate in having such sub-meters which can accurately measure the electrical consumption of our compressors, fans, pumps, etc., and the water consumption for this equipment. These meters have more than paid for themselves by alerting our engineering staff to unusual consumption patterns that have been corrected, which in turn has produced economy in operation.

I realize that many of these items, and others which I have not mentioned, are in most cases a matter of economics, stemming from the so-called preliminary or budget estimates for air conditioning systems. This is especially true where air conditioning of an old building is being considered. In order to sell the job, estimates are often kept too low, and then, in order to try and meet the estimate, changes must be made which tend to reduce the efficiency of the system. As an operator of buildings, I would like to make a plea for carefully written specifications that will produce a system which can be operated efficiently and economically the year round and, if certain things must be eliminated due to budget limitations, the owner should be advised of the possible shortcomings of the system, so that we, as operators of these systems, will not have to bear the brunt of the owner's ire when it does not meet his expectations or when premature replacement costs are necessary.

Another matter that is probably somewhat controversial is the use of the hinged entrance door to replace the revolving door. There are three banks on one corner in Philadelphia, all of which were equipped with automatic hinged doors when alterations were recently made. Subsequently, all three of those installations had to be changed, and the hinged doors replaced with revolving doors. In our building, which was one of the three, the installation was only two months old, and the bank had to spend $20,000 to take three sets of automatic hinged doors out and replace them with revolving doors, due to the difficulty of keeping the space heated. I realize that revolving doors are not necessarily a thing of beauty, but in two of our buildings we have revolving doors in the center and swinging doors on each side to meet fire safety restrictions. We note that about 95% of the people who come into the bank or the building customarily use the revolving doors. With the hinged doors, even though you have a vestibule, and even though you pump all the heat you can into the vestibule, if you have much traffic the automatic doors stand open too often and you cannot heat adequately.

Mr. Bailey:

I would like to see, in the writing of specifications, more attention given to better instrumentation of our buildings. Too often, because the owner is fighting the problem of costs, things that aren't considered entirely essential to the operation of the building are left out, and many times that means inadequate instrumentation. To those of us who operate the property, this is a regrettable omission, and although we try to remedy the situation later, often it is less expensive to have it done correctly in the first place.

Many of you have heard of the Building Planning Service of the National Association of Building Owners and Managers. This service has had some 200 assignments, including

many of the outstanding office buildings in this country and Canada. The modus operandi of this service is to call in from four to eight practical, experienced building operators to review the preliminary plans of the proposed office structure and to make recommendations with respect to the over-all economics of renting the building, the specifications as they relate to cost of maintenance, and the practicability from the standpoint of building operation. These people are not engineers, architects, or air conditioning consultants, but are the kind of people who, from their experience, can examine the preliminary plans in an intensive, two-day session, and uncover a great many things.

The over-all problem with commercial office buildings is not, of course, income. The design of these buildings is vitally important, and only by taking advantage of all the little things you can do to make a building economically sound, are we going to be able to combat the tremendous cost of building them. Generally, around the country, we find the cost of the ordinary, good multistory office building at about $40 per square foot, with some of the more elaborate buildings running as high as $60. And, of course, we recognize that, from the standpoint of renting, the glamour elements of some of these buildings are highly important. We sometimes have recommended that buildings be high, when they could have been built more cheaply per square foot if they were lower, simply because the lower building would lose some of its glamour, its appeal to the people who are going to rent space at high rates in that building.

For example, in the case of a new glass-walled building in Minneapolis, it was recommended that the building be 29 stories high, even though it could have produced as much area at about 18 stories. The average rental rate for office space in Minneapolis was somewhere around $3.75, but this building required $5.85 per square foot if the owners were to realize a fair return. In this case, one needs all the help he can get in the way of unusual design and special features in a building. If it's a big, glamorous-looking building, it makes the job easier for the man who is renting the space to fill it up. In this connection, we're in favor of all the glass perimeter possible, because that is what appeals to the prospective tenant—he wants plenty of windows. That doesn't necessarily mean glass that goes down to the floor level or above the ceiling, but rather it is the horizontal extension of the glass that is important.

In addition, we are opposed to buildings with a solid end wall. The corner office always brings a premium rental rate, and the premiums that you can get for corner offices on all floors of the building will more than offset any saving you may have in your required capacity of air conditioning by using that solid wall. Over the years, our thoughts have crystallized with respect to many features of office building design, but office buildings have changed radically since the last war, and many questions exist today which experience alone, for lack of elapsed time, cannot answer. It is our thought to propound here some of these questions, particularly since they relate in some degree to all buildings.

We are, quite frankly, more interested in preventive design than in corrective procedures. The purpose of the office building is to provide space of maximum utility for individual users or for multiple tenancy. There can be some difference in the respective requirements of the two, but we will restrict ourselves here to the large office building designed for multiple tenancy. In New York City, of course, the situation is somewhat different. They have built more space than we have in Chicago, but it is in many cases for occupancy by single large corporations who can use this very deep space to good advantage. Where you are renting to a number of tenants, and a man wants a small office, you can't divide that type of building up. Buildings for multitenant occupancy must take advantage of every favorable element of design if they are to survive economically. The effect on the monetary

return is geometric as between the improperly designed structure, and the building that is analytically designed to avail itself of every possible advantage.

We are concerned that every building be as economically sound as possible, because when a building fails, unlike industry, it doesn't go out of business—it's still there. As a consequence, someone buys it for much less than its original cost, and then can take a much lower rent for the space, and that makes for rather disastrous competition. Market and available finances will largely govern the size of a given development, but in general we favor the maximum size within a given range that can be supported by vertical facilities. If you can add two more floors to the building and your elevators don't have to be increased in number or you don't have to increase your foundations, you get those two additional floors at a lower rate per square foot, and they will bring you the maximum in rents. The top floors always give you the best rents.

For instance, in Detroit, a contemplated new structure was planned as a square tower. It was desirable that the building be square from the architectural standpoint, and yet that made it a very expensive building. By suggesting an additional 30 feet all across the back of the building, we did not increase the vertical facilities and, whereas the square tower would have cost about $60 per square foot, the other design came to about $50. In this particular building, the architect is creating almost a cathedral effect with a very unusual mosaic exterior. He's taking his glass all the way down to the floor, but he puts in an intermediate mullion to give people the necessary feeling of security. Many people don't like to be on the 20th floor, sitting next to glass that goes all the way down to the floor level.

We favor typical floors of at least 10,000 square feet, and space up to 30 feet in depth. Shallow space does not carry the premium it did when we depended upon windows for light and air. An extra depth of space can be constructed for less than proportional cost, and the net income therefrom is proportionately greater. Good design will usually produce some 76% of usable space net with respect to construction floor area. Don't believe the figures you hear that say you can get 80% or better in a multiple tenancy building. This can be achieved in the big corporate-type buildings, but not often in those constructed for multiple occupancy.

One of the major factors in floor efficiency is the design of the core, which should not only be of the minimum area consistent with utility, but should be designed to require a minimum of corridor to reach the stairway and the rest rooms. Too often we find a core with the elevators in the middle and the rest of the core designed that you must have a corridor all the way around it in order to get to the stairs and rest rooms. That isn't necessary; you can have a corridor across one side of the core that will lead into the stairs and rest rooms.

All of this may sound quite elementary, but it represents a difference between success and failure in the operation of a building, and as an element of economics, cannot be subject to too much analysis. We building operators are sold on a 4'6" module, a 9' ceiling height, pivoted windows, as much glass perimeter as possible, and windows extending from desk height to 8' above the floor. We particularly like the 4'6" module because when you have integrated your floor ducts, exterior mullions, ceiling lights and air conditioning, then revisions can be made in the floor space as time passes without prohibitive expense. With this module you can run partitions into the exterior mullions and obtain an office of 8'+ in width. For instance, a prospective tenant who runs an insurance company may be looking for 10 to 20 private offices. If you can provide 20

private offices 8' wide, he doesn't have to take nearly as much space as he would in a building with a 5' or 6' module. There are many 6' module buildings going up around the country, but it is awkward to take partitions and off-set when you get to the outside wall in order to reduce private offices to 8'. It looks bad from both the interior and exterior. In these new buildings, not so much in New York as in other cities, we are quoting rents of $5.50 to $6.50 per square foot to tenants who are currently paying $3.50 or $4.00, so we don't want to add to the burden of increased rate by making the tenant take more space than he really needs. That's what makes the module a most important thing in our business.

As to pivoted windows, we like them from the fire-safety point of view. There is still a question in my mind as to what will happen with fixed glass windows in case of fire. We know that the smoke and gas rise to the top of the building, and we are not sure, in the sealed buildings, whether the air conditioning system can take it out fast enough. If the stairways should happen to fill with gas and smoke, people would most probably panic, and as has happened, begin to throw furniture through the windows to get some air.

Another point in favor of pivoted windows is that they can be opened if the air conditioning system breaks down. In a sealed building, if your air conditioning goes off and you have your lights on, the temperature is going to rise about 20° in an hour, even with only 70 footcandles of lighting. That means no one can work and have lights on unless the air conditioning is working in the summer. Even in such locations as Calgary, Montreal and Duluth, it is becoming necessary to have refrigeration for commercial buildings because, while the weather would permit opening the windows and still keep tenants fairly comfortable, the large lighting loads we have today make air cooling mandatory.

On the matter of the glass perimeter, I might mention that the Detroit Edison Company built a building in which they used obscure glass windows, and most of these had to be replaced with clear glass because, after the building was occupied, the employees felt they could not work comfortably in such surroundings. They felt too confined and wanted to be able to see out of the windows. There is a sort of paradox in this, when you think of the people who sit way out in the middle of large open spaces in the new banks or corporation buildings and are perfectly satisfied not to look out of the window. However, the individual tenant, who represents by far the greatest user of office space, wants plenty of windows made of clear glass.

We like to have the glass start at desk height because of the heat loss in the floor-to-ceiling window, and because we get a certain amount of glare through the lower section. We also don't like glass to extend above 8' in height, thus permitting the janitor to clean it with a hand tool and not drag along a ladder or box and mar the furniture.

There are a number of other areas in which building operators are still seeking answers. For instance, there is no unanimity of opinion with respect to the various types of floor slabs, concrete, metal deck, etc. There is no consensus regarding the live load in these buildings, and we are all wondering about this in terms of the heavy office machinery that is being currently used in so many of them. That is something that must be considered if, as time goes by, our tenants are going to be using more and more computers and machines of that kind, which have to be moved in on the freight elevators. Too often, we find a freight elevator specified at the same lifting capacity as a passenger elevator, say 3,000 lbs. No freight elevator should have a capacity less than 5,000 lbs., and the expense of an elevator is largely in its speed, rather than its capacity, anyway. Also, speed in a freight elevator is something that should not be overlooked, because with high priced mechanics traveling up and down, a lot of time can be wasted both riding and waiting.

Exterior spandrels are another thing about which we are concerned. For instance, some of these spandrels with heavy aggregate have stones half the size of your fist, and they're half exposed, in order to give a certain effect. Is the cement going to hold those stones forever, or is it eventually going to break down a bit and precipitate stones from the upper floors?

Also, some of us are concerned about the installation of window frames. Too often there is condensation on the window frames immediately after we begin to raise the humidity on the inside of the building in the winter. This, of course, offsets the economy that should be inherent in the use of double glass. Whether these window frames of aluminum, stainless steel or bronze can be insulated so we don't have this condensation problem, is another thing that we would like to get the answer to.

As to the type of window glass, apparently nobody agrees on whether double glass is entirely justified today or not. Of course, it's a geographical consideration; when you get up as far North as Calgary, for instance, you have a real need for it in the winter, but at just what point this situation ends has not been determined. It isn't just a matter of the heat transmission of the respective light of glass, single or double. We must bear in mind that there is an extra cost for the double glass, and there is also the extra cost of the additional framing to carry it on the exterior of the building. Then there is this matter of tinted glass on which nobody agrees. You find green, amber, light blue and a lot of gray glass being installed today. We are beginning to hear from some of our members that tenants don't like the gray glass very well. That doesn't mean that everyone objects to it, but there is an increasing number of complaints.

Another consideration is the use of sun shading devices. While this also is a geographical matter, it is claiming more attention throughout the country. In Miami, Fla., one of the bank buildings contemplated would have vertical louvers extending about 10 stories. My first thought when I saw the plan, as a building operator, was how long is that system going to work before it breaks down? It is an automatic system, and we don't yet know, from a mechanical standpoint or a maintenance standpoint what it is going to entail. Then, there are the so-called "eyebrows" being put over windows to keep the sun load off the building itself. One building in Houston has these around every floor of the building, consisting of long strips of aluminum extending out about seven feet, with brackets and aluminum channels with the hollow side turned down so they won't catch the wind and water won't collect on them. One of the advantages to this installation is that the window washer can walk on these eyebrows, or travel around the building on a little trolley cart.

Another problem which has occurred with fixed windows arises in connection with washing them. It is necessary to use a scaffold and, if a man is taken sick and the scaffold gets stuck, and you want to get him off the scaffold quickly, you can't do so. You must make repairs, and then take him all the way to the top or to the bottom. Many of us feel there should be some intermediate point on the building where the workman can be brought inside in case of such trouble. Also, there is a great need for some standardization on types of scaffolding and their design for the utmost safety.

A problem that is occurring on glass-walled buildings with metal framing in some northern cities is the formation of icicles. They are proving to be quite a menace in some cases, falling suddenly into the streets. And, to list just a few more matters for consideration; we'd like to see some thought given to ceiling design of perimeter convectors, flexibility of air conditioning systems, plaster substitutes, adjustable doors that don't have to be cut off at the bottom when someone puts in carpeting, more practical window shades,

colored sidewalks, building intercommunication systems, fire alarm systems, fire fighting equipment, roofing materials, elevator cab lighting, control centers, individual light switching, etc.

All of these things are subjects that we feel have not been sufficiently studied. We are not unaware that everything should not, and cannot, be the same; that quality will often be dictated to a certain extent by circumstances. However, the foregoing list of items are some that trouble us on our various assignments, and they represent collectively an appeal for more research and the establishment of standards.

Industrial Buildings

By Robert F. McCaw,* Managing Editor
Power Engineering Magazine

To approach the subject of industrial building performance, we acted under the assumption that industrial buildings are of extreme importance to BRI members for several reasons. First, some 200 members of the BRI are manufacturers and, as such, have their own industrial plants to maintain. These same members, plus almost all of the others, are vitally interested in buildings, as such. Also, a large part of all the building products manufactured by members of BRI and other manufacturers are sold to the building industry.

With this in mind, our committee sent out a questionnaire to 200 manufacturer members of BRI, those members who are operating their own industrial plants. To limit the coverage, we arbitrarily selected six building components and, to get a best response, a check-off type of questionnaire was sent out. Returns amounted to 50% which, as many of you know, is a good return for any sort of a questionnaire. The arbitrarily selected building components were roofs, walls and floors; plumbing, heating, ventilating and air conditioning as a system; and the electrical system. In the questionnaire, cost data were invited, but as most of you probably realize it's very difficult to get anybody to tell how much he spends for things of that nature, so there wasn't much return on the cost question. The results of this survey have been tabulated and appear as an appendix to this paper.

Some of the highlights include, in the roof category, the fact that 74% of respondents stated that their biggest expense was with the covering and they had practically no expense with the insulation. Copper seemed to be the most satisfactory type of metal roof material and, in 52% of the cases, roofing maintenance is done by outside contractors.

In the walls category, solid brick seems to be lowest in maintenance cost, but leakage problems seem to occur as the result of poor flashing and mortar joints. As interior wall finish, painted plaster has been given the highest maintenance cost, and in the complete wall system, 65% of the respondents indicated that the sash are the greatest maintenance expense, the principal cost being rust. In the next category, floors, there seems to be a common problem in all industrial plants, ordinary concrete being the worst offender.

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Spalling was listed by 59% of the respondents, and dusting by 50%, as causing maintenance costs. As to floor coverings, where they were used, asphalt tile seems to be the most satisfactory.

Practically all of the respondents had quite a bit to complain about in their plumbing systems. Faucets, mixture valves and traps were given very low ratings in the degree of excellence scale. Apparently there is a definite need for improvement in both design and materials in this particular category. In the heating, ventilating, air conditioning department there seems to be room for great improvement in industrial plants. In general, pipes, valves and fittings come in for a lot of criticism maintenance-wise. In the complete air conditioning systems, controls and system balancing appeared to be the biggest problem. In ordinary heating systems without the air conditioning, 39% of the respondents reported the valves, traps and fittings caused the highest maintenance cost; piping second, and controls third. And finally, in building electrical systems, the greatest maintenance expense is in lamp replacement, second in overloaded circuits, third in maintenance of lighting fixtures, and fourth in the resistance wiring systems in the plant.

As you are well aware, the plant engineer is the owner's representative in industrial plants. He is the person responsible for the construction, maintenance and operation of all industrial buildings, and he is the one who has all the headaches as well as most of the answers. A questionnaire was also recently circulated among the members of the American Institute of Plant Engineers, which is an organization of about 1,800 plant engineers all over the country whose objective is to correlate all the information they have on building maintenance and operation. In this second survey the same factors came out as causing high maintenance costs in the industrial buildings as those cited in the BRI survey: heating and ventilating, roofs, floors, walls and windows. Another question in this particular survey was: "If you built a building in the last few years, how did you get along with the architect and engineer?" The report summary shows that of those employing architects and engineers, 44% were very satisfied with the relationship; 43% reasonably satisfied. Only 8% were somewhat dissatisfied, and the very nominal 5% were entirely dissatisfied.

In another question the respondents were asked to rank the problem areas they had in order of their importance to them. Some 96% of these people ranked from 4 to 13 items, and these have been correlated and weighted by number of first, second, third and fourth mentions. Even though we arbitrarily picked six categories for the BRI survey, it is interesting to note that there are many other problem areas in the maintenance of industrial plants. Responses to the AIPE survey listed ventilating equipment, roof, floors, heating equipment (which ultimately was lumped together with ventilating), walls, windows, electrical system, lighting, doors, water system, storm sewers, sanitary sewers, foundations, plumbing, docks, fire protection, basements, and last but not least, with one comment, tunnels.

Perhaps one of the most significant findings of that survey and also the BRI survey is that heating and ventilating combine to present at least 25%of the plant engineers' industrial maintenance headaches. So far, these surveys have just been figures showing where problems exist in industrial plants.

In addition, we have taken some of the comments from the surveys indicating particular problem areas. In heating and ventilating equipment comments, for instance, one respondent said the heating and ventilating unit was noisy, and was installed above a quiet area. He added, though, "This was our responsibility, and we will take steps to correct it." Also, heating and ventilating leaks and failure to design maintenance convenience

features into the system are common complaints. And again, some reported that ventilating systems became inadequate after the building had been occupied only one year. In another case, the ventilation provided was not adequate for removal of process fumes. This, of course, is a joint responsibility, and the architect may not have been properly advised on just exactly what the process was and how it would affect the ventilation of the building.

Roofing comments include slight leaks near the parapet, flashing leaks and gravel that starts blowing loose with the wind. One comment on floors stated, "We have a beautiful, well laid tile brick floor that does not pitch to the drains." In the area of walls, there were some comments on water coming through block walls which were planned as temporary because of proposed expansion in future years. Again, this comes back to proper design for expansion, and how that problem is to be solved. Another comment on walls involved reinforced concrete for 5' under metal siding. The concrete was not strong enough, and had had several holes knocked in it. That should be the contractor's problem, I would think.

On windows, covers had to be installed for a building with glass panels on three sides, on account of sun glare. The glass also leaked. To summarize, there are problems in industrial plants over and above those experienced in commercial buildings.

Obviously, the building owner or, in this case, the owner's representative who is the plant engineer, wants the best designed products because he's paying the bill, and will continue to pay the bill to maintain this building long after it is built and the architect and contractor have shaken hands, given a loud sigh of relief, and left the site. The manufacturer of building products who is selling to the plant engineer wants to sell his highest quality materials because he wants to maintain his good reputation and, of course, he wants to make a profit. Also, the architect wants to design the best industrial building, because satisfied clients are his best recommendation. And finally, the building contractor has probably the greatest stake in the picture, because he's blamed for every building defect and wants to protect his own reputation. So, what is the answer to industrial building problems? We suggest that the building owners might be the most valuable source of research obtainable, and at the lowest possible cost. We further suggest and recommend that to obtain the feedback these study groups are trying to get, particularly on items such as heating and ventilating, roofs, floors, walls, electrical systems, etc., in industrial plants, the BRI work together with the plant engineers as the owners' representatives in the industrial plants to set up surveys if necessary, or further study group work to progress toward faster solution of these problems.

APPENDIX

COMPILATION OF SURVEY ON INDUSTRIAL BUILDINGS

This survey was concerned only with main building components, as a whole. These were: roofs, walls, floors, heating-ventilating-air conditioning, plumbing and electrical systems. All questions applied only to building components, and not to production facilities. Responses by sections are listed below:

Roofs

1) Heaviest maintenance cost is:

   Roof covering—58%; Flashing—30%; Deck—7%; Insulation—0%; Other—5%.

2) If metal roof, greatest problems are with:

   Galvanized steel—66%; Aluminum—12%; Copper—2%; Stainless—2%; Protected metal—18%.

3) Most satisfactory pitch of roof is:

   Slight pitch—52%; Steep pitch—24%; Flat roof—19%; Uncertain—5%.

4) Most satisfactory type of flashing is:

   Copper—49%; Plastic—11%; Galvanized iron—10%; Stainless—7%; Aluminum—5%; Lead-coated copper—5%; Lead—1%; Miscellaneous—12%.

5) Most susceptible to wind damage:

   Metal—51%; Built-up—49%; Flat—50%; Pitched—50%.

6) Type of roof suffering most from winter ice and snow is the flat, built-up roofing combination.

7) Do you have a really practical system of preventive roof maintenance?

   Yes—60%; No—40%.

8) Preventive maintenance programs are:

   Scheduled repair—55%; Periodic inspection—26%; Repair when necessary—19%.

9) Roof-life extended by keeping roof wet:

   Yes—35%; No—65%.

10) Reflective coating extends roof life:

Yes—67%; No—33%.

11) Substantial temperature reduction:

Yes—76%; No—24%.

12) Cost is justified:

Yes—66%; No—34%.

13) Roof maintenance is handled by:

Outside contractor—52%; Own forces—48%.

Walls

1) Building walls are of these types:

Solid brick—21%; Brick and cinder block—13%; Glazed tile—7%; Brick and glazed tile—7%; Insulated concrete—3%; Sandwich panel—11%; Galvanized steel—6%; Mastic-coated steel—13%; Aluminum—5%; Concrete block—2%; Asbestos-cement—8%; Precast concrete—2%; Other—2%.

2) Lowest maintenance cost is with:

Solid brick—50%; Brick and cinder block—14%; Aluminum—12%; Concrete block—6%; Galvanized steel—6%; Glazed tile—4%; Asbestos-cement—4%; Precast concrete—4%.

3) Highest maintenance cost is with:

Galvanized steel—32%; Brick—20%; Asbestos-cement—18%; Concrete block—10%; Brick and cinder block—6%; others—14%.

4) Factors causing high wall maintenance:

Mechanical damage, erosion and corrosion, settlement, leakage.

5) Leakage through walls caused by:

Flashing—26%; Mortar joints—24%; Poor design—7%; Erosion—2%; Corrosion—6%; Poor gaskets—3%; Failure at sash—13%; Poor design of parapets—8%; Lack of weep-holes—6%; Lack of expansion joints—2%; Settlement—1%; Lack of waterproofing—1%.

6) Interior finishes having highest maintenance costs:

Painted plaster—61%; Painted brick—13%; Painted cement block—4%; Porcelain—2%; Plastic-covered—3%; Galvanized steel—2%; Asbestos-cement—10%; Other—5%.

7) Sash constitute a major maintenance problem:

Yes—65%; No—35%.

8) Principal causes of sash maintenance:

Rusting—21%; Glass breakage—20%; Painting—13%; Rotting—10%; Caulking—10%; Cleaning—9%; Operating mechanisms—7%; Warping—6%; Glare reduction—3%; Poor design 1%.

Floors

1) Types of floors having highest maintenance costs:

Plain concrete—47%; Hardwood—17%; Asphalt tile on concrete—12%; Wood block—10%; Steel plate—3%; Laminated wood—2%; Asphalt tile on wood—2%; Acid-resistant—2%; Other—5%.

2) Traffic aisles require heavy maintenance:

Yes—48%; No—52%.

(In those plants where aisles are a big problem, concrete is the worst—66%; wood block next—16%; other—18%.)

3) Concrete spalling is a problem in 59% of the plants reporting. Also, dusting is a problem in 50%.

4) Concrete floor repairs are made by:

Patching with mastics—33%; Patching with concrete—40%; Applying complete new surface—7%; (64% used concrete, 36% used mastic).

5) Best experience in floor covering has been with:

Asphalt tile—33%; Vinyl tile—27%; Vinyl-asbestos—19%; Linoleum—6%; Rubber tile—5%; Magnesite—3%; Other—7%.

6) Traffic aisles are of the same material as the floors in 88% of the plants reporting.

7) Acid-resistant floors are reported to be expensive to maintain in 48% of the cases. Most users are not satisfied with present materials; feel that improvement is needed.

8) In those plants using hard-surface topping materials, 43% report that material is unsatisfactory.

Plumbing

1) Greatest plumbing maintenance problems are:

   Stoppages in sewer lines—21%; Faucets—16%; Corrosion—11%; Flush valves—9%; Floor drains—8%; Traps—6%; Urinals—6%; Stoppages in toilets—6%; Stoppages in lavatories—4%; Other—13%.

2) Water softening equipment is used in 34% of plants reporting. In plants where water is not softened, 79% report no problems due to hardness.

3) Sweating on pipes is a problem in 40% of plants reporting. Of these, 20% consider the problem serious.

4) Replacement of piping in plumbing systems is made with:

   Copper—37%; Galvanized steel—30%; Plastic—10%; Black steel—8%; Cast iron—5%; Wrought iron—3%; Transite—3%; Stainless—2%; Aluminum—2%.

5) Plastic pipe is used for certain drain lines by 29% of plants reporting, and is found satisfactory.

6) Suggested improvements needed in plumbing equipment:

   Quiet, self-cleaning flush valves; standardized faucet washers; simple cleanout for traps; Non-plugging shower heads; better shower mixer valves.

7) Of the plants reporting, 43% are using water conservation devices; 57% are not. Large majority of users say these devices are not high-cost maintenance items.

Heating-Ventilating-Air Conditioning

1) Air conditioning systems used in the production areas:

   Natural draft—29%; Forced draft—25%; Equipment exhausts—18%; Wall exhausts—13%; Refrigerated air systems—9%; Washed air systems—4%; Evaporative coolers—2%.

2) In those plants using ventilating exhaust systems, 39% filter the incoming air; and, 50% heat it.

3) Greatest maintenance on ventilating systems:

   Motors, filter cleaning, lubrication, louvres.

4) In refrigerated air conditioning systems, the greatest maintenance problems are in:

   Filters—21%; Controls—19%; Balancing of air-flow—16%; Dirt around diffusers—14%; Compressors—10%; Evaporative condensers—6%; Fans—3%; Noise—3%; Ductwork—2%; Water consumption—2%; Vibration—1%; Other—3%.

5) In ventilating equipment, the problems are fairly well distributed over the range of components. Lubrication leads, and ductwork is at the other end of the scale. Many types of systems are in use in plants reporting; also, combinations of systems. (No general pattern.)

6) Respondents had many complaints concerning present air conditioning equipment.

7) In heating systems, the greatest problems are:

Valves, traps, fittings—39%; Piping—16%; Controls—16%; Boilers—13%; Radiation—6%; Motors—2%; Other—8%.

Electrical

1) Greatest electrical problems are:

Lamp replacement—23%; Overloaded circuits—18%; Fixture maintenance—12%; Inflexible wiring—7%; Grounds—7%; Fuse panels—6%; Starters (motor)—6%; Controls—5%; Circuit-breaker panels—3%; Other—13%.

2) Group replacement of lamps is practiced by 25% of plants reporting; 75% use single-relamp policy.

3) Electrical maintenance done by:

Outside contractors—12%; Own forces—88%.

4) Concerning location of lighting panels, 80% stated they are located satisfactorily; 20% find fault with locations.

(As to circuit arrangement of lighting circuits for most economical switching, 32% reported their circuits were not so laid out.)

5) Greatest elevator problems:

Controls—49%; Interlocks—34%; Hoist motor—8%; Signals—1%; Other—8%.

6) Automatic light and power conservation devices are used by 28% of the plants; 72% do not use them.

7) In suggesting better design of electrical systems, most respondents asked for more capacity and flexibility.

General

1) Major maintenance problems occur 20% in buildings under 10 years of age, and 80% in those over 10 years.

2) As to whether these major problems could have been reduced or eliminated at time when buildings were built, 77% stated they could have been by:

Spending more money—25%; Better work by contractor—15%; Better materials—16%; Better weather—8%; Better design—36%.

Panel Discussion

Moderator - Ronald Brown, Vice President,
The Tremco Manufacturing Co.

Panel Members - Harry H. Batchelor, Vice President, James W. Rouse & Co., Inc.
Robert B. Beach, Executive Vice President
Natl. Assn. of Building Owners and Managers
Robert Englebrecht, Editor for Architecture
LIVING for Young Homemakers
Monte Florman, Head, Appliance Division,
Consumers Union of U. S., Inc.
John L. Haynes, Managing Director, Producers' Council
Joseph Hazen, Managing Editor, Architectural Forum Magazine
Alfred Jaros, Jr., Partner, Jaros, Baum & Bolles
Gustave Keane, Production Administrator,
Associate of the firm of Eggers & Higgins
J. W. Kreuttner, Vice President, Buensod-Stacey, Inc.
Maxine Livingston, Family Home Editor, Parents' Magazine
Robert W. McKinley, Technical Representative,
Product Development Dept., Pittsburgh Plate Glass Co.
Saul Saulson, Vice President & Chief Mechanical Engineer,
Albert Kahn Associated Architects and Engineers, Inc.
Fred N. Severud, Partner, Severud-Elstad-Krueger Associates
James J. Souder, Project Director, Collaborative Research in
Hospital Planning; Partner, Kiff, Colean, Voss & Souder, Architects
Roger G. Spross, Architect,
Vorhees Walker Smith Smith & Haines, Architects
Oswald Stewart, Associate Editor, Factory Magazine
William C. Wallin, Plant Engineer, Western Electric Co.

Howard Phillips, American Tel. & Tel. Co.: It looks as though BRI is going to have quite a study project ahead of it with respect to commercial buildings and I hope that this information feedback will prove valuable and helpful. It seemed to me one of the most significant points made was that the people to be involved in operating commercial buildings should be consulted in the design stages of the proposed buildings, for the reason chiefly of keeping the architects aware of the importance of lower cost of operation in the interest of profitable operation of a building, and of putting into the building features that attract renters, safety features and things of that kind which the practical operators may be able to suggest.

Mr. Saulson: I have always had the greatest respect for the National Association of Building Owners & Managers and their consulting committees. I have had the good fortune to sit in on some of their meetings. I will never forget the remarks of the chairman of the first one I attended, in which he repeated over and over again, "Remember, gentlemen, those things you cut down on for the sake of economy you will find reflected in the list of maintenance costs that go on and on for the life of the buildings." Mr. Gilbert is the kind of operating man I'd like to work with in the early stages of a building. I would also say that the most important thing, from the mechanical standpoint, is to bring in the operating man, the engineer, if not at the design stage, then as soon as the building is started. If you consult a competent operating man who knows the job, you'll find your maintenance costs are considerably lower.

Mr. Phillips: Mr. Bailey's presentation exposed an array of problem areas, and the composite of all of these indicates to me that one of our big problems is the improper planning of buildings. This is a very serious problem that Mr. Bailey has defined and it would seem to be either a reflection on the architects and their designs, or on the owner in setting up his requirements.

Mr. Keane: I feel that the architect should take full responsibility for the entire building program. Someone said that the architect is a creative artist. Well, in our opinion, he is a great deal more than this. Actually, only 10% of the architect's work is in design and planning. The rest is a combination of structural, mechanical and electrical engineering, site planning, decorating, financing, taxes and all the rest of it. The architect is the one who takes the lead, who is the guide in the entire building operation. Speaking generally, we are not always so lucky as to have owners with their own engineering staffs, and who turn to the National Association of Building Owners & Managers for advice. So then, it is up to the architect to try and coordinate the work. As architects, we would certainly welcome any help and advice we can get from people who are more experienced in particular phases of building operation and maintenance. We have to know something about the entire operation, but often we aren't told very much about any of it. Therefore, we would welcome calling in all the experts possible.

Mr. Haynes: If you look in the crystal ball I think two words come out, speed and communication. I might say that I hope Mr. Bailey's report will be transmitted to designers and I am sure BRI plans to do this. I know some other people who would also like the privilege of reading it. Mr. Gilbert pinpointed the question, does it take years or months for this information to get back to the manufacturer. I think it's a matter of communication, and BRI's acceleration of this communication between the trouble spot and the manufacturer and the designer makes this type of conference very worthwhile.

Mr. Phillip: I have a question for my own information. One of the gentlemen mentioned a problem with automatic doors and I did not understand whether it was the failure of the doors, the mechanics of the door, or heat loss.

Mr. Gilbert: Entirely heat loss. The tenants could not live on that first floor because the traffic was so heavy that the automatic doors were never closed. There

was always somebody on the treadle, holding the door open and the wind just rushed through. The architect recognized the problem and the bank had to spend the money to put in three sets of revolving doors at the entrances.

Mr. Jaros: There are two points in Mr. Bailey's report that I would like to comment on briefly; one is control centers for mechanical equipment. There is no question that these are labor-saving and time-saving devices and, as such, very valuable in building management, but there is one important factor without which they present a risk. If you're going to start fans and other equipment all over a building from a remote point, it is vital that the control center should include all the necessary alarm devices to show you if any fan doesn't start properly, or if any valve doesn't open properly. This is the chief reason why men have usually been stationed in fan rooms in the past, not because the equipment couldn't be started by remote control, but to make sure that everything worked properly at the start.

The other point concerned outside sun-shading for large windows. The horizontal balcony or similar structures that Mr. Bailey mentioned are very valuable on the south and north exposures. They're useless on the east and west, because in the truly oriented building the hours when the sun is most intense are when it is nearing the horizontal. Also, the outside balconies are most valuable as you approach the equator where the sun is at a higher altitude in the sky during the mid-day hours. It may be worth mentioning at this point that the most serious sun load in our latitude, for example on south windows, is not in mid-summer but along in October when the sun is low in the South and therefore strikes those windows more strongly.

Mr. Kreuttner: I would like to add a comment about control centers. There is one other danger in starting equipment from a remote control point; maintenance men can be hurt or even killed, as a matter of fact. Perhaps, in the design of control centers, there should be a closed television circuit to show each piece of equipment, just from the standpoint of safety. It's a consideration that must be faced in these new installations.

Mr. Severud: In our field there is one thing of paramount importance to the economy of a building and that is to design the structure to carry the proper load. There is a lack of recognition that the girders and columns will never be subjected to uniformly heavy loads. Building codes have taken some little recognition of this fact, but not nearly enough. What results in great economy in building is to evaluate accurately the strengthening necessary for the pillow beams to take care of the heavy machines and thus relieve the girders and columns of the load. What is happening now is that a tremendous amount of money is being spent in strengthening the columns and the foundations, whereas this is really not necessary. There is a lot of confusion on this one point. Fortunately, studies are being made of this problem and I think it will come to a head very soon, because it's an economic waste.

Also, mention was made of solid, windowless walls as being undesirable from a rental standpoint with which we of course agree. But, we must not lose sight of the fact that in the tall buildings there may be a very sizable

maintenance cost from the cracking of partitions bearing against columns in a high wind. We know from experience that has happened time and again here in New York City. In a high wind, the partitions start bumping against the columns because there is not enough stiffness. Fortunately, it's not too difficult to provide the proper stiffness at the elevator walls, but there must be walls. This business of assuming that you can strengthen the skyscraper just by strengthening the joints between the columns and the girders is fictitious, because the partitions are much stronger. Therefore, if a skyscraper or a tall building is not strengthened to a rigidity that matches the partitions, then you will have a very sizable maintenance cost on your hands for the life of the building.

Mr. McKinley: I would like to make reference to two publications that would be helpful as regards this problem of windows or glass blowing out of buildings in high wind. The two publications are, first, the Building Research Institute report on its Conference on Windows and Glass in the Exterior of Buildings, held in Nov. 1956. (NAS-NRC Pub. No. 478) There is a paper in these proceedings which is basically sound regarding the structural properties of glass. It has not received a great deal of attention. It does provide an answer to this question, and some additional statistical data related to this problem are found in an ASTM publication on a recent meeting held in Pittsburgh. I don't have the exact title of that report but it contains good information on that particular problem.

Mr. Brown: Perhaps we all noted in the report on industrial buildings the continuous reference to the word, "problem." One of the things that seems to be characteristic of Americans is that we're willing to face up to problems that we recognize, but my wife and I spent several weeks in Russia not long ago talking to a great many people and going from city to city, and one of the things that struck us is that they refuse to recognize that they have a problem. When I talked to their Department of Construction Planning in Moscow, I told them we have a problem with leaks in buildings, and asked what they do about that problem. They said, "We don't have any such problem." Well, seven important problem areas in industrial buildings have been pointed out: roofs, walls, floors, plumbing, heating, ventilating and air conditioning, and electrical systems. It was suggested that the panel comment on each of these.

Mr. Wallin: I would like to comment briefly on the problem of roof coverings, particularly as they result in leaks. All of us who have buildings with flat roofs generally have auxiliary equipment on these roofs that must be maintained from time to time. Workmen go up on these roofs with heavy pieces of maintenance equipment, they drop tools, they walk with heavy shoes, they probably roll drums of lubricating oil, etc., and this results in eventual leakage of the roofs. I think we have arrived at a fairly good solution by providing walkways on the roof to reach these various pieces of equipment. Of course it's not always possible to reach every piece of equipment with the walkway, but it does help where you can install one.

On the matter of heating, I would like to mention the fact that we, as plant engineers, would like to see serious consideration given to the arrangement and location of auxiliary heating equipment such as pumps, etc. I was in

a brand new plant out in the Midwest about six months ago where the auxiliary equipment, due to the fact that the room was too small, had been placed directly in front of the boiler. How the engineers are going to remove boiler tubes I don't know, unless they cut them up; and how they put them back is still another problem. I would sincerely like to stress that the engineer and the architect work very closely together. Another shining example that they're not working together is a plant which I visited some months ago where the driveway was 6" higher than the plant floor level, consequently when it rained, the rain came right into the building instead of running off the driveway.

Mr. Jaros: There are three things I'd like to comment on. One of them is a matter that was referred to several times, directly or indirectly, ventilation and make-up air. In an air conditioning system, if you want an economically operating plant, except with a perimeter system, the plant should be designed so that in the intermediate, spring and fall, seasons it can operate on 100% outdoor air with no recirculation necessary. This means that for several months in the year you can run the system without refrigeration and without steam when the outdoor air is at about the right temperature to cool and maintain comfort in your space. We try to do this, as do many other engineers, on every job where we can, but it is frequently a matter of fighting for the fan room location, changing the building arrangement, etc., that make it possible.

My second point involves maintenance space. It is vital that those designing buildings should provide enough room with every piece of equipment to make it easy to maintain and operate, if it is to last and give proper service. I'll mention one horrible example, a large hotel where the air conditioning fan room for each bedroom floor was so arranged that a man had to climb up on top of the main conditioning unit and crawl for about 8' or 10' through a 3' high space between it and the ceiling beams in order to get to the air filters that needed cleaning or the dampers that had to be operated. This sort of thing occurs for one of two reasons. Either the design for mechanical equipment is worked out too late, after the building has crystallized, or the owner of the building isn't willing to pay for enough space, or to rearrange things to make it possible to have proper machine room.

A third point I would like to make is about the operating engineer or the building manager. The man who is to be operating engineer for a large new building should be selected by the time construction starts. He should be a man capable and competent for the job, and he should work with the architects and the designing engineer in inspecting and supervising the construction, both for the value of what he can contribute in the way of details, and so that he will afterwards know why every piece of concealed or visible equipment is where it is. This requires one thing, and let's face it, the designing engineer and the architect must recognize the operating man thus selected, or the operating man already in existence in the case of large companies, as their colleague not as their rival. They must be glad to answer his questions, glad to give him information, glad to think carefully about and give due weight to his suggestions. And, the operating man must do the same thing; he must regard them as his colleagues. That sort of cooperation can be a big help in making a building practical and economical to operate.

Mr. Brown: I believe that in the building of ships it's customary for the man who is going to be the Captain and the chief engineer of the ship to be at the shipyard during construction, so that each knows every part of the ship that these two men have to take over when it goes to sea. Maybe there is an analogy here.

Mr. Severud: On the subject of roofs, time and again, particularly with the high fenestration we find in modern buildings, the mistake is made, planning-wise, of creating an anchor at the end of the building. Everything is glass and then, at the end, there may be brick piers that restrain the roof. With the prevalence of metal deck and steel framing for the roofs, the conflicts that arise have been the cause of many more failures than people realize. They fix the roof and then they fix it again, but they don't realize the cause of the failure. I think that is one of the fundamental planning mistakes that is being made in roof construction.

It is a pitiful situation that so many of the modern floors go to pieces. You see them beautifully laid, and everything looks fine, but often someone made a mistake in not realizing that the vulnerable period of concrete is just after it has been laid. The floor should be sprinkled just as soon as possible, and someone should be there all night to see that the floor is kept wet. How often is this being done? Practically never. Then the damage is done, because the concrete has to fight between the strength and the deformation and, later on, when the building has dried out there are cracks. If that one point could always be recognized, it would vastly improve the construction of that vital building element, the floor. It is well recognized that the system of floor which is laid in layers with a sprinkling of cement on top is the far superior floor, because it cures more rapidly.

Now, may I bring up one minor item in connection with double glazing. When we get into large panels of double glazing there is the problem of creating a proper seal to keep the air out. At the same time, that seal must be so strong that, as the two panes of glass have different deformation due to temperature, the seal is not destroyed. By knowing these simple fundamentals many mistakes could be avoided.

Mr. Brown: The area of floors in industrial plants is one in which I think I have some competence. The problem seems to be that, at the time the building is built, all the precautions necessary to produce the best possible floors are not taken. The cost later on is then tremendous, because you are involved, first of all, in a tie-up of time with the necessity, perhaps, of shutting down a department, or of doing work on a weekend or at night when people are paid time-and-a-half or double time to do the work. And, if a cleaning job is necessary, it's almost impossible to do a thorough and complete cleaning job on an industrial floor that's become badly saturated and soaked with oil and grease. When you take into consideration the problems inherent in the maintenance of floors in industrial plants, there is certainly great economy in spending the extra money to put the floor in right in the first place.

I would also like to add to what Mr. Jaros said and suggest that, instead of bringing the operating man into the picture during construction, he be one of the team that designs the building. I think that Mr. Bailey indicated that he also felt it would be advisable to have the operator of a building, or the plant engineer, as a part of the team right in the beginning. Also, the engineer should not be brought in after the concept of the building is developed by the architect. He should be in at the time that concept is being developed. This is very important because the engineer is the one who knows how much space should be allocated to mechanical equipment so it can be properly and suitably serviced and maintained. The space required for properly installing mechanical equipment and maintaining it is a major consideration. If you are going to put 40% of your building dollar into mechanical equipment, you have to provide enough space so that it can be serviced. Most of the problems of this nature that do occur are in the air conditioning system, and the headaches are in large part due to lack of sufficient space to install conduits, ducts, shafts and the essential apparatus.

Mr. McKinley: In regard to sash and glazing, the comment was made that the glass was leaking. This is a very common statement; I have heard it often and seen it in print often. If someone has had the literal experience of seeing glass leak, he has certainly beaten me to it. However, the fact remains that we have talked about having an operating engineer on the team, and I think this is a good idea. The second thing I would like to suggest, and I think we all realize it but we hate to face up to it, is that there is a staging of construction work which has its own implications. One of the stages is the design, another stage is the fitting, and then you get into construction and finally you get into maintenance. People's ideas and attitudes change materially, and quite understandably, at each of these stages. I would like to suggest that the problems related to sash and glass are based on quite specific experience. It isn't a question of which materials or which methods are being used, but there is a way of improving the situation which I have found very helpful. After the bids are let, after all the fights and the arguments and all of the sales promotion and whatever else is related to the bidding situation has been completed, and everyone has settled down to the job of constructing this building, before things move ahead, the group of people who now are members of the team should sit down together in an informal way and review the plans, let their hair down somewhat as we have been doing here this morning, with relationship to their past experience. With the operating engineer taking part in the team and with the owner's representative sitting in while these people are getting under way, this would bring out many things that simply do not come out in the prebidding pattern of activity, and the necessary changes and adjustments could then be made as a team. On the basis of experience, I find this works rather well.

Now I would like to make to this group a specific proposal of a general nature, and that is that all of us, as a stimulus to a cooperative and informal feedback operation, add to the normal provisions of the contract documents that exist on almost every job what I would call, for lack of a better or more formal term, a Performance Review Schedule and Report. I suggested that the team get together before we build, and I now suggest that each year,

on the anniversary of the acceptance of the building, the team meet, formally inspect the building, and then formally report their findings. This would represent a joining together of the industry to collect that information which we so badly need. Having done this, BRI could then collect and document this material, so that the industry could draw on it. If all of us would experiment with this idea, and plan to come back to the BRI Spring Conferences five years from now with a batch of these reports related to his work, I think that this meeting might very well have accomplished something.

Mr. Brown: I can conceive of a great deal of benefit coming from architects and engineers going back to buildings that they have built, sitting down with the operating people, and saying, "Well, how are we doing? How did this building work out in terms of what we expected of it at the time we designed and built it? What things worked out well, and where do you think we could make improvements if we were to do it over again?" That sort of a thing is being done by many firms, but if it were done by more there would be advantages accruing to everybody involved.

I would just like to make a comment also in respect to sash. It seems from my observations over the years that people get the idea that since they're designing a factory building, an industrial building, they don't have to use the same quality of sash that they would put into a fine ornamental building. Perhaps this is so, and yet industrial buildings get some pretty rough wear. Often you see sash in which the ventilators don't work properly, perhaps because they are depending on the glass to keep the sash rigid. Some thought as to the use to which the sash is going to be put, or the abuse which it will stand, may result in greater expenditure for the sash itself, but certainly lower maintenance cost and lengthened life of the sash, particularly if the right kind of installation is made initially.

Mr. Stewart: I think this idea of a review at the anniversary period is a remarkable one. I am sure that plant engineers have a great deal to add to these findings, and it would be valuable if this information could be made a matter of record and taken advantage of in the future. There are hundreds of new plants being built around the country. We know that lessons are learned, but the lessons are tucked away in someone's mind and no one else profits from them. There is a big field for improvement here.

Mr. Souder: I think this is a wonderful idea and it would be marvelous to have it done on a broad scale, but I would suggest that anyone attempting to do it bear in mind that if this information is to be useful it must be readily comparable, and that some uniform methodology ought to be devised, either by this Study Group or by somebody else, that could be applied throughout. All of these problems we're talking about today are not new really to any of us. As long as I've been in architecture, I've heard these same things about leaking masonry, eroded roofs, wind around sash, etc. We're not going to find quick solutions, but if we get a body of data that will show how these difficulties are comparable and how they are unique, then we will have a better chance to attack them.

Mr. Spross: When people complain that their roofs leak, after admitting that they've been using them as floors, and putting machinery and equipment on them,

presumably they are having these problems because they didn't design the roof for such use, or otherwise it was, in fact, an error. Most of these problems are susceptible to solution, or improvement at least, if they are known beforehand. They are planning problems. In the case where some holes were knocked in the concrete wall, if this was done by some kind of cart or truck or something, the use perhaps was not apparent when the design was established. This, to me, indicates that there is a definite necessity for the owner to describe more adequately what he is going to do in this building, to work much more closely with the architect, or at least to join him in staring into the crystal ball so that they can find out exactly what it is they are going to do in the building, so it can be designed to do that job. A great many people are doing things in premises which are not particularly appropriate for that activity. And, when people buy a building, over a number of years their activities may change. When they do something different in this building, they may find that it doesn't serve their purpose nearly as well. Typical of this equipment-on-the-roof business, is the case that Mr. Jaros described about the necessity for space for the mechanical equipment. In such a case, it is almost obvious that the demand for maximum usable space in the building has relegated mechanical equipment to a corner somewhere, or even up to the roof. These things have to be looked at ahead of time. Almost all the engineers and architects, if they're competent, can handle these problems at least, if not solve them in an acceptable way, if the problem is apparent.

John Handley, Inland Steel: In a multitenant building how important is electrical flexibility with respect to ease of leasing space? How about the cost of making changes in an underfloor electrical system?

Mr. Bailey: I'd like to answer that by starting off on another subject. An underfloor duct system, unless it is a very complete system, doesn't serve the purpose. When the Board of Trade Building was built in Chicago, we had an underfloor duct water system, and not at the insistence of the architect but at the insistence of the owner, it was an incomplete underfloor duct system. We discovered in leasing the building that it was completely inadequate; they might almost as well have not had it. If there is an underfloor duct system, it should be a complete one and, over the years, the cost of making changes certainly justifies the complete underfloor duct system, because of flexibility of floor plans, telephones, buzzer systems, etc.

Residential Buildings

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(The authors wish to express appreciation for the cooperation of the Society of Residential Appraisers in helping to develop this report, and particularly to their BRI representative, Harry H. Batchelor and their Executive Vice President, James V. Morgan.)

MULTIFAMILY RESIDENTIAL SURVEY

This is a summary report of a questionnaire circulated to a number of large residential development owners. The questionnaire covered in some detail the component parts of residential multifamily buildings, both garden and multistory. Owners were requested to report failures and extraordinary performance, and to try to assess the causes for both within the following general classifications: Research, Manufacture, Design, Construction, Maintenance, and Construction Economies. No attempt was made in this report to evaluate fully any individual item. Rather, it provides an index for future discussion which can be conducted in greater detail on various individual items.

Casement Windows

Casement windows were a unanimous choice as a major headache. Complaints covered leakage from both wind and rain; high maintenance of window operating mechanism; poor performance of friction catches; and general tenant dissatisfaction. Some complaints covered not only the window itself but the method of its installation. Also cited were: insufficient research, poor manufacturing, poor design, poor construction, and the owners themselves for undue economy at the start. We might say that this was the outstanding complaint from all of those expressing dissatisfaction.

Plumbing

Plumbing drainage was next in line particularly in high-rise buildings. Due to the increased use of detergents, washing machines, dishwashers, etc., there were a large number of

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complaints of back-ups on the lower floors, which not only caused inconvenience to the tenants involved but also, in many cases, property damage. In the main it was felt that the causes were poor design, accompanied by too much economy in initial construction; and a lack of recognition of the problem, resulting in little reseafch towards its solution.

Heating

Heating problems took third place. Criticism here was directed at poor controls, inaccessibility of equipment for maintenance purposes, and noise. Many owners pointed out that controls were either inadequate or too complex; that in many cases these controls and other parts of the equipment, such as traps, were in spaces that were inaccessible and made maintenance a major job. Noise was mentioned by one operator of a hot water system as a major cause of complaint. Generally it was felt that further research, better design, and higher quality of original installations were necessary.

Painting

These problems involved particularly exterior paints and their tendency to peel on certain types of surfaces. This appears to indicate further research on the part of the manufacturer as well as another look at proper selection and application.

Masonry

Leaking masonry was reported by a few, and was blamed on the architect, the builder, and in one case the manufacturer.

Interior Bathroom Ventilation

Back drafts, noise transmission and difficulty in balancing of these systems were traced in general to bad design and improper installation.

Roofs

This subject, on which we had expected considerable criticism, came in for only one complaint, and that was from a garden apartment operator who complained of wooden gutters which resulted in high maintenance costs.

Electric Wiring

Inadequate and inflexible electric wiring systems caused complaint, which was certainly to be expected. It was felt that the advent of the window air conditioner has played a substantial part in this.

Floors

Floors raised two types of criticism. One was based on the improper installation of the hardwood type, and subsequent buckling or spreading. The other was directed at asphalt tile which was of poor quality when originally installed.

Acoustics

Many complaints were made of lack of noise control between apartments, indicating need for further research and more consideration on the part of the designer.

Landscaping Design

This subject came in for its share of criticism and praise. One return tersely suggested that walks and paths should be placed where people are going to use them, and not where you want the people to use them. Two returns complimented the designer on a very practical approach.

General Items

Garages or Garage Stalls were too small for the average large car.

Carriage and Storage Rooms in garden apartments were inadequate.

Crawl Spaces needed additional treatment to avoid condensation in apartments above. One recommendation suggested complete excavation, which would overcome the last two criticisms. People reporting on this felt that additional research and better design were the answers.

Heavy Duty Equipment. The New York Housing Authority, largest individual reporter, stressed the necessity for providing heavy duty equipment to offset heavy duty wear in such mechanical areas as elevators.

SINGLE FAMILY DWELLING SURVEY

This report on the maintenance and operating problems of the single family dwelling is based on a survey of the Senior Members of the Society of Residential Appraisers, a group not heard from before in BRI conferences. Their work and experience qualify them exceptionally well as sources of information on problems in the residential field. They are an important part of the building team we want to unify.

To qualify as a Senior Member of SRA one must have a minimum of five years appraisal experience and pass substantial tests of his qualifications. The Society estimates that a Senior Member represents an average of 15 years appraisal experience. The typical appraiser working with a financial institution or a government agency would average about 1,000 appraisals per year. Independent contractors doing larger, more difficult parcels, particularly in eminent domain, may spend several weeks of research on an individual assignment. The typical independent appraiser with a well-rounded clientele should average from 350 to 500 appraisals per year.

The rate of reply to this survey was about 20%, and these replies showed an underlying uniformity as to what and where the problem areas were, and what could be done by whom to help minimize them. Replies came from every State except Alaska, including one from Hawaii. The customary comments based on geographic location were evident. However, the real essence of the indicated problems and possible solutions transcends the limitations of geographical area. (See tabulation, page 73.)

The survey asked for information on three major parts of the residence:

1) Areas at or below grade such as foundations, basements and slab-on-grade construction.
2) The house shell.
3) Mechanical equipment.

We asked that these major headings be considered individually as to their contribution to maintenance and operation problems and, where possible solutions might be found, we asked that the problems highlighted be matched with one of the suggestions for solution shown below:

1) Quality control.
2) Product development.
3) Workmanship.
4) Labor productivity and construction methods.
5) Design and specifications.
6) Selection of higher quality materials and equipment for initial installation.
7) More coordinated inter-industry research.

The survey also asked for any other comments the respondents wished to make, and a cross-section of these comments is included as Appendix II.

A summary of all the findings would indicate that the combination of good quality materials, equipment, know-how, workmanship, pride and responsibility of ownership or occupancy are the essentials to minimum maintenance and operating costs in single family dwellings.

There are relative degrees of consequence that the acts of each one involved in the total building process produce. We'd like now to describe these and determine what can be done that might keep the unpleasant and costly consequences to a minimum.

Areas at or below Grade

Foundations, including adequate soil bearing characteristics, were not considered a major contributing item to maintenance and operation problems. Those parts of the house in and near the ground which were frequently mentioned as potential trouble areas were the basement and the slab-on-grade. Sources of trouble, of course, are drainage, dampproofing and waterproofing. The materials to take care of these problems are, for the most part, low in first cost, and available in good quality. Know-how regarding application is reasonably well documented. We think the survey indicates that there is a lack of good workmanship, a realization of the problem, and also of the ultimate seriousness of the consequences. The leaky, damp basement and the damp slab-on-grade floor are nearly impossible to correct after the house is finished and are a source of never-ending, costly and unpleasant problems.

The elevation and slope of finish grading is important to the disposal of total rain run-off. This water, if not carefully guided away from the house, reaches the basement wall, and thence the basement proper. There are many other places more appropriate for considering economies in home building that will have lesser consequences in terms of maintenance and operation costs, and the general livability of the home.

The House Shell

Considering the shell in its entirety, 41% of the replies indicated that better workmanship, labor productivity and construction methods could contribute to improved quality. Some 32% felt that the original quality of the products used could be at a better level. Of this group, one-third felt this could be accomplished by better quality control at the source of supply, while two-thirds felt that the use of higher quality materials was the answer. Fourteen percent of the reports indicated relief could come from the designer and specification

writer, which we could interpret to mean better details and higher quality materials specified. In either case, those paying the bill may and do have considerable influence on such details and quality.

Fourteen percent also mentioned research and development on the shell as a specific need. However, we can be fairly sure that almost every manufacturer is doing research and development work on his product, and in some instances in concert with other products, for example, sandwich panels and prefinished woods and metals.

The most likely area (and a difficult one, too) for research, then, is in techniques for assembling these pieces and parts more satisfactorily. The prefab approach, be it on the large project site or in the shop, certainly is a good start toward the needed coordination.

As for details and parts of the shell, the same general pattern of suggested solution prevailed. Items most frequently mentioned as problem areas were in this order:

1) Windows.
2) Exterior finishes.
3) Floors and floor coverings.
4) Interior finishes.
5) Roofs and flashings.

It appears that the appraisers feel that the best materials, poorly installed, can create problems, and that even a lesser (although not a really low) quality material, properly installed, would be preferable.

Methods and techniques recommended for fitting, joining and other installation procedures, whether provided by the thinking of the manufacturer, the designer, or the builder, are equally as important as the workmanship of the man with the tools. Even a top quality window with complex details for fitting, in the shop of the prefabber or on the site, will soon discourage the most meticulous craftsman from using it.

It is common knowledge that a major portion of the integrated research under way in the country now, and that which is being urged or planned, is directed at the reduction of on-site labor hours. This is not aimed solely at reduction of dollar cost of the total house, but also at bringing to the site higher quality components manufactured in an atmosphere where quality control can be adequately maintained. Meticulous inspection, even on large tract projects, of the multitude of operations involved in shell construction is almost an economic impossibility. However, even with large components making up a shell, there remains the necessity for their assembly in the field. We still have some joints; and joints are potential leaks and the source of many of the problems that increase maintenance and operation costs. Therefore, when the appraiser evaluates an "industrialized" house, he will take a second look at the areas where workmanship and methods are an important part of the installed quality. The shell reveals, and it also conceals. It is the concealed poor quality that really has serious consequences for the occupant's maintenance budget and, in many instances, no amount of money can repair it permanently.

Asphalt shingles, although difficult to handle, are used on the majority (75%) of single family dwellings. By and large, they are performing adequately. Factors to consider in minimizing roof maintenance and repair costs, as well as replacement, are:

1) Use a heavier shingle—250 lb. shingle costs very little more than the minimum requirement of 210 lbs.

2) Keep the color as light as possible.

3) Minimize flashing. The properly applied asphalt shingle roof is fairly free of joints except at points requiring flashing. However, even the minimum of flashing, if it is improperly installed, can void the sealing quality of the best roof, and its repair is most difficult. The original cost for the best of workmanship and materials is insignificantly greater than for average workmanship.

The problem of a poor roof is only one of these that an owner might face, but it can set up a chain reaction of other costly maintenance and repair situations on the interior of the house, including furnishings. This is mentioned to highlight the fact that a good roof can be responsible for eliminating maintenance and repair costs for the interior of the house, as well as the furnishings that it protects, and is thus a poor place to economize haphazardly.

New products have been appearing in the field of painting and finishing with great rapidity in the past 10 years. Many of these are for highly specialized uses, and there are complications resulting from the combinations of various products and their application. Our survey indicated that we do have quality paint materials available, but we are a bit weak in our application technology. With so many products apparently necessary for the production of a satisfactory job, the hazard is high with respect to getting the right brush in the wrong pail. A check list of some of the factors to be considered in achieving a high quality, long-lasting job are as follows:

1) Type of surface.
2) Characteristics of the materials to be finished.
3) Preparation of the surface to receive the finish (equally important in repainting).
4) Temperature and humidity conditions before, during and after application.
5) Use of the proper thinner.
6) Proper use of the appropriate brush, roller or other applicator.
7) Incorporation in the structure of the many necessary construction details, such as properly located and installed vapor barriers.

There is a marked increase in the use of prefinished materials in most exposed parts of the shell, interior as well as exterior. This trend should be continued and accelerated. Controlled conditions of application afforded by prefinishing will remove the danger of a sloppy-looking job, and insure a longer and less costly life to all such surfaces, which are not small factors in appraisals and in the owner's maintenance budget.

There will always be maintenance costs for all types of floors and floor coverings. However, modern materials, properly selected for the intended use, properly installed and given reasonable care will not be the cause of great expense to occupant. A recent report in "House & Home" magazine estimated a top figure of $200 in a 1500 sq. ft. house as the difference between the very cheapest of floors and a very adequately floored house. Carpeting and ceramic tile are not included in that estimate.

Floors, floor coverings and their problems are another combination involving the right selection for the intended use, its proper installation and its subsequent care. We have a good selection of quality flooring materials, and there is, and will continue to be,

research carried on to improve them. As evidence, there is already an electrically heated carpet on the market.

Mechanical Equipment

The survey respondents pointed to the quality of materials and equipment incorporated in the mechanical aspects of the home as the prime area for improvement. Some 47% indicated that higher quality items should be used. Two-thirds saw the original selection as the primary need; the other third felt that better quality control by the manufacturer was the key to the supply of good quality to the job. There were 25% who felt that more product development and integrated research was the important area to work in, and 14% felt that the conceiver, be it the architect or builder-designer, could render more guidance and exert more influence. Only 15% considered workmanship and on-site methods, as they have known them, a factor. Without doubt the advocates of more research and development had in mind that some of the research would include serious consideration of the on-site problems involved.

The survey adds its own weight to the results of many previous studies and research programs in the matter of heating and cooling. This one factor, including all facets such as adequate insulation and vapor control, can save anywhere from 20% to 50%, the largest item of household plant operating costs. This can be accomplished with a relatively minor investment in first cost and it will make a substantial difference in the operating cost estimates used to determine loan characteristics.

The know-how to attain economical heating and cooling is quite widespread, and both the prospective buyer and the lender are most receptive to its merits. Much basic research has been accomplished. Efforts to improve the efficiency and lower the cost of some of the units, such as the heating plant, are being continued. An excellent example of this is the so-called "one-for-all" furnace developed as a result of study and cooperation between the manufacturer and the user, in this case, a prefabricator of houses.

Wiring systems elicited considerable comment, and a minimum 100-ampere service was indicated necessary in order to save costly up-grading later on.

Failure of the water heater has been the cause of considerable expense in the early life of many homes. As opposed to a repainting job, repair of a water heater is not subject to delay. However, spending an additional $50 on the original equipment could take the water heater out of the problem area in most cases.

Total plumbing quality necessary for minimum upkeep cost must include quality pipe, fixtures and fittings. Money to provide this necessary quality can be saved by more study and basic planning of the total system, and this includes an active, cooperative research effort by the industry as a whole, including the plumber, himself. With the proper approach much can be done in this area to provide a good system and lower maintenance costs.

Appliances, built-in or otherwise, are a source of upkeep costs. There are so many now considered essential to our way of life that it would be impossible to list them in this report. The kitchen is reported to be the most costly room in the house, and it's approaching the most mechanical, too. With so many dollars spent for such a relatively small space, it seems axiomatic that continued planning and study are essential. Saving even a small percentage here could give us quite a few dollars for up-grading other parts of the house.

Higher quality in the mechanical area needs constant attention by the manufacturers, the planners and the installers, with increased efforts by each to understand the other's problems and make contributions to the solution. The results might well be an economical, high quality and acceptable mechanical core. This is a field fof standardization that would not hamper design flexibility. The survey indicated that the mechanical aspects of the house needed more attention by the owner if he is to enjoy lower maintenance costs. Simple, routine chores performed at the right time are essential to reasonable life even if the best quality equipment is installed at the outset. Good access to mechanical units was mentioned as an important planning consideration, since difficult access discourages the needed attention.

Many statistics could be quoted in an effort to show problems of maintenance and operation in the home, but the multitude of influencing factors make them practically hopeless as true indicators. However, one indicator that seems to point to improvement in the major problem, that of cooperation, integration and coordination (technically and otherwise), is the fact that there are more houses being built per builder today. Other indicators of substance include the objectives and efforts of such groups as the Research Institute of the Natl. Association of Home Builders, and the conferences conducted by the Building Research Institute.

The maintenance and operating costs of the single family dwelling do not appear to be basically an economic burden on life in this country. They reflect in a large measure the rising standard of living and our greater appreciation of the better way of life. Good quality, be it in housing or elsewhere, is not cheap, but neither does it need to be labeled expensive.

For the continuation and up-grading of this better way of life, and in particular of the houses we live in, (without excessive maintenance and operating costs) we need to do with one dollar what any fool can do with two, and that requires mental alertness and cooperation, or unification, if you please.

CONCLUSIONS

The following conclusions resulting from study of the survey returns are presented here in the form of recommendations for consideration by BRI as subjects for further study. It is recommended that subjects selected for study be studied with the basic objective of trying to do more with what we have (or can get) to up-grade the total quality and at the same time maintain or reduce current levels of all costs involved.

1) The total subject of windows with particular reference to residential buildings.

2) Acoustical treatment of multifamily dwellings with emphasis on noise transmission between the individual family units.

3) Increased flexibility in wiring equipment and systems.

4) Heating and cooling systems for single family dwellings, encompassing all essential factors such as:

Central utility cores	Air supply
Insulation	Flexibility of capacities
Controls	Fuels (including electric)
Vapor problems	Orientation
Air cleaning	

The objective here is a high-quality total system, properly integrated with all the mentioned factors, plus a minimum of divided responsibility to attain the objective. Representatives of labor should be part of a study on this subject.

5) Joints and joining. More simplicity in design, manufacture and installation details of the mechanical aspects of joints seems indicated. More consideration might be given the theory of "self-flashing." The key to the joint problem is fewer joints, particularly in exterior walls and roofs.

6) The performance of prefinished materials for walls, floors and roofs with particular emphasis on maintenance and service costs and the outlook for ultimate costs.

7) Reduction of the number of pieces necessary to build a house. Large components preclude combinations of various materials. The proper combination technique is the key to the foolproof large component. The study should start there and progress towards a total system or systems.

8) The problems of drainage and the simple, common-sense solutions that may be used. This would be a good subject for the use of models and photographs.

9) General workmanship, the methods employed and the productivity thereof seem appropriate to group together. Men are going to be required to help us build our buildings whether on the site or in the factory; their cooperation seems essential in either case. The sooner they are made to feel they are a more intimate part of the building team the sooner we will see progress to better total quality and at no increase in cost. We suggest a preliminary discussion of how BRI might approach this general subject with such a person as John T. Dunlop, Chairman of Construction Industry Joint Conference.

10) The kitchen, as the most expensive room in a house or apartment. Many worthwhile studies have been made and are being continued, such as the Cornell Study and the activity of certain groups in the U. S. Dept. of Agriculture. The presentation of their methods of approach and some of the results should be a worthwhile program.

11) The concept of fewer kinds of materials incorporated in a structure, to obtain higher total quality at no cost increase. This might re-establish the more basic principles of design which, in residential construction, are often lost, or confused by overlapping functions, ill-matched relationships, unnecessary complications of material composition. Residential construction as differentiated from large commercial construction has been basically subject to substitution and duplication. Quantity has replaced quality or simplicity. It is inevitable that a structure using five to 10 different materials with different coefficients of expansion, different structural qualities, etc., will multiply the problems related to maintenance. There is no assurance that limiting the types of materials eliminates or reduces maintenance problems, however, it appears to reduce the different types of maintenance problems. The coefficient of expansion can be consistent, as can methods of juncture and surface finish. Maintenance of surfaces then relegates itself simply to understanding how to care for one material rather than five or more. This philosophy is currently being studied in the Basic Materials Research Program sponsored by the magazine, LIVING For Young Homemakers.

12) Crowded conditions in equipment rooms and other "accessibility" problems, as reported by apartment house operators. Inasmuch as this was a common problem in most categories of buildings, resultant studies should include apartment buildings.

13) If and when appropriate, create a subcommittee to study and report on the recent BRAB—FHA pilot study regarding home owners' problems.

14) Currently available statistics related to housing, with particular reference to maintenance, repair and operation. The objective here would be to: sift out those that are significant and study them for possible up-grading; and highlight what is, or could be, significant that is not available, with the objective of finding a way to have statistics provided and maintained. This might include such topics as:

    (a) What we have and what we need.
    (b) Definition of terms.
    (c) Universal acceptance of definitions.
    (d) Objective, end use and value of each statistic.
    (e) Maintenance and distribution.

APPENDIX I

Survey Tabulation

The results of a survey among 2600 Senior Members of the Society of Residential Appraisers, of whom 20% replied to the questionnaire.

Problem or Need	At or Below Grade %	The House Shell %	Mechanical Equipment %
Quality Control	2	10	14
Product Development	4	7	11
Workmanship	47	30	9
Labor Productivity and Construction Methods	10	11	6
Design & Specifications	19	14	14
Selection of Higher Quality Products for Initial Installation	13	22	32
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APPENDIX II

Selected Comments from Returned Questionnaires

"Builders need to know more about the over-all economics of good construction, better methods and good design ..."

"Minor slighting in materials and workmanship in original construction often results in excessive maintenance and operational costs for the owner ..." Ft. Worth, Texas

"Workmanship above ground has improved somewhat in the past 10 years ..." Anniston, Ala.

"Manufacturers should clearly label heating and cooling equipment with Btu capacities ..." Jacksonville, Fla.

"Quality in this area generally better than 10 years ago ..." Tulsa, Okla., New Orleans, La.

"We need an insect-repellant and mildew-resistant exterior paint ..." Florida.

"There is enough obsolescence without planning it ..." Seattle, Wash.

"Floor furnaces should be outlawed ..." Tacoma, Wash.

"They should quit making 30-gallon hot water heaters: a 30-gallon heater costs $3.20 per gallon; 60-gallon costs $2.00 per gallon ..." Colorado Springs, Colo.

"With some basic thinking in the area of work simplification, builders could produce a better product for the same price ..." Lafayette, Calif.

"Equipment and appliance builders should be exposed to the module concept: replacements, when necessary, would be less involved and less costly ..." California

"We should have more pride of workmanship and cooperation between all the building tradesmen. It would help topple high costs. ..." San Diego, Calif.

"Termite and dry rot control services need more competent applicators—materials seem adequate ..." Los Angeles, Calif.

"Many builders are after the fast buck—and there are appraisers who lack thoroughness in their inspections ..." Indianapolis, Ind.

"There is a tendency to cut corners where it does not show—concealed problems are the costly ones ..." St. Louis Park, Minn.

"Research is always a must in this business. The average heating plant is still a glorified stove ..." Wyandotte, Mich.

"There are plenty of good materials and equipment available. Seek them out and combine with proper installation and good workmanship . . . " Indianapolis, Ind.

"A reasonable approach to care and maintenance of the average home built today will make it endure for many years . . . " Minneapolis, Minn.

"Plan for good accessibility to components requiring routine up-keep chores. Hard-to-get-to items discourage even the minimum attention they require . . . " Tacoma, Wash.

"The average prospective buyer does not know good quality construction. What influences him are down payments and monthly payments. So, to compete for such payments, quality is lowered and maintenance and operation is upped. Good quality is available; knowledge of its real value is needed . . . " Bradenton, Fla.

"Prospective owners need to be educated to the ultimate cost picture of poor vs. good quality. The industry should cooperate on some means to provide this knowledge. Lenders and government agencies need some persuasion in this area, too . . . " Los Angeles, Calif.

"Home owners and occupants need more knowledge of their responsibilities in upkeep to avoid high maintenance and operation costs . . . " Denver, Colo.

"The difference in costs between a poor and good quality house is not great. We give the good quality full credit . . . " New York, N. Y.

"Built-in weaknesses of mechanical and electrical equipment lead to breakdowns. Higher original quality and better quality control are indicated to overcome these problems . . . " Honolulu, Hawaii

"A wet cellar, a leaky roof or excessive condensation can take all the good out of any house . . . " New York, N. Y.

"Many new products need more customer service to put them on the road to success . . . " Michigan

"Recognize and pursue the integration of all building elements. This is the road to simplification of the process, and to more for the same dollar . . . " Maryland

Institutional Buildings

By Fred J. Hildebrandt,* Vice President, Construction
Harley, Ellington & Day, Inc., Architects and Engineers

Approximately 110 questionnaires were sent to schools, colleges, universities and hospitals throughout the United States. It was the intention of our Committee that the questionnaire bring out those areas of building design and construction which should receive continued or additional research to better satisfy the owner's needs and decrease maintenance problems. It was also considered advisable to have the owners indicate the areas in which they felt the industry had done a good or satisfactory job.

Thirty-two questionnaires were returned from 19 States representing all areas of the country. Three of the questionnaires represent a cross-section of three governmental departments, i.e., General Services Administration, the Navy, and the Veterans Administration. About 60%of the owners responding operate more than one building, because several colleges, universities and sanitariums are included.

The results are set forth in about the same sequence as contained in the questionnaire, but, for greater clarity, some general results are noted first.

GENERAL RESULTS

Geographical location has little bearing on building operation and maintenance. Only two such problems were noted, one being freezing cycles of exterior walls, and the other salt air near an ocean.

Two-thirds of those who answered stated that their problems have no real relation to unusual or even changed uses of buildings. Seasonal factors during construction had no bearing on problems except in three instances, and these were listed as a possible factor only.

More specific comments which were pointed out by enough owners to be included for consideration were:

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1) Crowded and inaccessible mechanical equipment.
2) More and better supervision during construction.
3) Main electrical equipment rooms too small.
4) Inaccessible piping, valves, etc.
5) Too much aesthetic consideration by architect, sacrificing practicability.
6) Sacrificing quality for low first cost that results in high and continuous maintenance costs.
7) Insufficient time allowed during design stage.

Seventy percent of the owners have a planned and budgeted maintenance program. The other 30% believe that such a program would reduce their maintenance and operational problems. However, two owners stated that they did not feel that their planned maintenance resulted in lower costs.

Fifty percent of the owners stated that there is essential need of improvement of wall and door construction to reduce noise transmission. Fifteen percent stated the same about floors and ceilings, and pointed out that all space around pipe and duct shafts should be sealed off at the floor slab.

SPECIFIC RESULTS—ARCHITECTURAL & STRUCTURAL

Roofing and Flashings

Seventy percent to 75% of the owners stated that roof repair and maintenance for built-up composition roof, and bitumen and aggregate roofs, were normal, or at least not excessive. On metal roofs, such as copper or cast iron, about 40% stated that repair and maintenance were normal, and 25% stated they were excessive. The normal repair comments exceeded the excessive comments for asphalt shingles. Two owners expressed a strong preference for bitumen and aggregate roof, and one a preference for copper roofs. Roofing and flashing troubles apparently were caused by faulty installation.

For roofing insulation, 70% of the owners expressed a preference for glass fiber, and about 45% rated corkboard as "good" or "satisfactory." The same results applied to fiberboard insulation, except that about 25% have had unsatisfactory experience with fiberboard. Foamglas rated "good" or "satisfactory" in the majority of cases, with only two owners having unsatisfactory experience. Expanded mineral mixtures for insulation were rated "good" or "satisfactory" by about 20%. Several owners commented that moisture problems were the cause of unsatisfactory experiences, which means that the roofing materials allowed water to penetrate the insulation.

Composition flashing material (bitumen and fibers) was rated "good" or "satisfactory" on about 50% of the questionnaires, and "unsatisfactory" on about 25%. Sheet copper and coated copper received by far the most favorable comments, with the only objection being that where copper had not been satisfactory it was not of the proper gauge. Three owners expressed a strong preference for copper. The one or two objections to copper were due to the fact that the joints had not allowed for proper expansion and contraction.

Roof drainage systems were given a "satisfactory" rating on about 60% of the questionnaires, and an "unsatisfactory" rating on 30%. The comments related to unsatisfactory drainage included trouble with downspouts and gutters becoming clogged, especially in climates where snowfall is heavy. There were seven comments to the effect that the drains in the roof had not been installed at the low points. In other words, there seems room for improvement

in roof drain installation so that the added thickness of the flashing around the drain will not result in a high spot. Two owners commented that all roof drains should run continuously in a vertical position without bends or turns.

About 70% of the owners stated that they had no hard surface roof decks which had given satisfactory service. The majority of the seven owners who had had satisfactory experience were located in those areas of the country where the climate is very temperate. Seven owners stated definitely that the use of hard surface roof deck should be avoided.

Eighteen owners expressed a preference for flat roof areas, while 10 preferred saddles with slope to the drains.

Ordinary Exterior Walls

Sixty percent of the respondents stated that brick walls with brick or block back-up were lowest in maintenance cost. Nine stated that limestone with brick or block back-up was lowest in maintenance cost. Highest in maintenance cost were wood, stucco, insulated cement-asbestos panels, local stone, insulated metal panels, and one owner stated that brick and block were highest in maintenance cost. For giving good, weathertight performance, all favorable answers cited either brick or limestone with proper back-up. Mentioned as allowing undue weather penetration were such walls as stucco, native stone, concrete block, metal panels and glass. Walls said to give erratic performance because of temperature changes included masonry, curtain walls, insulated panels, concrete block and metal panels. All walls listed as giving most dependable performance were brick or limestone, with one preference expressed for granite. Those named as giving unpredictable performance included wood, stucco, insulated panels, local stone and glass. Five owners definitely stated that solid brick walls were the best.

Where walls are made up of assembled panels in frame, unsatisfactory performance was blamed on failure of material in two instances. There were four instances of bad assembly workmanship. Temperature changes were blamed in six instances, and poor or inadequate design was the cause in four instances. One owner stated that unsatisfactory performance was due to poor caulking.

Windows (Not fixed)

Seventy-five percent of the respondents rated double-hung windows as "good." Only 10% gave double-hung windows an "unsatisfactory" rating. This clearly indicates that the double-hung window is by far the most popular type. The other types of sash listed were: bottom hinged vented, awning type vented, 90° pivoted, full pivoted, sliding vents, and casement sash. All except the casement sash had about an equal number of comments divided between "good" and "unsatisfactory." Twenty percent of the owners gave casement sash a rating of "good," while 40% rated casement sash as "unsatisfactory." The most popular window material was aluminum, although, surprisingly, wood rated very high in spite of its higher maintenance cost. Five owners stated that they preferred wood windows because of less condensation. Three owners stated that they would have no steel windows of any kind.

Four owners rated heat-absorbing glass as ineffective. Four owners stated that they thought tinted glass did a fair job, but these four plus one additional owner stated that it was too costly.

Interior Walls and Finishes

Over 90% of the owners gave a "good" rating to glazed structural tile and ceramic glazed tile walls. None rated these two types as "unsatisfactory." Seventy percent of the owners rated marble walls as "good," with only one "unsatisfactory" rating. Painted cinder block and painted gypsum plaster were rated "good" by about 65%, while about 12% gave these two types of walls an "unsatisfactory" rating. About 50% of the owners rated painted wallboard as "unsatisfactory," while 25% rated it "good." There were ten "good" ratings for plastic-covered plaster, but six owners rated this as "unsatisfactory." Two owners' comments rated glazed tile as the best wall material.

Sixty percent of the ratings for movable partitions stated that they were not practical, while 20% stated that they had proven satisfactory. The "unsatisfactory" ratings were based on too much cutting and refitting when a move is made. Five owners stated that their infrequent moves did not justify the added cost of movable partitions. Two owners found movable partitions satisfactory only if they were frequently changed.

Thirteen owners rated folding partitions as "satisfactory," while seven rated them as "unsatisfactory." Ten of these owners stated that they were unsatisfied with folding partitions because of sound transmission.

Floors

In resilient floor coverings, asphalt tile, vinyl tile, and asbestos vinyl tile were all given "satisfactory" performance ratings and acceptable maintenance costs on 50% of the questionnaires. Rubber tile and linoleum did not rate quite as high. Sheet rubber and sheet vinyl rated far below the foregoing types. Ten ratings of "outstanding service" were given for vinyl asbestos tile, and five for vinyl tile. Linoleum received four ratings of "outstanding service," and asphalt tile received three. Asphalt tile also received four "unsatisfactory" ratings, because owners said it indents under legs of furniture, etc. Cork received three "unsatisfactory" ratings because of difficulty and high cost of maintenance.

Quarry tile was rated as "satisfactory" for performance and maintenance on 70% of the questionnaires, and over 50% rated ceramic tile in the same category. Terrazzo received six very favorable ratings. Quarry tile and ceramic tile floors were rated "outstanding" on 40% of the questionnaires. Colored concrete received a rating of "outstanding" on about 10%, with the provision that, if the concrete was colored, the coloring should be mixed with the upper layer of finish, rather than attempting to trowel it into the surface.

"Unsatisfactory" rating for painted concrete floors was given on 50% of the questionnaires. All qualified the "unsatisfactory" rating by stating that the fault lies with the paint and not the concrete. The paint wears off too readily where it receives appreciable traffic, and therefore becomes unsightly and difficult to maintain.

Wood floors received an "unsatisfactory" rating on about 20% of the questionnaires for reason of difficulty and high cost of maintenance. In food preparation and serving areas, quarry tile was recommended on 90% of the questionnaires, ceramic tile on about 20%, and one or two "good" ratings were made for terrazzo and vinyl tile. Ease of washing and cleaning was the big factor for quarry tile, even though it was recommended on several questionnaires that the quarry tile be of the abrasive type.

In hard-use or service areas, such as maintenance shops, boiler rooms, etc., hardened concrete was recommended by 90% of the respondents. About 10% recommended quarry

tile if first cost was not a factor. Many owners again pointed out that the hardened concrete should have integral coloring, and not be painted. According to the questionnaires, most of the floor problems are directly due to the surfacing material rather than the subfloor. A few of the replies stated that failure occurred in both the surface materials and the subfloor. Improper adherence of the flooring material to the subfloor also was mentioned.

Ceilings

As a ceiling material, painted plaster received a rating of "very good" or "satisfactory" on about 70%of the questionnaires. Among acoustical ceiling materials, mineral tile received by far the most ratings of "best." The fireproof feature of the mineral tile was pointed out by most of the respondents. Perforated metal ceilings received a "best" rating on about 30% of the questionnaires, the reason being its ease of cleaning and resultant low maintenance cost. Two of the owners commented that acoustical plaster is too costly to maintain.

Where exposed structural slabs, joists, etc. are painted for ceilings, over 50% of the questionnaires gave this a "satisfactory" rating, as compared to 15% "unsatisfactory" ratings. Three replies pointed out that such ceilings were not good acoustically, and two stated that the unsatisfactory results were due to poor workmanship.

SPECIFIC RESULTS—MECHANICAL

Ninety percent of the owners contacted are generally satisfied with heating systems in structures built since World War II. Three stated that their central heating plants were highly satisfactory and efficient. However, 50% of the owners stated that there was need for improvement in temperature control systems. Several said that traps in steam lines should be improved for better operation and reduction of undue maintenance. Two stated that means should be developed for reducing rust damage.

About 85% of the respondents are satisfied with modern-day plumbing systems. Areas mentioned as needing improvement included: grease traps; water treatment systems; noise in flush valves and water closets; laboratory drainage systems; outmoded building codes for plumbing; soap-dispensing systems; leaky faucets.

Seventy-five percent of the owners prefer paper towels for hand drying in toilet rooms. The remainder were about equally divided between roll towels and electric dryers. It is noted that over 25% of the respondents said they would not have electric dryers.

About one-third of the owners prefer individual dispensers of liquid soap, and about the same number were equally divided between powder soap, bar soap, liquid lather and central liquid systems. This indicates the need for a better soap-dispensing system than is now available.

Owner comments on central air-cooling systems were limited to about 10% of the questionnaires, and therefore inconclusive. Two owners commented favorably on a chilled water dual duct system, and two commented favorable on a "dual unit" system, which may be what is commonly called the "dual duct system."

Thirty-five percent of the owners stated that fan and duct noises were excessive in ventilating systems, and should be reduced. Twenty-five percent noted that fan vibration

was objectionable, and about the same number commented that metal duct work, in general, should be improved upon through new materials, or coating or covering the bare metal.

SPECIFIC RESULTS—ELECTRICAL

About 50% of the questionnaires contained comments on optimum lighting intensity as follows:

Classrooms.....	40 foot-candles	Patient Bedrooms ...	15 foot-candles
Libraries.....	50-75 "	Corridors.....	10 "
Laboratories.....	100 "	Lounge Areas.....	35 "
Lecture Halls.....	30 "	Offices.....	50-70 "

Comments on lighting fixtures were varied and inconclusive, except that the impression is gathered that good fixtures (easy to lamp and maintain) are too costly.

Sixty percent of the owners stated that original electrical service facilities had proven inadequate, while only 12% found such facilities satisfactory. These comments applied to transformers, lighting and power panels, and the distribution system.

CONCLUSIONS

After tabulating the results of several questionnaires received from owners, it soon became apparent that the owners who exercised real care in filling them out were the exception rather than the rule. This suggests that further research might be done to find a better means of collecting data than questionnaires.

Workmanship is certainly a most important factor in any structure and, if the materials are not properly installed, the results will be bad. Therefore, it would seem that the Building Research Institute must do faster research aimed at improving workmanship, as well as improving materials.

After finishing the entire tabulation, a few facts stood out in the writer's opinion. As others may interpret this report, there may not be complete agreement, but it would seem to be in order to note the following impressions:

1) The roofing material manufacturers are doing a good job; their problems appear to be entirely a matter of workmanship. Copper or coated copper is outstanding as a flashing material. Good results with coated steel are the exception rather than the rule.

2) Too much care cannot be exercised in the installation of roof drainage systems. Gutters of all types are highly unsatisfactory in areas of the country where heavy snowfall takes place. Owners must understand that regular inspection and proper cleaning of roof drainage systems is essential. It is too late when a drain or a downspout becomes clogged.

3) If an owner insists on hard-surface roof deck areas, extreme care in the selection and installation of materials is essential. Movement due to temperature changes is most difficult to overcome, and all such surfaces should have the regular roofing felts properly mopped in underneath. It is significant that seven owners recommended the use of roof decks for any but the normal purpose of a roof be avoided.

4) Good masonry as an exterior wall rates very high with owners who maintain them and depend on them for weathertight performance. It is surprising that so few owners had comments on the new so-called "curtain walls." This would indicate that it will be several years before the good or bad features of such wall construction are known.

5) For institutional use, the window manufacturers should not overlook the popularity of the double-hung window.

6) Generally speaking, interior walls and finishes are doing a very good job except for painted wallboard partitions. This type apparently needs much improvement.

7) Modern floor materials are doing a very good job. It would appear that paint manufacturers still have to develop a product which is suitable for use on concrete. Quarry tile is outstanding in food preparation and serving areas, and hardened concrete is by far the most popular for hard-use service areas, e.g., shops, boiler rooms, etc.

8) Modern heating systems generally appear to be satisfactory, but should be further refined by better temperature control systems. Ample room for and accessibility of maintenance equipment and piping are essential. Plumbing systems, except for refinements, seem to be good. The most complaints are made in connection with noise, as is the case with ventilating systems. These noises include flush valves, water closets, fans, and movement of air in ductwork.

9) There apparently is a great need for a more satisfactory soap-dispensing method.

10) In setting up the electrical service facilities for structures, there is need for much more foresight and a better method of forecasting power and lighting loads than is presently being used.

The foregoing report does not touch upon one or two of the items which appeared in the questionnaires, because the results were inconclusive and almost impossible to interpret properly. It may be noted that, in some instances, the percentage of owners mentioned in the report would exceed one hundred. It should be borne in mind that some owners answered the questions about more than one material. This actually was the rule rather than the exception.

Appendix

SUMMARY OF NEEDS FOR FUTURE STUDY AND PROGRAMS REPORTED BY STUDY GROUP AT BRI 1960 SPRING CONFERENCES

The following conclusions resulting from study of the reports of the four subcommittees are presented here in the form of recommendations for consideration by the Building Research Institute as subjects for further study. It is recommended that whatever may be selected for study, be studied with the basic philosophy of trying to do more with what we have (or can get) to up-grade the total quality and at the same time maintain or reduce current levels of all costs involved.

Residential Buildings

1) Further study of the total subject of windows with particular reference to residential buildings.

2) Acoustical treatments of multifamily dwellings with emphasis on noise transmission between the individual family units.

3) Development of increased flexibility in wiring equipment and systems.

4) Study of heating and cooling systems for the single family dwellings. This should encompass all such essential factors as:

Central utility cores	Air supply
Insulation	Flexibility of capacities
Controls	Fuels, (including electric)
Vapor problems	Orientation
Air cleaning	

The objective here is high quality of the total system, properly integrated with all the mentioned factors, plus a minimum of divided responsibility to attain the objective. Representatives of labor should be part of a study of this subject.

5) Current techniques as well as some of those forecast indicate continued study of "joints." More simplicity in design, manufacture and installation details of the mechanical aspects of joints seems indicated. More consideration might be given the theory of "self-flashing." The key to the "joint" problem is fewer joints, particularly in exterior walls and roofs.

6) A report on the performance of prefinished materials for walls, floors and roofs, with particular emphasis on maintenance and service cost and the outlook for ultimate costs.

7) More study to reduce the number of pieces necessary to build a house; large components preclude combinations of various materials. The proper "combination" technique is the key to the foolproof large component. The study should start there and progress towards a total system or systems.

8) A graphically demonstrated study of the problems of drainage and the simple, common sense solutions that may be used. This would be a good subject for the use of models and might be reported photographically.

9) General workmanship, the methods employed and productivity thereof seem appropriate to group together. Men are going to be required to help us build our buildings whether on the site or in the factory, and their cooperation seems essential in either case. The sooner they are made to feel a more intimate part of the building team, the sooner we will see progress toward better total quality at no increase in cost. We suggest a preliminary discussion of how BRI might approach this general subject with such a person as John T. Dunlop of Harvard College, Chairman of the Construction Industry Joint Conference.

10) The kitchen is considered the most expensive room in a house or apartment, which seems to preclude an area susceptible to cost savings and retainment of quality. Many worthwhile studies have been made and are being continued, such as the Cornell Study and the activity of certain groups in the Department of Agriculture. We think the presentation of their methods of approach and some of the results would be a worthwhile program. Much has been done and the methods and results need better and wider distribution.

11) The concept of fewer kinds of materials incorporated in a structure seems worth exploration to the end of achieving higher total quality at no cost increase. This might re-establish the more basic principles of design which, in residential construction, is often lost or confused by overlapping functions, ill-matched relationships, unnecessary complications of material composure.

Residential construction as differentiated from large commercial construction has been basically subject to substitution and duplication. Quantity has replaced quality or simplicity. It is inevitable that a structure using five to 10 different materials with different coefficients of expansion, different structural qualities, etc., will multiply the aftermath problems related to maintenance.

There is no assurance that limiting the types of materials eliminates or reduces maintenance problems, however, it appears to reduce the different types of maintenance problems. The coefficient of expansion can be consistent, methods of juncture can be consistent, surface finish can be consistent.

Maintenance of surfaces then relegates itself to a simple educational method of understanding how to care for one material rather than caring for five materials, or however many might be involved.

12) Crowded conditions in equipment rooms and other accessibility problems were reported by apartment house operators. Inasmuch as this was a "common denominator" problem with most categories of buildings, resultant studies should include apartment buildings.

13) If and when appropriate, we recommend the creating of a subcommittee to study and report on the recent BRAB—FHA pilot study regarding house owners' problems.

14) A search and study of the currently available statistics about and related to housing, with particular reference to maintenance, repair and operation. The objective here would be to: (a) sift out what we have that are significant and study them for possible up-grading; (b) highlight what is, or could be, significant that is not available, with the objective of trying to find a way to have these statistics provided and maintained.

    This might include such topics as:

    (a) What we have and what we need.
    (b) Definition of terms.
    (c) Universal acceptance of definitions.
    (d) Objective, use and value of each statistic.
    (e) Maintenance and distribution.

Institutional Buildings

Materials and Equipment—

1) Eliminate noise and vibration in fans and ducts of ventilating and heating systems.

2) Eliminate noise in plumbing systems by improving flush valves, shower heads, water closets, pumps, etc.

3) Develop a substantial, low-cost, double-hung aluminum window.

4) Improve or develop new systems of dispensing hand soap or detergent in toilet rooms.

5) Improve wallboard type of partition to prevent puncturing and thus decrease cost of maintenance.

6) Improve applied (trowel or gun) type of acoustical coatings to simplify maintenance.

7) Develop a good-wearing, nonslip coating for concrete floors.

8) Improve sound absorption of folding partitions and doors.

Design and Construction—

9) Eliminate crowded conditions of mechanical and electrical prime service equipment.

10) Locate pipes, valves, pumps, small motors, fans, etc. so that they can be properly maintained and repaired.

11) Improve methods of forecasting future loads so that prime electrical service equipment for power and light can be properly sized.

12) Do not permit too much aesthetic consideration by architect to sacrifice practicability.

13) Allow sufficient time during design stage of the building.

14) Provide more and better technical supervision and coordination during construction.

Industrial Buildings

1) Research should be done to develop a complete packaged modular roof. In other words, a modular size roof slab which contains the structural element, insulation, acoustical treatment and permanent roof covering.

2) Modular wall panels should be developed which will eliminate the present maintenance problems. It seems wasteful to keep installing walls bit-by-bit, as we now do it.

3) We recommend that a future study group be assigned the problem of developing modular plumbing fixtures.

Commercial Office Buildings

1) Improve instrumentation for operation of buildings. Develop better information on optimum degree of consolidation of instruments in control centers.

2) Improve office building planning modules to permit efficient office layouts.

3) Improve window design so that emergency ventilation can be provided although windows are normally fixed.

4) Develop recommendations on the most suitable floor structures for commercial office buildings including consideration for increased future use of electronic equipment.

5) Analyze required capacity of freight elevators in relation to passenger service.

6) Investigate the durability of large, semi-exposed aggregate in cast concrete spandrels.

7) Reconsider the use of operating sash vs. fixed glass in relation to the need for ventilation in spring and fall.

8) Analyze the economic justification for double glazing in commercial office buildings and define the geographic zones where the use of such glazing is indicated.

9) Review the selection of size of windows with regard to structural safety and prevention of glass breaking out of sash as a result of negative pressures.

10) Evaluate the reaction of occupants of buildings to the use of glass of various colors.

11) Improve the materials used for window stools.

12) Evaluate the reliability of automatic movable louvers used as sunshading on the exterior of buildings.

13) Develop satisfactory fixed sunshading devices to reduce cooling operating costs.

14) Develop practical solutions to window cleaning in commercial office buildings. Scaffolding for exterior cleaning of fixed windows needs improvement and standardization. When scaffolding is used, some means must be developed for emergency exit for window washers.

15) Determine practical limitations of lighting intensity for office buildings.

16) Improve lighting fixtures.

17) Evaluate the relative advantages of distribution systems in suspended ceilings vs. under-floor duct systems.

18) Improve air conditioning and duct systems to achieve maximum flexibility of utilization in offices where movable partitions are used.

19) Find fire-resistant substitutes for plastered partitions.

20) Develop adjustable door bottoms to permit carpets to be installed or removed by tenants without requiring door replacement.

21) Improve the design of curtain wall buildings to prevent the formation and showering of icicles on pedestrians.

22) Develop practical window shades.

23) Improve methods of coloring sidewalks.

24) Improve ceramic surfaces.

25) Improve capacity of elevator service by development of techniques for using more than one cab in an elevator shaft to save floor space.

26) Improve corridor doors.

27) Develop satisfactory facilities for pre-sorting of mail.

28) Improve areawells with respect to maintenance.

29) Develop intercommunication systems for use by building operators.

30) Improve fire alarm systems and fire fighting equipment.

31) Evaluate central vs. individual soap-dispensing systems.

32) Improve roofing materials so they will better withstand traffic.

33) Improve elevator cab lighting.

34) Evaluate central control centers for light switching vs. individual light switches.

35) Improve the design of drive mechanisms for air-moving fans and air conditioning equipment installed out-of-doors to reduce maintenance problems with belts and pulleys.

36) Improve sleeves and seals on condensate pumps of air conditioning equipment.

37) Evaluate the use of a number of small compressors vs. large compressors to achieve spring and fall operating economy and prevent total breakdowns of systems.

38) Develop auxiliary pump systems or other methods to prevent breakdown of heating and cooling systems involving circulation of liquids at the perimeter of buildings.

39) Develop means of providing up to 100% fresh air in air-cooling and heating systems to provide comfortable conditions during the spring and fall.

40) Improve design of heating and cooling systems to provide for simultaneous requirement of heating and cooling at different sides of a building during the spring and fall.

41) Improve instrumentation and metering equipment on electrical service and water supply for air-conditioning equipment.

42) Evaluate the advantages of revolving doors vs. swinging doors, with or without the use of vestibules, with respect to both heating and cooling.

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METAL CURTAIN WALLS, 1955, 190 pages, illustrated, NAS—NRC Pub. No. 378, $4.00.

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